**3GPP TSG-RAN WG2 Meeting#123 *R2-230xxxx***

**Toulouse, France 21st – 25th August, 2023**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
|  |
|  | **38.321** | **CR** | **-** | **rev** | **-** | **Current version:** | **17.5.0** |  |
|  |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **x** | Radio Access Network | **x** | Core Network |  |

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|  |
| ***Title:***  | MAC running CR for eMBS |
|  |  |
| ***Source to WG:*** | Apple |
| ***Source to TSG:*** | R2 |
|  |  |
| ***Work item code:*** | NR\_MBS\_enh-Core |  | ***Date:*** | 2023-08-28 |
|  |  |  |  |  |
| ***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)* |
|  |  |
| ***Reason for change:*** | This CR introduces the enhancements specified on support of MBS in R18. |
|  |  |
| ***Summary of change:*** | Introduction of multicast reception for UEs in RRC\_INACTIVE and shared processing for simultaneous reception of broadcast and unicast.  |
|  |  |
| ***Consequences if not approved:*** | Rel-18 MBS enhancement is not supported in NR. |
|  |  |
| ***Clauses affected:*** | 5.3.1, 5.3.2.1, 5.3.2.2, 5.7b, 7.1 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **x** |  Other core specifications  | TS/TR ... CR ...  |
| ***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 DL-SCH data transfer

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.

Editor Note 1: whether to restrict the multicast MTCH in this section in RRC\_CONNECTED state is FFS.

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

1> 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

1> 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

1> 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; or

1> if 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

1> 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

1> 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

1> 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

1> if the HARQ process is equal to the broadcast process; or

1> if the HARQ process is associated with a transmission indicated with a MCCH-RNTI or a G-RNTI for MBS broadcast; or

1> if the HARQ process is associated with a transmission indicated with a multicast-MCCH-RNTI for MBS multicast; or

1> 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

1> 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

1> 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

1> 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 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];

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

1> if the PDCCH addressed to G-CS-RNTI indicates a DL multicast transmission and CS-RNTI is configured; or

1> 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;

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

Editor Note 1: FFS on whether DRX Command MAC CE is applicable for inactive multicast DRX operation.

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 applied in RRC\_INACTIVE:

4> start the *drx-HARQ-RTT-TimerDL-PTM* for the corresponding HARQ process when the the reception has not been successful.

Editor Note 2: FFS on the timepoint to start the drx-HARQ-RTT-TimerDL-PTM.

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).

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, SLCS-RNTI SL Semi-Persistent Scheduling V-RNTI, AI-RNTI, G-RNTI, G-CS-RNTI, and CG-SDT-CS-RNTI |
| FFF3–FFFB | Reserved |
| 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 |
| SLCS-RNTI | Configured scheduled sidelink transmission(activation, reactivation and retransmission) | SL-SCH | SCCH, STCH |
| SLCS-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. |

Editor Note: FFSon the value of the multicast-MCCH-RNTI.

Annex - RAN2 agreements on MBS enhancement in Rel-18

## RAN2#123 Agreements

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| Multicast reception in RRC\_INACTIVE * *Control Plane*

*#Resume due to bad quality and new resume cause(s)** For a UE receiving multicast in RRC\_INACTIVE, the UE resumes the RRC connection when the measured RSRP or RSRQ based on the existing measurement requirements (whichever is configured by the NW) of the serving cell becomes lower than the threshold configured by network. FFS whether/how we need to address ping-pong issue
* The threshold can be configured in PTM configuration per MBS session via RRCRelease or multicast MCCH message.
* Unless issues are identified with using one of existing resume causes, no new resume causes are introduced for UEs receiving MC in INACTIVE when they resume due to bad quality or lack of SIBx/PTM configuration

*#Frequency prioritization** Dedicated frequencies in RRCRelease can be used by the NW, as legacy
* FFS whether we need something more, e.g. frequency priorities in MCCH or a solution based on FSAI
* *User Plane*

*#Connected mode MRBs handling** NW indicates which multicast service can be received in INACTIVE in suspendConfig of RRC Release. FFS how exactly this is indicated
* Unless blocking issues are identified, UE behaviour is not to suspend corresponding multicast MRBs and to keep using them in INACTIVE

*# PDCP COUNT handling** For “non-synchronised“ cell (in terms of PDCP COUNT), upon cell reselection, UE sets the initial PDCP count of the MRB for the multicast reception in RRC\_INACTIVE state based on the same mechanism as R17 MBS broadcast.
* One cell can indicate "synchronized", if by implementation, it follows a common QoS flow to MRB mapping rule and at the same time PDCP COUNT is set according to the MBS QoS Flow SN.
* FFS how the UE is indicated about cells being synchronized (i.e. what information the NW needs to provide to the UE)
* Solutions which require COUNT broadcasting via MCCH are not considered

*# SPS support** SPS is not supported for multicast reception in RRC\_INACTIVE.

*# DRX handling** 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
 |
| Shared processing for MBS broadcast and Unicast reception* As per the previous agreement, if the UE is able to get the additional information (i.e. its current configuration does not prevent it from doing so), the UE shall do this (if capable and configured by the network)
* In case additional information (SCS, bandwidth) is not available at the time of sending the MII to the unicast serving cell (e.g. the UE is not able to read SIB1 from the non-serving cell), the UE reports whatever is available information at that time (i.e. at least the frequency, and optionally SCS and/or BW as available).
* UE reports updated MII after acquiring additional information from the non-serving cell (if previously it reported only frequency) or if the information in the non-serving cell changes.
* The SCS in the MII is set to the SCS of the CORESET#0 for the MBS broadcast cell.
* Combination of FreqBandIndicatorNR and ARFCN-ValueNR is used to signal the frequency information in the MII for shared processing.
* At least CFR bandwidth is reported by the UE in MII. FFS whether “location” needs to be also reported and how exactly this is captured in RRC (i.e. which IE is used).
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## RAN2#122 Agreements

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| Multicast reception in RRC\_INACTIVE * *Control Plane*
* The multicast MCCH configuration takes the broadcast MCCH configuration structure (i.e., mcch-Config-r17) as baseline.
* To notify the multicast MCCH change, change notification mechanism for Rel-17 broadcast MCCH is the baseline.
* Working assumption (to be confirmed by RAN1 via pending reply LS): One bit in the MCCH DCI is used to notify the change of the multicast MCCH. We reuse the bit used for MCCH change indication from Rel-17 MBS broadcast. This does not cover session deactivation which is FFS.
* It is not supported to provide the PTM configuration of intra-gNB neighbour cells in the dedicated signalling.
* For PTM configuration structure on the multicast MCCH, Rel-17 broadcast PTM configuration structure is taken as baseline.
* As a baseline, The PTM configuration in the RRCRelease message with suspendconfig has the same structure as the PTM configuration in multicast MCCH.
* FFS how existing MRBs are handled.
* Introduce a new indication per tmgi in the group paging which informs Rel-18 UEs having a valid PTM configuration to receive the multicast in RRC\_INACTIVE.
* MCCH is used for notifying MC session deactivation for multicast reception in RRC\_INACTIVE to enable Rel-18 UE to stay in RRC\_INACTIVE and stop monitoring corresponding G-RNTI.
* This is assumed to have no/minor impact on RAN1/PHY
 |
| Shared processing for MBS broadcast and Unicast reception* The granularity for capability of receiving MBS broadcast from a non-serving cell is at FeatureSetDownlinkPerCC level. This capability does not imply simultaneous reception on multiple CCs.
* No additional signalling is introduced to control information to be reported by the UE (on top of what we have already agreed).
* When sending MII, UE reports the whole information (i.e. at least frequency, bandwidth, SCS) when indicated by SIB1 of its unicast serving cell. FFS whether there are cases where this information is not available at the UE and what happens then.
* FFS if any special handling is needed when the non-serving cell updates the configuration (which is relevant for MII)
* No additional information is added to MII on top of what has been already agreed.
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## RAN2#121bis Agreements

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| Multicast reception in RRC\_INACTIVE * *Control plane*

*# service continuity scenarios in RRC\_INACTIVE** Similar to Rel-17 broadcast reception procedure, UE acquires new SIB and multicast MCCH to get PTM configuration after cell reselection.
* When a UE reselects to a cell for which PTM configuration is not available in multicast MCCH, the UE initiates RRC resumption procedure for an active multicast session it is interested to receive or continue receiving.
* UE may trigger RRC connection resumption if the reception quality of the multicast data is below a configured threshold, FFS how to specify the threshold/reception quality.

*# frequency prioritization & NCL** Frequency prioritization may be provided to the UE for cell reselection for multicast reception in RRC\_INACTIVE, detailed mechanism on how to identify the frequency info (e.g., SAI, USD, or frequency info directly provided by network) is FFS.
* No need to define a mechanism other than the frequency prioritization, i.e., per cell based prioritization in cell re-selection, to help UE choose the right cell to camp on.
* The neighbor cell list mechanism for multicast reception in RRC\_INACTIVE may be configured e.g. it can be used by UE to resume RRC connection if service is not available in the re-selected cell by NCL, without reading MCCH in the re-selected cell, in some aspects similar to Rel-17 NCL mechanism in MBS broadcast.

*# NCL notification on session state change or data availability* * A "special UE" identified by MBS assistance information from 5GC can be released to RRC\_INACTIVE (e.g., when the session is deactivated). FFS how can network enable such UE to resume to RRC\_CONNECTED upon session activation
* Rel-18 UE can stay in RRC\_INACTIVE and start monitoring corresponding G-RNTI upon an enhanced group paging (e.g., upon session activation or data transmission resumed). Details FFS.
* For one UE already in RRC\_INACTIVE, it can stay in RRC\_INACTIVE and stop monitoring corresponding G-RNTI upon events like session deactivation/temporary no data.
* FFS which option to take: enhanced group paging or enhanced MCCH, to enable Rel-18 UE to stay in RRC\_INACTIVE and stop monitoring corresponding G-RNTI upon events like session deactivation/temporary no data.
* No additional enhancement (with regard to enhancements made for ‘deactivation/temp no data’) is needed specifically for enabling UE to stay in RRC\_INACTIVE and stop monitoring corresponding G-RNTI upon session release.
* Legacy group paging (i.e., Rel-17 group paging) can be used to resume UE to RRC\_CONNECTED state.
* Upon events like session activation/data transmission resumed, if PTM configuration is not available to UE, UE initiates RRC connection resumption.
* UE-specific paging (i.e. PagingRecordList) can be used to move specific MBS multicast UE(s) to RRC\_CONNECTED (i.e. legacy UE behavior).
* When both enhanced group paging and unicast paging are received by the UE (and targeted for this UE), the UE follows unicast Paging and goes to RRC CONNECTED.
* *User plane*

*# CFR* * From the location&bandwidth and SCS configuration perspective,  follow R17 MBS broadcast CFR principle (i.e. case A,C,E) to provide multicast CFR configuration in RRC\_INACTIVE.
* Multicast CFR in RRC\_INACTIVE and broadcast CFR can be configured differently. FFS whether we need to restrict that one CFR is completely contained within the other in this case (we should understand what the issue is otherwise).
* Case B and case D are not supported for multicast CFR in RRC\_INACTIVE;
* Whether multicast CFR in RRC\_CONNECTED and in RRC\_INACTIVE are different is up to NW implementation. FFS whether this causes some issues which need to be addressed.
* The same CFR is used for multicast MCCH and MTCH. It can be revisited if there is any issue found, e.g. for RedCap UEs.

*# HARQ, Beam, DCI** HARQ feedback related information in the DCI is not needed or can be ignored for multicast transmission to RRC\_INACTIVE UE.
* The HARQ operation for multicast reception in RRC\_INACTIVE is same as the operation without HARQ feedback in RRC\_CONNECTED state.
* The multicast transmission RRC\_INACTIVE is performed via beam sweeping based on SSB index like broadcast MBS (i.e. beam information is not need in DCI.
* For MTCH, RAN2 assumes to reuse the same DCI format of R17 multicast (i.e. DCI format 4-1/4-2) for dynamic scheduling of multicast in RRC INACTIVE. RAN2 assumes for MCCH scheduling, DCI format 4-0 is used. We will ask RAN1 to confirm whether it is feasible and whether both 4-1 and 4-2 are needed.
* We will also indicate other relevant agreements to RAN1 (e.g. on beam sweeping etc.)

*# Others** 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).
* Postpone the UP discussion on L2 operation during RRC state transition until the signaling design of PTM configuration in RRCRelease message is concluded.
* Postpone the discussion on L2 operation during mobility to next RAN2 meeting.
* Including the following two issues in LS to RAN1:
	+ - * Issue 1: RAN1 to confirm RAN2 understanding that PDSCH aggregation is supported for multicast MTCH in RRC\_INACTIVE (as that is supported in Rel-17 multicast MTCH in RRC\_CONNECTED as well as broadcast MTCH).
			* Issue 2: RAN1 to check the feasibility of following Rel-17 CSS design for multicast MTCH and MCCH: 1) reusing the same CSS for multicast MTCH in RRC\_INACTIVE (same as multicast MTCH in RRC\_CONNECTED); 2) separate CSS for MCCH and MTCH.
* UE in RRC CONNECTED state is not required to read multicast MCCH to be able to receive multicast MBS service i.e. the UE receives the PTM configuration via dedicated signalling. This can be revisited if issues with service continuity are identified.
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## RAN2#121 Agreements

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| Multicast reception in RRC\_INACTIVE * *PTM configuration aspects and mobility*
* UE shall join in the multicast session before receiving multicast in RRC INACTIVE.
* If network finds it useful, the PTM configuration for the (single) serving cell can be configured to UE before the session activation, and UE stores the configuration. When session is activated, UE can receive multicast in INACTIVE state by applying the configuration without going back to RRC\_CONNECTED, if not updated by MCCH after being configured.
* When network configures UE to receive multicast in INACTIVE state, RRCRelease message with suspendconfig can be used to deliver the PTM configuration. Other dedicated RRC messages will not be used to provide PTM configuration for MBS multicast for INACTIVE.
* We introduce a new MCCH logical channel for multicast in INACTIVE (different from broadcast MCCH)
* Multicast MCCH configuration is provided via new SIB.
* Optionally, Multicast MCCH configuration for the serving cell can also be provided in dedicated signalling. Understanding is we are not optimizing mobility case because of this.
* Serving cell will not provide the PTM configuration of neighbour cells from other gNBs.
* FFS whether the network can provide PTM configuration for intra-gNB cells.
 |
| Shared processing for MBS broadcast and Unicast reception* Indicate the capability of receiving MBS broadcast from a non-serving cell. FFS whether the granularity is at FeatureSetDownlink or FeatureSetDownlinkPerCC level.
* FFS Whether to include additional information in MII can be controlled by the network. Should consider whether this would be two-step procedure or one-step procedure (e.g. having more info in SIB1)
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## RAN2#120 Agreements

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| Multicast reception in RRC\_INACTIVE* *PTM configuration and PTM reconifguration during mobility*
* We will have a mixed approach and we start with the following:
	+ 1. When NW configures UE to continue the multicast reception in INACTIVE state, NW provides the PTM configuration for the activated multicast session via the RRC dedicated signalling, at least for the serving cell (FFS other cases).
		2. MCCH is used in case there is a need to indicate a PTM configuration in case there is a need for change in PTM config or during mobility beyond serving cell / gNB. FFS session status change and other indications.
		3. We assume that the UE can only receive multicast service after it joined the session.
		4. FFS whether MCCH configuration is initially provided to the UE via dedicated signalling.
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## RAN2#119bis Agreements

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| Multicast reception in RRC\_INACTIVE* The following general description is taken as baseline for PTM configuration delivery Option 1:

(1-a) PTM configuration(s) (i.e., configurations used for multicast reception in RRC\_INACTIVE) of one or more multicast sessions for at least one cell are provided via dedicated RRC signaling to a UE. (1-b) The RRC message for this includes RRCReconfiguration and/or RRCRelease and/or RRCResume (details FFS)(1-c) UE stores the received configurations while it is in RRC\_INACTIVE, and if there is a need to update some or all the configurations, the UE is notified of such changes and may trigger RRC connection resume to obtain the updated configurations. In case of mobility in RRC\_INACTIVE, the UE triggers RRC connection resume if the configuration of the session is not available for the new cell.* The following general description is taken as baseline for PTM configuration delivery Option 2:

(2-a) PTM configurations (i.e., configurations used for multicast reception in RRC\_INACTIVE) are provided via an MCCH-like channel (same or different as used for MBS broadcast), and information regarding MCCH scheduling is provided via SIB, FFS dedicated signalling(2-b) UE can receive such configurations when it is in RRC\_INACTIVE, FFS whether it is allowed/needed to also receive when UE is in RRC\_CONNECTED(2-c) If there is a need to update some or all the received configurations, UE does not need to resume RRC connection but is notified of such changes (e.g. via MCCH DCI) and obtains the updated configurations via MCCH.* Dedicated RRC signalling (i.e. RRC release message with suspendConfig) is used for switching a multicast receiving UE from RRC\_CONNECTED to RRC\_INACTIVE and continue multicast reception (details FFS).
* For both option 1 and option 2, as a baseline, group paging can be used to switch UEs receiving multicast from RRC\_INACTIVE to RRC\_CONNECTED, and UEs continue the multicast reception in CONNECTED. FFS if there is any potential issue if Rel-17 group paging is reused. FFS if there are other cases when UE triggers resume. FFS if MCCH can also be used in case of option 2.
* Rel-18 UE in INACTIVE can be informed when the session is activated (Details FFS).
* As a baseline, group paging can be used to inform Rel-18 UE(s) about the session activation (Details FFS, e.g., UE behavior when receiving such group notification).
* If a UE is in RRC\_INACTIVE and is configured to receive a multicast session in RRC\_INACTIVE, the UE may be notified when the multicast session is deactivated. FFS how (e.g., informed via group paging, MCCH, or other ways).
* Rel-17 mechanism (NAS-based indication) is applicable for multicast session release. FFS if any enhancement is needed.
* FFS how UE determines whether it can receive the multicast session in RRC\_INACTIVE or not when the session is activated, taking into account the following solutions (can further update the descriptions if needed, and several solutions may be needed, some solutions may apply only for certain configuration options)

1. When the multicast session is activated, UE can receive the multicast session in RRC\_INACTIVE if the PTM configuration used in RRC\_INACTIVE for the session is available to the UE and the UE has joined the session already (e.g., configuration provided to UE via dedicated RRC signaling or via MCCH), otherwise it goes back to RRC\_CONNECTED to receive the multicast session. 2. When the multicast session is activated, UE is indicated by group paging whether it can receive the multicast session in RRC\_INACTIVE or not (detailed signaling FFS).3. UE is configured "whether it can receive the multicast session in RRC\_INACTIVE" by dedicated signaling before UE is released. When the multicast session is activated, UE stays in RRC\_INACTIVE or resumes RRC connection accordingly (detailed signaling FFS).* If option 1 is supported for PTM configuration

As a baseline, group paging may be used to inform the UE when network changes the PTM configurations, and UE upon reception triggers RRC connection resume procedure to obtain the updated configurations (details of group paging can be FFS).FFS whether and how to solve the issue in signalling/system load when a large number of UEs in the cell need PTM configuration update.* FFS if there is an issue that a UE can obtain all the PTM configurations for a multicast service via Option 2 without/before joining the multicast session on the condition that security is enabled by service layer. And if yes FFS how to solve the issue (e.g., dedicated configuration + MCCH).
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| Shared processing for MBS broadcast and Unicast reception* For shared processing we adopt the following as a baseline:

1) new IE is added in system information to control whether MBSInterestIndication for shared processing can be sent or not; 2) MBSInterestIndication message content and related procedure is updated for shared processing.* New IE to control whether MBSInterestIndication for shared processing can be sent or not is added to SIB1.
* In MBSInterestIndication, for a broadcast service that the UE is receiving or is interested to receive, at least the following information can be signalled: broadcast frequency, subcarrier spacing, and bandwidth. FFS details/exact parameters and other information. FFS in which scenarios the UE reports this information (e.g. intra-PLMN case, inter-PLMN case)
* FFS whether UE capability is needed to enable shared processing.
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## RAN2#119 Agreements

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| Multicast reception in RRC\_INACTIVE* *General assumptions, scenarios*
* In Rel-18, multicast reception for UEs in INACTIVE supports at least the following scenarios, with the assumption that the UE already has a valid PTM configuration:

- Scenario 1: a UE has been receiving multicast in CONNECTED, and it enters INACTIVE and continues the multicast reception.- Scenario 2: a UE has joined a multicast session and has been directed to INACTIVE, the UE starts to receive the multicast session FFS for state changes, e.g. due to service being not provided in INACTIVE anymore etc.* It is up to gNB to decide whether a multicast session may be received by UE(s) in INACTIVE. FFS what information gNB may be provided to form such decision (related to SA2 discussion).
* It is supported that gNB transmit one multicast session to both UEs in CONNECTED and INACTIVE in the same cell. FFS how the gNB configures this.
* It is assumed the network can choose which UEs receive in RRC INACTIVE and which in RRC Connected and can move UEs between the states for Multicast service reception.
* The following is taken as baseline: we assume the same PDCCH/PDSCH resources (e.g. resources used for MTCH) can be used for all UEs (including UEs in CONNECTED and/or INACTIVE states) for receiving the same multicast session. Different configuration/resources are not precluded as well. FFS what exactly can be common and what not (e.g. HARQ, SPS etc.) and what is needed in addition (to legacy PTM config).
* *PTM configuration for RRC\_INACTIVE*
* For PTM configuration delivery, RAN2 further investigates the following solutions:

Option 1: Dedicated signallingOption 2: Solution based on SIB+MCCHWe do not preclude some “mix” of the options* HARQ feedback and PTP are not supported for multicast reception in RRC\_INACTIVE.
* *Mobility support*
* Multicast service continuity after cell reselection in RRC\_INACTIVE state (i.e. without resuming RRC connection) will be supported (if the configuration of the new cell is available for the UE). FFS whether there are cases where the UE needs to resume the connection. FFS RAN3 impacts due to inter-gNB mobility.
* Upon cell reselection to neighbour cells during active multicast session, if the configuration of the session is not available for the new cell for UEs in INACTIVE, then the UE is required to resume RRC connection to get the Multicast MRB configuration.
 |
| Shared processing for MBS broadcast and Unicast reception* RAN2 focuses on solutions taking multi-Rx UEs (i.e. no specific enhancements for 1Rx UEs).
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