**3GPP TSG-RAN WG1 Meeting #107-e *R1-211xxxx***

**e-Meeting, November 11–19, 2021**

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| *CR-Form-v12.1* | | | | | | | | |
| **Draft CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **38.212** | **CR** |  | **rev** | **-** | **Current version:** | **16.7.0** |  |
|  | | | | | | | | |
| *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:*** | Introduction of NR Multicast and Broadcast Services | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Huawei | | | | | | | | | |
| ***Source to TSG:*** | R1 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_MBS | | | | |  | ***Date:*** | | | 2021-11-29 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-17 |
|  | *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-15 (Release 15) Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | Inclusion of Rel-17 NR Multicast and Broadcast Services | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Support of Rel-17 NR Multicast and Broadcast Services:   1. Section 3.3: Add abbreviation for MBS 2. Section 5.4.2.1: Update to support limited buffer rate matching for multicast and broadcast. 3. Section 7.3.1.5 & 7.3.1.5.1 & 7.3.1.5.2: Define DCI formats for scheduling of MBS | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | NR Multicast and Broadcast Services in Rel-17 will be incomplete | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 3.3, 5.4.2.1, 7.3.1, 7.3.1.5(new), 7.3.1.5.1(new), 7.3.1.5.2(new), 7.3.1.5.3(new) | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | | **X** |  | Other core specifications | | | | TS 38.211, TS 38.213, TS 38.214 | | |
| ***affected:*** | |  | **X** | Test specifications | | | |  | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | |  | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

## 3.3 Abbreviations

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

BCH Broadcast channel

CBG Code block group

CBGTI Code block group transmission information

CG Configured grant

CG-DFI CG downlink feedback information

CG-UCI CG uplink control information

CORESET Control resource set

COT Channel occupancy time

CQI Channel quality indicator

CRC Cyclic redundancy check

CRI CSI-RS resource indicator

CSI Channel state information

CSI-RS CSI reference signal

DAI Downlink assignment index

DCI Downlink control information

DL Downlink

DL-SCH Downlink shared channel

DMRS Dedicated demodulation reference signal

HARQ Hybrid automatic repeat request

HARQ-ACK Hybrid automatic repeat request acknowledgement

LDPC Low density parity check

LI Layer indicator

MBS Multicast broadcast services

MCS Modulation and coding scheme

OFDM Orthogonal frequency division multiplex

PBCH Physical broadcast channel

PCH Paging channel

PDCCH Physical downlink control channel

PDSCH Physical downlink shared channel

PMI Precoding matrix indicator

PRB Physical resource block

PRACH Physical random access channel

PSBCH Physical sidelink broadcast channel

PSCCH Physical sidelink control channel

PSFCH Physical sidelink feedback channel

PSSCH Physical sidelink shared channel

PTRS Phase-tracking reference signal

PUCCH Physical uplink control channel

PUSCH Physical uplink shared channel

RACH Random access channel

RI Rank indicator

RSRP Reference signal received power

SCI Sidelink control information

SFCI Sidelink feedback control information

SFN System frame number

SL Sidelink

SL-BCH Sidelink broadcast channel

SL-SCH Sidelink shared channel

SR Scheduling request

SRS Sounding reference signal

SS Synchronisation signal

SUL Supplementary uplink

TPC Transmit power control

TrCH Transport channel

UCI Uplink control information

UE User equipment

UL Uplink

UL-SCH Uplink shared channel

VRB Virtual resource block

ZP CSI-RS Zero power CSI-RS

< Unchanged parts are omitted >

5.4.2 Rate matching for LDPC code

The rate matching for LDPC code is defined per coded block and consists of bit selection and bit interleaving. The input bit sequence to rate matching is . The output bit sequence after rate matching is denoted as .

5.4.2.1 Bit selection

The bit sequence after encoding  from Clause 5.3.2 is written into a circular buffer of length  for the -th coded block, where  is defined in Clause 5.3.2.

For the -th code block, let  if  and  otherwise, where, ,  is determined according to Clause 6.1.4.2 in [6, TS 38.214] for UL-SCH and Clause 5.1.3.2 in [6, TS 38.214] for DL-SCH/PCH, assuming the following:

For one TB for DL-SCH with PDSCH scheduled by DCI format 4\_0/4\_1/4\_2,

- if the PDSCH is scheduled by DCI format 4\_1/4\_2,

- maximum number of layers is given by X, where

- if the higher layer parameter *maxMIMO-Layers-Multicast* of *PDSCH-Config-Multicast* is configured*,* X is given by that parameter;

- Otherwise, X equals to 1;

- if the higher layer parameter *mcs-Table* given bya *PDSCH-Config-Multicast* for at least one CFR is set to 'qam256', maximum modulation orderis assumed for DL-SCH; otherwise a maximum modulation orderis assumed for DL-SCH;

- if the PDSCH is scheduled by DCI format 4\_0,

- maximum number of layers is 1;

- if the higher layer parameter *mcs-Table* given by a *PDSCH-Config-MCCH* is set to 'qam256', maximum modulation order is assumed for DL-SCH; otherwise a maximum modulation order is assumed for DL-SCH;

- if the higher layer parameter *mcs-Table* given by a *PDSCH-Config-MTCH* is set to 'qam256', maximum modulation orderis assumed for DL-SCH; otherwise a maximum modulation order is assumed for DL-SCH;

- is given by Table 5.4.2.1-1, where the value of for DL-SCH is determined according to the size of the CFR if only one CFR is configured to the UE;

- maximum coding rate of 948/1024;

- ;

- is the number of code blocks of the transport block determined according to Clause 5.2.2.

For one TB for UL-SCH, or for one TB for DL-SCH/PCH except for DL-SCH with PDSCH scheduled by DCI format 4-0/4\_1/4\_2,

- maximum number of layers for one TB for UL-SCH is given by X, where

- if the higher layer parameter *maxMIMO-Layers* of *PUSCH-ServingCellConfig* of the serving cell is configured, X is given by that parameter

- elseif the higher layer parameter *maxRank* of *pusch-Config* of the serving cell is configured, X is given by the maximum value of *maxRank* across all BWPs of the serving cell

- otherwise, X is given by the maximum number of layers for PUSCH supported by the UE for the serving cell

- maximum number of layers for one TB for DL-SCH/PCH is given by the minimum of X and 4, where

- if the higher layer parameter *maxMIMO-Layers* of *PDSCH-ServingCellConfig* of the serving cell is configured, X is given by that parameter

- otherwise, X is given by the maximum number of layers for PDSCH supported by the UE for the serving cell

- if the higher layer parameter *mcs-Table* or *mcs-TableDCI-1-2* given by a *pdsch-Config* for at least one DL BWP of the serving cell is set to 'qam256', maximum modulation order  is assumed for DL-SCH; otherwise a maximum modulation order  is assumed for DL-SCH;

- if the higher layer parameter *mcs-Table* or *mcs-TableTransformPrecoder* or *mcs-TableDCI-0-2* or *mcs-TableTransformPrecoderDCI-0-2* given by a *pusch-Config* or the higher layer parameter *mcs-Table* or *mcs-TableTransformPrecoder* given by *configuredGrantConfig* for at least one UL BWP of the serving cell is set to 'qam256', maximum modulation order  is assumed for UL-SCH; otherwise a maximum modulation order  is assumed for UL-SCH

- maximum coding rate of 948/1024;

-  is given by Table 5.4.2.1-1, where the value of  for DL-SCH is determined according to the initial downlink bandwidth part if there is no other downlink bandwidth part configured to the UE;

- ;

-  is the number of code blocks of the transport block determined according to Clause 5.2.2.

**Table 5.4.2.1-1: Value of **

|  |  |
| --- | --- |
| Maximum number of PRBs across all configured DL BWPs and UL BWPs of a carrier for DL-SCH and UL-SCH, respectively,  or  Maximum number of PRBs across all CFRs of a carrier for DL-SCH with PDSCH scheduled by DCI format 4\_1/4\_2 |  |
| Less than 33 | 32 |
| 33 to 66 | 66 |
| 67 to 107 | 107 |
| 108 to 135 | 135 |
| 136 to 162 | 162 |
| 163 to 217 | 217 |
| Larger than 217 | 273 |

Denoting by  the rate matching output sequence length for the -th coded block, where the value of  is determined as follows:

Set 

for  to 

if the -th coded block is not scheduled for transmission as indicated by CBGTI according to Clause 5.1.7.2 for DL-SCH and 6.1.5.2 for UL-SCH in [6, TS 38.214]

;

else

if 

;

else

;

end if

;

end if

end for

where

-  is the number of transmission layers that the transport block is mapped onto;

-  is the modulation order;

-  is the total number of coded bits available for transmission of the transport block;

-  if CBGTI is not present in the DCI scheduling the transport block and  is the number of scheduled code blocks of the transport block if CBGTI is present in the DCI scheduling the transport block.

Denote by  the redundancy version number for this transmission (= 0, 1, 2 or 3), the rate matching output bit sequence , , is generated as follows, where  is given by Table 5.4.2.1-2 according to the value of  and LDPC base graph:

;

;

while 

if 

;

;

end if

;

end while

**Table 5.4.2.1-2: Starting position of different redundancy versions, **

|  |  |  |
| --- | --- | --- |
|  |  | |
| LDPC base graph 1 | LDPC base graph 2 |
| 0 |  |  |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |

< Unchanged parts are omitted >

### 7.3.1 DCI formats

The DCI formats defined in table 7.3.1-1 are supported.

Table 7.3.1-1: DCI formats

|  |  |
| --- | --- |
| **DCI format** | **Usage** |
| 0\_0 | Scheduling of PUSCH in one cell |
| 0\_1 | Scheduling of one or multiple PUSCH in one cell, or indicating downlink feedback information for configured grant PUSCH (CG-DFI) |
| 0\_2 | Scheduling of PUSCH in one cell |
| 1\_0 | Scheduling of PDSCH in one cell |
| 1\_1 | Scheduling of PDSCH in one cell, and/or triggering one shot HARQ-ACK codebook feedback |
| 1\_2 | Scheduling of PDSCH in one cell |
| 2\_0 | Notifying a group of UEs of the slot format, available RB sets, COT duration and search space set group switching |
| 2\_1 | Notifying a group of UEs of the PRB(s) and OFDM symbol(s) where UE may assume no transmission is intended for the UE |
| 2\_2 | Transmission of TPC commands for PUCCH and PUSCH |
| 2\_3 | Transmission of a group of TPC commands for SRS transmissions by one or more UEs |
| 2\_4 | Notifying a group of UEs of the PRB(s) and OFDM symbol(s) where UE cancels the corresponding UL transmission from the UE |
| 2\_5 | Notifying the availability of soft resources as defined in Clause 9.3.1 of [10, TS 38.473] |
| 2\_6 | Notifying the power saving information outside DRX Active Time for one or more UEs |
| 3\_0 | Scheduling of NR sidelink in one cell |
| 3\_1 | Scheduling of LTE sidelink in one cell |
| 4\_0 | Schedulng of PDSCH with CRC scrambled by MCCH-RNTI/G-RNTI for broadcast |
| 4\_1 | Schedulng of PDSCH with CRC scrambled by G-RNTI/G-CS-RNTI for multicast |
| 4\_2 | Schedulng of PDSCH with CRC scrambled by G-RNTI/G-CS-RNTI for multicast |

The fields defined in the DCI formats below are mapped to the information bits  to  as follows.

Each field is mapped in the order in which it appears in the description, including the zero-padding bit(s), if any, with the first field mapped to the lowest order information bit  and each successive field mapped to higher order information bits. The most significant bit of each field is mapped to the lowest order information bit for that field, e.g. the most significant bit of the first field is mapped to .

If the number of information bits in a DCI format is less than 12 bits, zeros shall be appended to the DCI format until the payload size equals 12.

The size of each DCI format is determined by the configuration of the corresponding active bandwidth part of the scheduled cell and shall be adjusted as described in clause 7.3.1.0 if necessary.

If a UE is configured with *pdsch-HARQ-ACK-CodebookList-r16*, *pdsch-HARQ-ACK-Codebook* is replaced by the relevant entry in *pdsch-HARQ-ACK-CodebookList-r16* in this clause.

< Unchanged parts are omitted >

#### 7.3.1.5 DCI formats for scheduling of MBS

##### 7.3.1.5.1 Format 4\_0

DCI format 4\_0 is used for the scheduling of PDSCH for broadcast in DL cell.

The following information is transmitted by means of the DCI format 4\_0 with CRC scrambled by MCCH-RNTI or G-RNTI configured by *MBS-SessionInfo*:

- Frequency domain resource assignment – bits where equals to as given by clause 7.3.1.0

- Time domain resource assignment – 4 bits as defined in Clause 5.1.2.1 of [6, TS38.214]

- VRB-to-PRB mapping – 1 bit according to Table 7.3.1.2.2-5

- Modulation and coding scheme – 5 bits as defined in Clause 5.1.3 of [6, TS38.214]

- Redundancy version – 2 bits as defined in Table 7.3.1.1.1-2

- MCCH change notification – 2 bits as defined in Clause x.x.x of [8, TS38.321] if the CRC of the DCI format 4\_0 is scrambled by MCCH-RNTI. Otherwise, this bit field is reserved.

- Padding bits, if required

Zeros shall be appended to DCI format 4\_0 until the payload size equals that of DCI format 1\_0 monitored in common search space in the same serving cell.

##### 7.3.1.5.2 Format 4\_1

DCI format 4\_1 is used for the scheduling of PDSCH for multicast in DL cell.

The following information is transmitted by means of the DCI format 4\_1 with CRC scrambled by G-RNTI configured by *G-RNTI-Config* or G-CS-RNTI:

- Frequency domain resource assignment – bits where equals to as given by clause 7.3.1.0

- Time domain resource assignment – 4 bits as defined in Clause 5.1.2.1 of [6, TS38.214]

- VRB-to-PRB mapping – 1 bit according to Table 7.3.1.2.2-5

- Modulation and coding scheme – 5 bits as defined in Clause 5.1.3 of [6, TS38.214]

- New data indicator – 1 bit

- Redundancy version – 2 bits as defined in Table 7.3.1.1.1-2

- HARQ process number – 4 bits

- Downlink assignment index – 2 bits as defined in Clause 9.1.3 of [5, TS 38.213], as counter DAI

- PUCCH resource indicator – 3 bits as defined in Clause 9.2.3 of [5, TS38.213]

- PDSCH-to-HARQ\_feedback timing indicator – 3 bits as defined in Clause 9.2.3 of [5, TS38.213]

- Reserved bits – 3 bits

- Padding bits, if required

Zeros shall be appended to DCI format 4\_1 until the payload size equals that of DCI format 1\_0 monitored in common search space in the same serving cell.

##### 7.3.1.5.3 Format 4\_2

DCI format 4\_2 is used for the scheduling of PDSCH in DL cell.

The following information is transmitted by means of the DCI format 4\_2 with CRC scrambled by G-RNTI configured by *G-RNTI-Config* or G-CS-RNTI:

- Frequency domain resource assignment – number of bits determined by the following, where is the size of the common frequency resource as configured by higher layer parameter *locationAndBandwidth-Multicast*:

- bits if only resource allocation type 0 is configured, where is defined in Clause 5.1.2.2.1 of [6, TS38.214],

- bits if only resource allocation type 1 is configured, or

- bits if *resourceAllocation* in *PDSCH-Config-Multicast* is configured as '*dynamicSwitch'*.

- If *resourceAllocation* in *PDSCH-Config-Multicast* is configured as '*dynamicSwitch'*, the MSB bit is used to indicate resource allocation type 0 or resource allocation type 1, where the bit value of 0 indicates resource allocation type 0 and the bit value of 1 indicates resource allocation type 1.

- For resource allocation type 0, the LSBs provide the resource allocation as defined in Clause 5.1.2.2.1 of [6, TS 38.214].

- For resource allocation type 1, the LSBs provide the resource allocation as defined in Clause 5.1.2.2.2 of [6, TS 38.214]

- Time domain resource assignment – 0, 1, 2, 3, or 4 bits as defined in Clause 5.1.2.1 of [6, TS 38.214]. The bitwidth for this field is determined as bits, where *I* is the number of entries in the higher layer parameter *pdsch-TimeDomainAllocationList* if the higher layer parameter is configured; otherwise *I* is the number of entries in the default table.

- VRB-to-PRB mapping – 0 or 1 bit:

- 0 bit if only resource allocation type 0 is configured or if *vrb-ToPRB-Interleaver* in *PDSCH-Config-Multicast* is not configured;

- 1 bit according to Table 7.3.1.2.2-5 otherwise, only applicable to resource allocation type 1, as defined in Clause 7.3.1.6 of [4, TS 38.211].

- PRB bundling size indicator – 0 bit if the higher layer parameter *prb-BundlingType* is not configured in *PDSCH-Config-Multicast* or is set to 'staticBundling', or 1 bit if the higher layer parameter *prb-BundlingType* in *PDSCH-Config-Multicast* is set to 'dynamicBundling' according to Clause 5.1.2.3 of [6, TS 38.214].

- Rate matching indicator – 0, 1, or 2 bits according to higher layer parameters *rateMatchPatternGroup1* and *rateMatchPatternGroup2* in *PDSCH-Config-Multicast*, where the MSB is used to indicate *rateMatchPatternGroup1* and the LSB is used to indicate *rateMatchPatternGroup2* when there are two groups.

For transport block 1:

- Modulation and coding scheme – 5 bits as defined in Clause 5.1.3.1 of [6, TS 38.214]

- New data indicator – 1 bit

- Redundancy version – 2 bits as defined in Table 7.3.1.1.1-2

- HARQ process number – 4 bits

- Downlink assignment index – number of bits as defined in the following

- 4 bits if more than one serving cell are configured in the DL for multicast and the higher layer parameter *pdsch-HARQ-ACK-Codebook-Multicast=dynamic*, where the 2 MSB bits are the counter DAI and the 2 LSB bits are the total DAI;

- 2 bits if only one serving cell is configured in the DL for multicast and the higher layer parameter *pdsch-HARQ-ACK-Codebook-Multicast=dynamic*, where the 2 bits are the counter DAI;

- 0 bits otherwise.

If the UE is configured with a PUCCH-SCell, the number of serving cells is determined within a PUCCH group.

If the UE is configured with a PUCCH-SCell, *pdsch-HARQ-ACK-Codebook* is replaced by *pdsch-HARQ-ACK-Codebook-secondaryPUCCHgroup-r16* if present for the secondary PUCCH group.

If higher layer parameter *priorityIndicatorDCI-1-1* is configured in *PDSCH-Config-Multicast*, if the bit width of the Downlink assignment index in DCI format 1\_1 for one HARQ-ACK codebook is not equal to that of the Downlink assignment index in DCI format 1\_1 for the other HARQ-ACK codebook, a number of most significant bits with value set to '0' are inserted to smaller Downlink assignment index until the bit width of the Downlink assignment index in DCI format 1\_1 for the two HARQ-ACK codebooks are the same.

- PUCCH resource indicator – 3 bits as defined in Clause 9.2.3 of [5, TS 38.213]

- PDSCH-to-HARQ\_feedback timing indicator – 0, 1, 2, or 3 bits as defined in Clause 9.2.3 of [5, TS 38.213]. The bitwidth for this field is determined as bits, where *I* is the number of entries in the higher layer parameter *dl-DataToUL-ACK* in *PUCCH-Config-Multicast1* if configured or *PUCCH-Config-Multicast2* if configured; otherwise, *I* is the number of entries in the higher layer parameter *dl-DataToUL-ACK* in *PUCCH-Config.*

If higher layer parameter *priorityIndicatorDCI-1-1* is configured in *PDSCH-Config-Multicast*, if the bit width of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 1\_1 for one HARQ-ACK codebook is not equal to that of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 1\_1 for the other HARQ-ACK codebook, a number of most significant bits with value set to '0' are inserted to smaller PDSCH-to-HARQ\_feedback timing indicator until the bit width of the PDSCH-to-HARQ\_feedback timing indicator in DCI format 1\_1 for the two HARQ-ACK codebooks are the same.

- Antenna port(s) – 4, 5, or 6 bits as defined by Tables 7.3.1.2.2-1/2/3/4, where the number of CDM groups without data of values 1, 2, and 3 refers to CDM groups {0}, {0,1}, and {0, 1,2} respectively. The antenna ports shall be determined according to the ordering of DMRS port(s) given by Tables 7.3.1.2.2-1/2/3/4.

If a UE is configured with both *dmrs-DownlinkForPDSCH-MappingTypeA* and *dmrs-DownlinkForPDSCH-MappingTypeB*, the bitwidth of this field equals , where is the "Antenna ports" bitwidth derived according to *dmrs-DownlinkForPDSCH-MappingTypeA* and is the "Antenna ports" bitwidthderived according to *dmrs-DownlinkForPDSCH-MappingTypeB*. A number of zeros are padded in the MSB of this field, if the mapping type of the PDSCH corresponds to the smaller value of and .

- Transmission configuration indication – 0 bit if higher layer parameter *tci-PresentInDCI* in *PDCCH-Config-Multicast* is not enabled; otherwise 3 bits as defined in Clause 5.1.5 of [6, TS38.214].

- DMRS sequence initialization – 1 bit.

- Priority indicator – 0 bit if higher layer parameter *priorityIndicatorDCI-1-1* is not configured in *PDSCH-Config-Multicast*; otherwise 1 bit as defined in Clause 9 in [5, TS 38.213].

- Enabling/disabling HARQ-ACK feedback indication –1 bit if higher layer parameter *harq-FeedbackEnabler-Multicast* indicates *dci-enabler*; 0 bit, otherwise.

< Unchanged parts are omitted >