**3GPP TSG-RAN WG2 Meeting #117-e R2-22xxxxx**

**E-meeting, 21 February – 03 March 2022**

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| *CR-Form-v11.4* |
| **CHANGE REQUEST** |
|  |
|  | **38.321** | **CR** |  **1171** | **rev** | **5** | **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:***  | Running CR to 38.321 on Integrated Access and Backhaul for NR Rel-17 |
|  |  |
| ***Source to WG:*** | Samsung |
| ***Source to TSG:*** | R2 |
|  |  |
| ***Work item code:*** | NR\_IAB\_enh-Core |  | ***Date:*** | 2022-03-01 |
|  |  |  |  |  |
| ***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 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-12 (Release 12)**Rel-13 (Release 13)Rel-14 (Release 14)Rel-15 (Release 15)Rel-16 (Release 16)* |
|  |  |
| ***Reason for change:*** | Ensure support for IAB by making necessary changes to the NR MAC specification. |
|  |  |
| ***Summary of change:*** | (Rev 0)* LCG space extension introduced

(Rev 1)* Agreements from RAN2#116-e implemented.

(Rev 2)* Revisions made based on Rev1 and discussion [AT116bis-e][050][eIAB] during RAN2#116bis-e.

(Rev 3)* Revisions made based on agreements made in [AT116bis-e][050][eIAB] as captured in Chair’s notes, using the version endorsed in R2-2201850 as baseline, and further discussions in [Post116bis-e][077][eIAB].

(Rev 4)* Revisions made by the rapporteur in preparation for RAN2#117-e, to resolve the following EN: “Editors Note: Further discussion is needed on whether the Case-7 timing offset can be represented via T\_delta MAC CE, as per the current version of the running CR.” Rapporteur’s proposal is NOT to represent the Case-7 timing offset via the T\_delta MAC CE, due to the different nature of the two parameters, but to have a separate MAC CE section instead. This is also the majority view in [Pre117-e][014][eIAB].

(Rev 4)* Agreements implemented from RAN2#117-e including the one on padding BSR.
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| ***Consequences if not approved:*** | Rel-17 will not support IAB. |
|  |  |
| ***Clauses affected:*** | 5.4.3.1.3 Allocation of resources5.4.5 Buffer Status Reporting5.18.18 Timing offset adjustment for IAB5.18.19 Guard symbols for IAB6.1.3 MAC Control Elements (CEs)6.2.1 MAC subheader for DL-SCH and UL-SCH |
|  |  |
|  | **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:*** | See Summary of change |

FIRST CHANGE

###

##### 5.4.3.1.3 Allocation of resources

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

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

1> allocate resources to the logical channels as follows:

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

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

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

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

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

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

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

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

- the UE should maximise the transmission of data;

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

The MAC entity shall:

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

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

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

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

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

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

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

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

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

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

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

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

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

- Configured Grant Confirmation MAC CE or MAC CEs for BFR or Multiple Entry Configured Grant Confirmation MAC CE;

- Sidelink Configured Grant Confirmation MAC CE;

- LBT failure MAC CE;

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

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

- Single Entry PHR MAC CE or Multiple Entry PHR MAC CE;

- MAC CE for the number of Desired Guard Symbols;

- MAC CE for Pre-emptive BSR;

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

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

- MAC CE for Recommended bit rate query;

- MAC CE for BSR included for padding;

- MAC CE for SL-BSR included for padding.

NOTE 2: Prioritization among Configured Grant Confirmation MAC CE, Multiple Entry Configured Grant Confirmation MAC CE, and MAC CEs for BFR is up to UE implementation.

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

Editors Note: Priority of MAC CEs needs to be updated to reflect newly added MAC CEs and those yet to be added, pending further information from RAN1.

NEXT CHANGE

### 5.4.5 Buffer Status Reporting

The Buffer Status reporting (BSR) procedure is used to provide the serving gNB with information about UL data volume in the MAC entity.

RRC configures the following parameters to control the BSR:

- *periodicBSR-Timer*;

- *retxBSR-Timer*;

- *logicalChannelSR-DelayTimerApplied*;

- *logicalChannelSR-DelayTimer*;

- *logicalChannelSR-Mask*;

- *logicalChannelGroup*.

Each logical channel may be allocated to an LCG using the *logicalChannelGroup*. The maximum number of LCGs is eight except for IAB-MTs configured with *logicalChannelGroup-IABExt-r17*, for which the maximum number of LCGs is 256.

The MAC entity determines the amount of UL data available for a logical channel according to the data volume calculation procedure in TSs 38.322 [3] and 38.323 [4].

A BSR shall be triggered if any of the following events occur:

- UL data, for a logical channel which belongs to an LCG, becomes available to the MAC entity; and either

- this UL data belongs to a logical channel with higher priority than the priority of any logical channel containing available UL data which belong to any LCG; or

- none of the logical channels which belong to an LCG contains any available UL data.

 in which case the BSR is referred below to as 'Regular BSR';

- UL resources are allocated and number of padding bits is equal to or larger than the size of the Buffer Status Report MAC CE plus its subheader, in which case the BSR is referred below to as 'Padding BSR';

- *retxBSR-Timer* expires, and at least one of the logical channels which belong to an LCG contains UL data, in which case the BSR is referred below to as 'Regular BSR';

- *periodicBSR-Timer* expires, in which case the BSR is referred below to as 'Periodic BSR'.

NOTE 1: When Regular BSR triggering events occur for multiple logical channels simultaneously, each logical channel triggers one separate Regular BSR.

For Regular BSR, the MAC entity shall:

1> if the BSR is triggered for a logical channel for which *logicalChannelSR-DelayTimerApplied* with value *true* is configured by upper layers:

2> start or restart the *logicalChannelSR-DelayTimer*.

1> else:

2> if running, stop the *logicalChannelSR-DelayTimer*.

For Regular and Periodic BSR, the MAC entity for which *logicalChannelGroup-IABExt-r17* is not configured by upper layers shall:

1> if more than one LCG has data available for transmission when the MAC PDU containing the BSR is to be built:

2> report Long BSR for all LCGs which have data available for transmission.

1> else:

2> report Short BSR.

For Regular and Periodic BSR, the MAC entity for which *logicalChannelGroup-IABExt-r17* is configured by upper layers shall:

1. if more than one LCG has data available for transmission when the MAC PDU containing the BSR is to be built:

2> report Extended Long BSR for all LCGs which have data available for transmission.

1> else:

2> report Extended Short BSR.

For Padding BSR, the MAC entity for which *logicalChannelGroup-IABExt-r17* is not configured by upper layers shall:

1> if the number of padding bits is equal to or larger than the size of the Short BSR plus its subheader but smaller than the size of the Long BSR plus its subheader:

2> if more than one LCG has data available for transmission when the BSR is to be built:

3> if the number of padding bits is equal to the size of the Short BSR plus its subheader:

4> report Short Truncated BSR of the LCG with the highest priority logical channel with data available for transmission.

3> else:

4> report Long Truncated BSR of the LCG(s) with the logical channels having data available for transmission following a decreasing order of the highest priority logical channel (with or without data available for transmission) in each of these LCG(s), and in case of equal priority, in increasing order of LCGID.

2> else:

3> report Short BSR.

1> else if the number of padding bits is equal to or larger than the size of the Long BSR plus its subheader:

2> report Long BSR for all LCGs which have data available for transmission.

For Padding BSR, the MAC entity for which *logicalChannelGroup-IABExt-r17* is configured by upper layers shall:

1> if the number of padding bits is equal to or larger than the size of the Extended Short BSR plus its subheader but smaller than the size of the Extended Long BSR plus its subheader:

2> if more than one LCG has data available for transmission when the BSR is to be built:

3> if the number of padding bits is smaller than 32 bytes plus the size of Extended Long Truncated BSR subheader:

4> report Extended Short Truncated BSR of the LCG with the highest priority logical channel with data available for transmission.

3> else:

4> report Extended Long Truncated BSR of the LCG(s) with the logical channels having data available for transmission following a decreasing order of the highest priority logical channel (with or without data available for transmission) in each of these LCG(s), and in case of equal priority, in increasing order of LCGID.

2> else:

3> report Extended Short BSR.

1> else if the number of padding bits is equal to or larger than the size of the Extended Long BSR plus its subheader:

2> report Extended Long BSR for all LCGs which have data available for transmission.

For BSR triggered by *retxBSR-Timer* expiry, the MAC entity considers that the logical channel that triggered the BSR is the highest priority logical channel that has data available for transmission at the time the BSR is triggered.

The MAC entity shall:

1> if the Buffer Status reporting procedure determines that at least one BSR has been triggered and not cancelled:

2> if UL-SCH resources are available for a new transmission and the UL-SCH resources can accommodate the BSR MAC CE plus its subheader as a result of logical channel prioritization:

3> instruct the Multiplexing and Assembly procedure to generate the BSR MAC CE(s) as defined in clause 6.1.3.1;

3> start or restart *periodicBSR-Timer* except when all the generated BSRs are long or short Truncated or Extended long or short Truncated BSRs;

3> start or restart *retxBSR-Timer*.

2> if a Regular BSR has been triggered and *logicalChannelSR-DelayTimer* is not running:

3> if there is no UL-SCH resource available for a new transmission; or

3> if the MAC entity is configured with configured uplink grant(s) and the Regular BSR was triggered for a logical channel for which *logicalChannelSR-Mask* is set to *false*; or

3> if the UL-SCH resources available for a new transmission do not meet the LCP mapping restrictions (see clause 5.4.3.1) configured for the logical channel that triggered the BSR:

4> trigger a Scheduling Request.

NOTE 2: UL-SCH resources are considered available if the MAC entity has been configured with, receives, or determines an uplink grant. If the MAC entity has determined at a given point in time that UL-SCH resources are available, this need not imply that UL-SCH resources are available for use at that point in time.

A MAC PDU shall contain at most one BSR MAC CE, even when multiple events have triggered a BSR. The Regular BSR and the Periodic BSR shall have precedence over the padding BSR.

The MAC entity shall restart *retxBSR-Timer* upon reception of a grant for transmission of new data on any UL-SCH.

All triggered BSRs may be cancelled when the UL grant(s) can accommodate all pending data available for transmission but is not sufficient to additionally accommodate the BSR MAC CE plus its subheader. All BSRs triggered prior to MAC PDU assembly shall be cancelled when a MAC PDU is transmitted and this PDU includes a Long, Extended Long, Short, or Extended Short BSR MAC CE which contains buffer status up to (and including) the last event that triggered a BSR prior to the MAC PDU assembly.

NOTE 3: MAC PDU assembly can happen at any point in time between uplink grant reception and actual transmission of the corresponding MAC PDU. BSR and SR can be triggered after the assembly of a MAC PDU which contains a BSR MAC CE, but before the transmission of this MAC PDU. In addition, BSR and SR can be triggered during MAC PDU assembly.

NOTE 4: Void

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

NEXT CHANGE

### 5.18.18 Timing offset adjustments for IAB

For IAB operation, in order to achieve time-domain synchronization across multiple backhaul hops, a timing adjustment may be provided to an IAB node by its parent node. Two different values may be provided, related to Case-1 and Case-7 timing modes respectively. These parameters are applicable only to IAB nodes. The Timing Delta MAC CE carries Tdelta which is used to determine the IAB-DU DL Tx timing adjustment for the Case-1 timing mode. The Case-7 Timing advance offset MAC CE carries Toffset,2 which is used to determine the IAB-MT UL Tx timing adjustment for the Case-7 timing mode.

Upon reception of a Timing Delta MAC CE the IAB node shall:

- apply the value of Tdelta as specified in TS 38.213 [6].

Upon reception of a Case-7 Timing advance offset MAC CE the IAB node shall:

- apply the value of Toffset,2 as specified in TS 38.213 [6].

NEXT CHANGE

### 5.18.19 Guard symbols for IAB

For IAB operation, the MAC entity on the IAB-DU or IAB-donor-DU reserves a sufficient number of symbols at the beginning and/or the end of slots where the child IAB-node switches operation from its IAB-DU to its IAB-MT function and operation from its IAB-MT to its IAB-DU function. The MAC entity on the IAB-DU or IAB-donor-DU informs the child node about the number of guard symbols it provides via the Provided Guard Symbols MAC CE. The IAB-MT on the child node may inform the parent IAB-DU or IAB-donor-DU about the number of guard symbols desired via the Desired Guard Symbols MAC CE. IAB-MT transmission timing modes are specified in clause 14 of TS 38.213 [6].

Upon reception of a Provided Guard Symbols MAC CE the MAC entity shall:

- indicate to lower layers the number of provided guard symbols and the SCS configuration for the indicated Serving Cell.

The MAC entity may:

1> if a Desired Guard Symbol query has not been triggered:

2> trigger a Desired Guard Symbol query for this Serving Cell.

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

1> for each Desired Guard Symbol query that has been triggered and not cancelled:

2> if the allocated UL resources can accommodate a Desired Guard Symbols MAC CE plus its subheader as a result of LCP as defined in clause 5.4.3.1:

3> instruct the Multiplexing and Assembly procedure to generate the Desired Guard Symbols MAC CE;

3> cancel this Desired Guard Symbol query.

For Case-1 timing mode, a separate value for the number of guard symbols is specified for each of the following eight switching scenarios (see Table 5.18.19-1).

Table 5.18.19-1: Switching scenarios and relevant guard symbols for Case-1 timing mode

|  |  |
| --- | --- |
| Switching scenario | Field for number of guard symbols in MAC CE |
| IAB-MT operation to IAB-DU operation | MT Rx to DU Tx | NmbGS1 |
| MT Rx to DU Rx | NmbGS2 |
| MT Tx to DU Tx | NmbGS3 |
| MT Tx to DU Rx | NmbGS4 |
| IAB-DU operation to IAB-MT operation | DU Rx to MT Tx | NmbGS5 |
| DU Rx to MT Rx | NmbGS6 |
| DU Tx to MT Tx | NmbGS7 |
| DU Tx to MT Rx | NmbGS8 |

For Case-6 and Case-7 timing modes, a separate value for the number of guard symbols is specified for each of the following eight switching scenarios (see Table 5.18.19-2):

Table 5.18.19-2: Switching scenarios and relevant guard symbols for Case-6 and Case-7 timing modes

|  |  |
| --- | --- |
| Switching scenario | Field for number of guard symbols in MAC CE |
| IAB-MT operation to IAB-DU operation | MT Tx (Case-6) to DU Tx (Case-1) | NmbGS9 |
| MT Tx (Case-6) to DU Rx (Case-1) | NmbGS10 |
| MT Tx (Case-7) to DU Tx (Case-1) | NmbGS11 |
| MT Tx (Case-7) to DU Rx (Case-1) | NmbGS12 |
| IAB-DU operation to IAB-MT operation | DU Tx (Case-1) to MT Tx (Case-6) | NmbGS13 |
| DU Rx (Case-1) to MT Tx (Case-6) | NmbGS14 |
| DU Tx (Case-1) to MT Tx (Case-7) | NmbGS15 |
| DU Rx (Case-1) to MT Tx (Case-7) | NmbGS16 |

Editors Note: Switching scenarios covering Case-6 MT Tx to/from Case-1 DU TX in the above table are currently the subject of a Working Assumption in RAN1, and support and detals thereof may change.

NEXT CHANGE

# 6 Protocol Data Units, formats and parameters

## 6.1 Protocol Data Units

6.1.3 MAC Control Elements (CEs)

Editors Note: Further MAC CEs need to be captured pertaining to RAN1’s work on eIAB, details of which are awaited.

#### 6.1.3.1 Buffer Status Report MAC CEs

Buffer Status Report (BSR) MAC CEs consist of either:

- Short BSR format (fixed size); or

- Extended Short BSR format (fixed size); or

- Long BSR format (variable size); or

- Extended Long BSR format (variable size); or

- Short Truncated BSR format (fixed size); or

- Extended Short Truncated BSR format (fixed size); or

- Long Truncated BSR format (variable size); or

- Extended Long Truncated BSR format (variable size).

Pre-emptive BSR MAC CE consists of:

- Pre-emptive BSR format (variable size); or

- Extended Pre-emptive BSR format (variable size).

The BSR formats are identified by MAC subheaders with LCIDs as specified in Table 6.2.1-2.

The Extended BSR formats and Pre-emptive BSR formats are identified by MAC subheaders with eLCIDs as specified in Table 6.2.1-2b.

The fields in the BSR MAC CE are defined as follows:

- LCG ID: The Logical Channel Group ID field identifies the group of logical channel(s) whose buffer status is being reported. The length of the field is 3 bits for the case of Short BSR and Short Truncated BSR formats, and 8 bits for the case of Extended Short BSR and Extended Short Truncated BSR formats;

- LCGi: For the Long BSR format, Extended Long BSR format, Pre-emptive BSR format, and Extended Pre-emptive BSR format, this field indicates the presence of the Buffer Size field for the logical channel group i. The LCGi field set to 1 indicates that the Buffer Size field for the logical channel group i is reported. The LCGi field set to 0 indicates that the Buffer Size field for the logical channel group i is not reported. For the Long Truncated BSR format and the Extended Long Truncated BSR format, this field indicates whether logical channel group i has data available. The LCGi field set to 1 indicates that logical channel group i has data available. The LCGi field set to 0 indicates that logical channel group i does not have data available;

- Buffer Size: The Buffer Size field identifies the total amount of data available according to the data volume calculation procedure in TSs 38.322 [3] and 38.323 [4] across all logical channels of a logical channel group after the MAC PDU has been built (i.e. after the logical channel prioritization procedure, which may result the value of the Buffer Size field to zero). The amount of data is indicated in number of bytes. The size of the RLC headers and MAC subheaders are not considered in the buffer size computation. The length of this field for the Short BSR format and the Short Truncated BSR format is 5 bits. The length of this field for the Extended Short BSR format and the Extended Short Truncated BSR format is 8 bits. The length of this field for the Long BSR format, the Long Truncated BSR format, the Extended Long BSR format, and the Extended Long Truncated format is 8 bits. The values for the 5-bit and 8-bit Buffer Size fields are shown in Tables 6.1.3.1-1 and 6.1.3.1-2, respectively. For the Long BSR format, the Long Truncated BSR format, the Extended Long BSR format, and the Extended Long Truncated format, the Buffer Size fields are included in ascending order based on the LCGi. For the Long Truncated BSR format and the Extended Long Truncated format the number of Buffer Size fields included is maximised, while not exceeding the number of padding bits. For the Pre-emptive BSR format and the Extended Pre-emptive BSR format, the Buffer Size field identifies the total amount of the data expected to arrive at the IAB-MT of the node where the Pre-emptive BSR/Extended Pre-emptive BSR is triggered and does not include the volume of data currently available in the IAB-MT. Pre-emptive BSR format is identical to the Long BSR format. Extended Pre-emptive BSR format is identical to the Extended Long BSR format.

NOTE 1: For the Pre-emptive BSR, if configured, the LCGs to be reported, the expected data volume calculation, the exact time to report Pre-emptive BSR and the associated LCH are left to implementation.

NOTE 2: The mapping of LCGs between the ingress and egress links of an IAB node for purposes of determining expected change in occupancy of IAB-MT buffers (to be reported as Pre-emptive BSR) is left to implementation.

NOTE 3: The number of the Buffer Size fields in the Long BSR, Extended Long BSR, Long Truncated BSR, and Extended Long Truncated BSR format can be zero.

NOTE 4: The Extended versions of the BSR formats may only be used by IAB nodes.



Figure 6.1.3.1-1: Short BSR and Short Truncated BSR MAC CE



Figure 6.1.3.1-2: Long BSR, Long Truncated BSR, and Pre-emptive BSR MAC CE



Figure 6.1.3.1-3: Extended Short BSR and Extended Short Truncated BSR MAC CE



Figure 6.1.3.1-4: Extended Long BSR , Extended Long Truncated BSR, and Extended Pre-emptive BSR MAC CE

Table 6.1.3.1-1: Buffer size levels (in bytes) for 5-bit Buffer Size field

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Index | BS value | Index | BS value | Index | BS value | Index | BS value |
| 0 | 0 | 8 | ≤ 102 | 16 | ≤ 1446 | 24 | ≤ 20516 |
| 1 | ≤ 10 | 9 | ≤ 142 | 17 | ≤ 2014 | 25 | ≤ 28581 |
| 2 | ≤ 14 | 10 | ≤ 198 | 18 | ≤ 2806 | 26 | ≤ 39818 |
| 3 | ≤ 20 | 11 | ≤ 276 | 19 | ≤ 3909 | 27 | ≤ 55474 |
| 4 | ≤ 28 | 12 | ≤ 384 | 20 | ≤ 5446 | 28 | ≤ 77284 |
| 5 | ≤ 38 | 13 | ≤ 535 | 21 | ≤ 7587 | 29 | ≤ 107669 |
| 6 | ≤ 53 | 14 | ≤ 745 | 22 | ≤ 10570 | 30 | ≤ 150000 |
| 7 | ≤ 74 | 15 | ≤ 1038 | 23 | ≤ 14726 | 31 | > 150000 |

Table 6.1.3.1-2: Buffer size levels (in bytes) for 8-bit Buffer Size field

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Index | BS value | Index | BS value | Index | BS value | Index | BS value |
| 0 | 0 | 64 | ≤ 560 | 128 | ≤ 31342 | 192 | ≤ 1754595 |
| 1 | ≤ 10 | 65 | ≤ 597 | 129 | ≤ 33376 | 193 | ≤ 1868488 |
| 2 | ≤ 11 | 66 | ≤ 635 | 130 | ≤ 35543 | 194 | ≤ 1989774 |
| 3 | ≤ 12 | 67 | ≤ 677 | 131 | ≤ 37850 | 195 | ≤ 2118933 |
| 4 | ≤ 13 | 68 | ≤ 720 | 132 | ≤ 40307 | 196 | ≤ 2256475 |
| 5 | ≤ 14 | 69 | ≤ 767 | 133 | ≤ 42923 | 197 | ≤ 2402946 |
| 6 | ≤ 15 | 70 | ≤ 817 | 134 | ≤ 45709 | 198 | ≤ 2558924 |
| 7 | ≤ 16 | 71 | ≤ 870 | 135 | ≤ 48676 | 199 | ≤ 2725027 |
| 8 | ≤ 17 | 72 | ≤ 926 | 136 | ≤ 51836 | 200 | ≤ 2901912 |
| 9 | ≤ 18 | 73 | ≤ 987 | 137 | ≤ 55200 | 201 | ≤ 3090279 |
| 10 | ≤ 19 | 74 | ≤ 1051 | 138 | ≤ 58784 | 202 | ≤ 3290873 |
| 11 | ≤ 20 | 75 | ≤ 1119 | 139 | ≤ 62599 | 203 | ≤ 3504487 |
| 12 | ≤ 22 | 76 | ≤ 1191 | 140 | ≤ 66663 | 204 | ≤ 3731968 |
| 13 | ≤ 23 | 77 | ≤ 1269 | 141 | ≤ 70990 | 205 | ≤ 3974215 |
| 14 | ≤ 25 | 78 | ≤ 1351 | 142 | ≤ 75598 | 206 | ≤ 4232186 |
| 15 | ≤ 26 | 79 | ≤ 1439 | 143 | ≤ 80505 | 207 | ≤ 4506902 |
| 16 | ≤ 28 | 80 | ≤ 1532 | 144 | ≤ 85730 | 208 | ≤ 4799451 |
| 17 | ≤ 30 | 81 | ≤ 1631 | 145 | ≤ 91295 | 209 | ≤ 5110989 |
| 18 | ≤ 32 | 82 | ≤ 1737 | 146 | ≤ 97221 | 210 | ≤ 5442750 |
| 19 | ≤ 34 | 83 | ≤ 1850 | 147 | ≤ 103532 | 211 | ≤ 5796046 |
| 20 | ≤ 36 | 84 | ≤ 1970 | 148 | ≤ 110252 | 212 | ≤ 6172275 |
| 21 | ≤ 38 | 85 | ≤ 2098 | 149 | ≤ 117409 | 213 | ≤ 6572925 |
| 22 | ≤ 40 | 86 | ≤ 2234 | 150 | ≤ 125030 | 214 | ≤ 6999582 |
| 23 | ≤ 43 | 87 | ≤ 2379 | 151 | ≤ 133146 | 215 | ≤ 7453933 |
| 24 | ≤ 46 | 88 | ≤ 2533 | 152 | ≤ 141789 | 216 | ≤ 7937777 |
| 25 | ≤ 49 | 89 | ≤ 2698 | 153 | ≤ 150992 | 217 | ≤ 8453028 |
| 26 | ≤ 52 | 90 | ≤ 2873 | 154 | ≤ 160793 | 218 | ≤ 9001725 |
| 27 | ≤ 55 | 91 | ≤ 3059 | 155 | ≤ 171231 | 219 | ≤ 9586039 |
| 28 | ≤ 59 | 92 | ≤ 3258 | 156 | ≤ 182345 | 220 | ≤ 10208280 |
| 29 | ≤ 62 | 93 | ≤ 3469 | 157 | ≤ 194182 | 221 | ≤ 10870913 |
| 30 | ≤ 66 | 94 | ≤ 3694 | 158 | ≤ 206786 | 222 | ≤ 11576557 |
| 31 | ≤ 71 | 95 | ≤ 3934 | 159 | ≤ 220209 | 223 | ≤ 12328006 |
| 32 | ≤ 75 | 96 | ≤ 4189 | 160 | ≤ 234503 | 224 | ≤ 13128233 |
| 33 | ≤ 80 | 97 | ≤ 4461 | 161 | ≤ 249725 | 225 | ≤ 13980403 |
| 34 | ≤ 85 | 98 | ≤ 4751 | 162 | ≤ 265935 | 226 | ≤ 14887889 |
| 35 | ≤ 91 | 99 | ≤ 5059 | 163 | ≤ 283197 | 227 | ≤ 15854280 |
| 36 | ≤ 97 | 100 | ≤ 5387 | 164 | ≤ 301579 | 228 | ≤ 16883401 |
| 37 | ≤ 103 | 101 | ≤ 5737 | 165 | ≤ 321155 | 229 | ≤ 17979324 |
| 38 | ≤ 110 | 102 | ≤ 6109 | 166 | ≤ 342002 | 230 | ≤ 19146385 |
| 39 | ≤ 117 | 103 | ≤ 6506 | 167 | ≤ 364202 | 231 | ≤ 20389201 |
| 40 | ≤ 124 | 104 | ≤ 6928 | 168 | ≤ 387842 | 232 | ≤ 21712690 |
| 41 | ≤ 132 | 105 | ≤ 7378 | 169 | ≤ 413018 | 233 | ≤ 23122088 |
| 42 | ≤ 141 | 106 | ≤ 7857 | 170 | ≤ 439827 | 234 | ≤ 24622972 |
| 43 | ≤ 150 | 107 | ≤ 8367 | 171 | ≤ 468377 | 235 | ≤ 26221280 |
| 44 | ≤ 160 | 108 | ≤ 8910 | 172 | ≤ 498780 | 236 | ≤ 27923336 |
| 45 | ≤ 170 | 109 | ≤ 9488 | 173 | ≤ 531156 | 237 | ≤ 29735875 |
| 46 | ≤ 181 | 110 | ≤ 10104 | 174 | ≤ 565634 | 238 | ≤ 31666069 |
| 47 | ≤ 193 | 111 | ≤ 10760 | 175 | ≤ 602350 | 239 | ≤ 33721553 |
| 48 | ≤ 205 | 112 | ≤ 11458 | 176 | ≤ 641449 | 240 | ≤ 35910462 |
| 49 | ≤ 218 | 113 | ≤ 12202 | 177 | ≤ 683087 | 241 | ≤ 38241455 |
| 50 | ≤ 233 | 114 | ≤ 12994 | 178 | ≤ 727427 | 242 | ≤ 40723756 |
| 51 | ≤ 248 | 115 | ≤ 13838 | 179 | ≤ 774645 | 243 | ≤ 43367187 |
| 52 | ≤ 264 | 116 | ≤ 14736 | 180 | ≤ 824928 | 244 | ≤ 46182206 |
| 53 | ≤ 281 | 117 | ≤ 15692 | 181 | ≤ 878475 | 245 | ≤ 49179951 |
| 54 | ≤ 299 | 118 | ≤ 16711 | 182 | ≤ 935498 | 246 | ≤ 52372284 |
| 55 | ≤ 318 | 119 | ≤ 17795 | 183 | ≤ 996222 | 247 | ≤ 55771835 |
| 56 | ≤ 339 | 120 | ≤ 18951 | 184 | ≤ 1060888 | 248 | ≤ 59392055 |
| 57 | ≤ 361 | 121 | ≤ 20181 | 185 | ≤ 1129752 | 249 | ≤ 63247269 |
| 58 | ≤ 384 | 122 | ≤ 21491 | 186 | ≤ 1203085 | 250 | ≤ 67352729 |
| 59 | ≤ 409 | 123 | ≤ 22885 | 187 | ≤ 1281179 | 251 | ≤ 71724679 |
| 60 | ≤ 436 | 124 | ≤ 24371 | 188 | ≤ 1364342 | 252 | ≤ 76380419 |
| 61 | ≤ 464 | 125 | ≤ 25953 | 189 | ≤ 1452903 | 253 | ≤ 81338368 |
| 62 | ≤ 494 | 126 | ≤ 27638 | 190 | ≤ 1547213 | 254 | > 81338368 |
| 63 | ≤ 526 | 127 | ≤ 29431 | 191 | ≤ 1647644 | 255 | Reserved |

NEXT CHANGE

#### 6.1.3.22 Guard Symbols MAC CEs

The Guard Symbols MAC CEs (i.e. Provided Guard Symbols MAC CE and Desired Guard Symbols MAC CE) for Case-1 timing mode are identified by the MAC subheader with eLCID as specified in Table 6.2.1-1b for DL-SCH and in Table 6.2.1-2b for UL-SCH.

It has fixed size and consists of four octets defined as follows (Figure 6.1.3.22-1):

- R: Reserved bit, set to 0;

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

- Sub-carrier spacing (SCS): This field indicates the subcarrier spacing used as reference for the guard spacing. The length of this field is 2bits. The values for the SCS field are shown in Table 6.1.3.22-2;

- Number of Guard Symbols (NmbGSi): This field indicates the number of guard symbols for the switching scenario shown in Table 5.18.19-1. The number of guard symbols can take values within the range of 0..4. Higher values 5-7 are reserved.



Figure 6.1.3.22-1: Guard Symbols MAC CEs

Table 6.1.3.22-2: Subcarrier spacing for Guard Symbols MAC CEs

|  |  |
| --- | --- |
| Subcarrier spacing | SCS value |
| 15kHz | 00 |
| 30kHz | 01 |
| 60kHz | 10 |
| 120kHz | 11 |

NEXT CHANGE

#### 6.1.3.x Guard Symbols MAC CEs for Case-6 and Case-7 timing modes

The Guard Symbols MAC CEs (i.e. Provided Guard Symbols MAC CE and Desired Guard Symbols MAC CE) for Case-6 and Case-7 timing modes are identified by the MAC subheader with eLCIDs as specified in Table 6.2.1-1b for DL-SCH and in Table 6.2.1-2b for UL-SCH.

The MAC CEs have fixed size and consist of four octets each, defined as follows (Figure 6.1.3.x-1 and Figure 6.1.3.x-2):

- R: Reserved bit, set to 0;

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

- Sub-carrier spacing (SCS): This field indicates the subcarrier spacing used as reference for the guard spacing. The length of this field is 2bits. The values for the SCS field are shown in Table 6.1.3.22-2;

- Number of Guard Symbols (NmbGSi): This field indicates the number of guard symbols for the switching scenario shown in Table 5.18.19-2.



Figure 6.1.3.x-1: Case-6 timing Guard Symbols MAC CEs



Figure 6.1.3.x-2: Case-7 timing Guard Symbols MAC CEs

Editors Note: FFS the number of guard symbols associated with Case #6 and Case #7 timing modes.

NEXT CHANGE

#### 6.1.3.y Case-7 Timing advance offset MAC CE

The Case-7 Timing offset MAC CE is identified by MAC subheader with eLCID as specified in Table 6.2.1-1b.

The Case-7 Timing offset MAC CE is related to the Case-7 timing mode, has a fixed size and consists of two octets defined as follows (Figure 6.1.3.21-2):

- R: Reserved bit, set to 0;

- Toffset,2: This field indicates the value (0, 1, 2… 4095) used to control the amount of timing adjustment that MAC entity indicates (as specified in TS 38.213 [6]). The length of the field is 12 bits.



Figure 6.1.3.21-2: Case-7 Timing Delta MAC CE

Editors Note: The exact range of values indicated by Toffset,2 is still TBC.

NEXT CHANGE

## 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 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;

- 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: 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.

- 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 |
| 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 241 | 64 to 305 | Reserved |
| 242 | 306 | Timing offset for Case-7 timing mode |
| 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 6.2.1-2 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]) |
| 1–32 | Identity of the logical channel |
| 33 | Extended logical channel ID field (two-octet eLCID field) |
| 34 | Extended logical channel ID field (one-octet eLCID field) |
| 35–44 | Reserved |
| 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]) |
| 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 242 | 64 to 306 | Reserved |
| 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 |