**3GPP TSG-RAN WG2 #130 R2-2504778**

**St.Julians, Malta, May 19th – 23rd, 2025**

Agenda Item: 8.9.3

Source: MediaTek

Title: Report of [AT130][301][R19 IoT NTN] CB-msg4 design – Second round

Document for: Discussion

# 1 Introduction

This is the phase 2 report of below offline discussion:

* [AT130][301][R19 IoT NTN] CB-msg4 design (Mediatek)

 Scope: discuss open issues MAC-12, MAC-13, MAC-14

 Intended outcome: summary of the offline discussion

 Offline time: Monday 2025-05-19 afternoon coffee break in BO3

 Deadline for offline discussion summary: Tuesday 2025-05-20 11:00

 Scope: discuss remaining two proposals for CB-msg4 design marked CB Friday

 Intended outcome: summary of the offline discussion

 Deadline for companies’ feedback: Thursday 2025-05-22 20:00

 Deadline for offline discussion summary (in R2-2504778): Friday 2025-05-23 08:00

# 2 Current agreements

RAN2 had made the following agreements related to CB-Msg4 structure before RAN2#130.

RAN2 Agreements

Contention resolution identity

- The UE stops the PDCCH monitoring window(s) once it receives a CB-msg4 containing a matching Contention Resolution Identity (FFS if there is no RRC message together with the CB-msg4)

Multiplexing

- RAN2 confirms the working assumption that one CB-Msg4 can target multiple UEs simultaneously. FFS how the multiplexing is organized.

C-RNTI

- The C-RNTI is included in CB-Msg4 if the UE is expected to receive additional RRC messages or data from the network after CB-Msg4 (FFS how to include the C-RNTI)

Timing alignment information

- The timing alignment information (FFS reusing TAC MAC-CE) can be included in the CB-Msg4

Backoff information

- Backoff information could be included in CB-Msg4.

In this meeting, RAN2 has below agreements related to CB-Msg4 structure.

Agreements:

3. Multiple contention resolution IDs could be included in CB-MSG4, the information related to multiple UEs can be multiplexed in the MAC PDU.

4. The number of Msg3 replies in one Msg4 can be left to eNB implementation. Expect no SPEC impact.

5. The HARQ feedback resource information can be included in the CB-Msg4 together with contention resolution ID which identity the specific UE. RAN2 could revisit this proposal if RAN1 has some concern.

6. Whether to send the HARQ feedback for CB-Msg4 can be controlled by NW. UE does not send HARQ NACK.

8. Reuse the existing format of HARQ ACK allocation signalling in the DCI. There is 2-bit HARQ ACK resource for eMTC and 4-bit HARQ ACK resource for NB-IoT. Reuse the meaning of DCI field in R1 SPEC. Send LS to RAN1 for information on all RAN2 decisions related to HARQ feedback

9. Introduce a new MAC PDU for CB-Msg4 including new types of MAC sub-header and a new type of MAC payload

10. The MAC PDU for CB-Msg4 consists of sub-header(s) followed by MAC payload and optional padding if needed.

11. Introduce a new CB BI MAC sub-header in CB-MSg4 for backoff parameter. There is 4 bits BI for backoff indication.

12. Introduce a new CB-Msg3 Response (CBR) MAC sub-header in CB-Msg4. It has 1bit E for sub-header/payload indication, 2 bits T for sub-header type, 1bit T2 for HARQ ACK resource present, 1 bit T3 for TAC present, 1 bit T4 for C-RNTI present and 2bit R for reservation.

Agreements – part 2:

5. The TAC is optionally used in the CB-Msg3 response.

6. RAN2 assumes that NTA=0 for initial CB-msg3 transmission. Include this in the LS to RAN1 and RAN4

7. RAN2 assumes the length of the TAC field is 6 bits (we can revisit this if there is major R1 impact on TA calculation)

# 3 Discussion

We discuss below two proposals in this offline.

Proposal 12: (MAC-13) Introduce a new CB Data MAC sub-header in CB-MSg4 for MAC SDU for logical channel data. It has 1 bit E for sub-header/payload indication, 2 bits T for sub-header type, 5 bits LCID, 8 bits L for MAC SDU length.

* CB Friday

Additional proposal from R2-2504528 (MTK) which was not included in offline 301:

Proposal 13c: (MAC-13) New CB-Msg3 Response (CBR). It has 48 bits contention resolution ID, 2 bits HARQ ACK resource offset for eMTC, 4 bits HARQ-ACK resource for NB-IoT, 6 bits TAC, 16 bits C-RNTI.

* CB Friday

Based on the agreement below, the rapporteur proposes to have the PDU format in Figure 1.

Agreements:

9. Introduce a new MAC PDU for CB-Msg4 including new types of MAC sub-header and a new type of MAC payload

10. The MAC PDU for CB-Msg4 consists of sub-header(s) followed by MAC payload and optional padding if needed.



Figure 1 MAC PDU format of CB-Msg4

Based on the agreement below, the rapporteur proposes to have the BI MAC sub-header structure in Figure 2.

Agreements:

11. Introduce a new CB BI MAC sub-header in CB-MSg4 for backoff parameter. There is 4 bits BI for backoff indication.



Figure 2 CB BI MAC sub-header

Agreements:

12. Introduce a new CB-Msg3 Response (CBR) MAC sub-header in CB-Msg4. It has 1bit E for sub-header/payload indication, 2 bits T for sub-header type, 1bit T2 for HARQ ACK resource present, 1 bit T3 for TAC present, 1 bit T4 for C-RNTI present and 2bit R for reservation.



Figure 3 CBR MAC sub-header

**Proposal 1:** **(MAC-13) Introduce a new CB Data MAC sub-header in CB-MSg4 for MAC SDU for logical channel data. It has 1 bit E for sub-header/payload indication, 2 bits T for sub-header type, 5 bits LCID, 8 bits L for MAC SDU length.** **There is one L field per CB Data sub-header except for the last sub-header.**



Figure 4a (Original) CB Data MAC sub-header



Figure 4b (Mobified) CB Data MAC sub-header

Q1: Do companies agree the P1?

Nokia – MT to consider, so L=8 may not enough. HW think 8 bits is enough.

2536 bits is the current maximum for category NB-2, so L=8 may not enough.

**Summary**

Figure 4a is selected as legacy.

**Proposal 2: (MAC-13) introduce a new CB-Msg3 Response (CBR) with variable length. It has 48-bit contention resolution ID, optional HARQ ACK, optional TAC, optional 16-bit C-RNTI.**



Figure 5 CBR for NB-IoT

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Figure 6 CBR for eMTC

Q2: Do companies agree the P2?

Samsung suggest to have one format for both eMTC and NB-IoT. HW/Vivo/Nokia prefer separate format.

**Summary**

Separate eMTC and Nb-IoT format.

# 4 Conclusion

**Proposal 1: (MAC-13)** **Introduce a new CB Data MAC sub-header in CB-MSg4. It has 1 bit E for subhead/payload indication, 2 bits T for subhead type, 5 bits LCID, 7 bits or 15 bits L for MAC SDU length, 1 bit F for 15 bits L indication. There is one L field per CB Data sub-header except for the last sub-header.**



**Proposal 2: (MAC-13) introduce a new CB-Msg3 Response (CBR) with variable length. It has 48-bit contention resolution ID, optional HARQ ACK, optional TAC, optional 16-bit C-RNTI.**



Figure 5 CBR for NB-IoT

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Figure 6 CBR for eMTC

**Proposal 3: The field name in above agreements could be further changed during running CR review.**

Agreements:

9. Introduce a new MAC PDU for CB-Msg4 including new types of MAC sub-header and a new type of MAC payload

10. The MAC PDU for CB-Msg4 consists of sub-header(s) followed by MAC payload and optional padding if needed.

11. Introduce a new CB BI MAC sub-header in CB-MSg4 for backoff parameter. There is 4 bits BI for backoff indication.

12. Introduce a new CB-Msg3 Response (CBR) MAC sub-header in CB-Msg4. It has 1bit E for sub-header/payload indication, 2 bits T for sub-header type, 1bit T2 for HARQ ACK resource present, 1 bit T3 for TAC present, 1 bit T4 for C-RNTI present and 2bit R for reservation.

# Appendix – TP for CB-MSG4

6.1.2 MAC PDU (DL-SCH and UL-SCH except transparent MAC and Random Access Response, MCH, CB-MSG4)

A MAC PDU consists of a MAC header, zero or more MAC Service Data Units (MAC SDU), zero, or more MAC control elements, and optionally padding; as described in Figure 6.1.2-3.

Both the MAC header and the MAC SDUs are of variable sizes.

A MAC PDU header consists of one or more MAC PDU subheaders; each subheader corresponds to either a MAC SDU, a MAC control element or padding.

A MAC PDU subheader consists of the header fields R/F2/E/LCID/(R/R/eLCID)/(F)/(L). The L field is present in the MAC PDU subheader except for the last subheader in the MAC PDU and fixed sized MAC control elements. The last subheader in the MAC PDU and subheaders for fixed sized MAC control elements consist of the header fields R/F2/E/LCID/(R/R/eLCID). A MAC PDU subheader corresponding to padding consists of the four header fields R/F2/E/LCID.

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**Figure 6.1.2-1: R/F2/E/LCID/(R/R/eLCID)/F/L MAC subheader with 7-bits and 15-bits L field**

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**Figure 6.1.2-1a: R/F2/E/LCID/(R/R/eLCID)/L MAC subheader with 16-bits L field**

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**Figure 6.1.2-2: R/F2/E/LCID/(R/R/eLCID) MAC subheader**

MAC PDU subheaders have the same order as the corresponding MAC SDUs, MAC control elements and padding.

MAC control elements are always placed before any MAC SDU.

Padding occurs at the end of the MAC PDU, except when single-byte or two-byte padding is required. Padding may have any value and the MAC entity shall ignore it. When padding is performed at the end of the MAC PDU, zero or more padding bytes are allowed.

When single-byte or two-byte padding is required, one or two MAC PDU subheaders corresponding to padding are placed at the beginning of the MAC PDU before any other MAC PDU subheader.

A maximum of one MAC PDU can be transmitted per TB per MAC entity. A maximum of one MCH MAC PDU can be transmitted per TTI.

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**Figure 6.1.2-3: Example of MAC PDU consisting of MAC header, MAC control elements, MAC SDUs and padding**

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6.1.5 MAC PDU (Random Access Response)

A MAC PDU consists of a MAC header and zero or more MAC Random Access Responses (MAC RAR) and optionally padding as described in figure 6.1.5-4.

The MAC header is of variable size.

A MAC PDU header consists of one or more MAC PDU subheaders; each subheader corresponding to a MAC RAR except for the Backoff Indicator subheader. If included, the Backoff Indicator subheader is only included once and is the first subheader included within the MAC PDU header.

A MAC PDU subheader consists of the three header fields E/T/RAPID (as described in figure 6.1.5-1) but for the Backoff Indicator subheader which consists of the five header field E/T/R/R/BI (as described in figure 6.1.5-2).

A MAC RAR consists of the following fields R/Timing Advance Command/UL Grant/(R/ER)/Temporary C-RNTI (as described in figures 6.1.5-3, 6.1.5-3a, 6.1.5-3b and 6.1.5-3c). For BL UEs and UEs in enhanced coverage in enhanced coverage level 2 or 3 (see clause 6.2 in TS 36.213 [2]) the MAC RAR in figure 6.1.5-3a is used, for NB-IoT UEs (see clause 16.3.3 in TS 36.213 [2]) the MAC RAR in figure 6.1.5-3b is used, except for NB-IoT UEs using preamble format 2, the MAC RAR in figure 6.1.5-3c is used. Otherwise the MAC RAR in figure 6.1.5-3 is used.

Padding may occur after the last MAC RAR. Presence and length of padding is implicit based on TB size, size of MAC header and number of RARs.

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**Figure 6.1.5-1: E/T/RAPID MAC subheader**

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**Figure 6.1.5-2: E/T/R/R/BI MAC subheader**

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**Figure 6.1.5-3: MAC RAR**

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**Figure 6.1.5-3a: MAC RAR for PRACH enhanced coverage level 2 or 3**

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**Figure 6.1.5-3b: MAC RAR for NB-IoT UEs**

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**Figure 6.1.5-3c: MAC RAR for NB-IoT UEs using PRACH preamble format 2**

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**Figure 6.1.5-4: Example of MAC PDU consisting of a MAC header and MAC RARs**

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6.1.x MAC PDU (CB-Msg4)

A MAC PDU consists of a MAC header, one or more MAC CB-Msg3-EDT Responses (MAC CBR), zero or more optionally MAC SDUs, and optionally padding as described in figure 6.1.x-5. The MAC SDU is associated with the UE indicated by the MAC CBR that precedes it.

The MAC header is of variable size.

A MAC PDU header consists of one or more MAC PDU subheaders; each subheader except for the CB Backoff Indicator subheader corresponding to a MAC CBR, MAC SDU, or padding. If included, the CB Backoff Indicator subheader is only included once and is the first subheader included within the MAC PDU header.

The CB Backoff Indicator subheader consists of the four header field E/T/R/BI (as described in figure 6.1.x-1).

A CBR subheader consists of the seven header fields E/T/R/R/T2/T3/T4 (as described in figure 6.1.x-2).

A MAC PDU subheader consists of the header fields R/T/LCID/(L). The L field is present in the MAC PDU subheader except for the last subheader in the MAC PDU. (as described in figure 6.1.x-3). A MAC PDU subheader corresponding to padding consists of the four header fields E/T/LCID.

For BL UEs and UEs in enhanced coverage, a MAC CBR consists of the following fields UE Contention Resolution Identity/(Timing Advance Command)/(HARQ ACK resource)/(C-RNTI) (as described in figures 6.1.x-4). For NB-IoT UEs, a MAC CBR consists of the following fields UE Contention Resolution Identity/(R)/(HARQ ACK resource) /(R)/(Timing Advance Command)/(C-RNTI) (as described in figures 6.1.x-5).

Padding occurs at the end of the MAC PDU, except when single-byte or two-byte padding is required. Padding may have any value and the MAC entity shall ignore it. When padding is performed at the end of the MAC PDU, zero or more padding bytes are allowed.

When single-byte or two-byte padding is required, one or two MAC PDU subheaders corresponding to padding are placed at the beginning of the MAC PDU before any other MAC PDU subheader.

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**Figure 6.1.x-1: E/T/R/BI MAC subheader**

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**Figure 6.1.x-2: E/T/R/R/T2/T3/T4 MAC subheader**

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**Figure 6.1.x-3:E/T/LCID/(L) MAC subheader**

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**Figure 6.1.x-4: MAC CBR for BL UEs and UEs in enhanced coverage**

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**Figure 6.1.x-5: MAC CBR for NB-IoT UEs**

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**Figure 6.1.x-6: Example of MAC PDU consisting of a MAC header, MAC CBRs, MAC SDUs and padding**

6.2 Formats and parameters

6.2.1 MAC header for DL-SCH, UL-SCH and MCH

The MAC header is of variable size and 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 control element or padding as described in tables 6.2.1-1, 6.2.1-2 and 6.2.1-4 for the DL-SCH, UL-SCH and MCH respectively. There is one LCID field for each MAC SDU, MAC control element or padding included in the MAC PDU. In addition to that, one or two additional LCID fields are included in the MAC PDU, when single-byte or two-byte padding is required but cannot be achieved by padding at the end of the MAC PDU. If the LCID field is set to "10000", an additional octet is present in the MAC PDU subheader containing the eLCID field and this additional octet follows the octet containing LCID field. A UE of Category 0, as specified in TS 36.306 [12], except when in enhanced coverage, and *unicastFreqHoppingInd-r13* is indicated in the BR version of SI message carrying *SystemInformationBlockType2*, and UE supports frequency hopping for unicast, as specified in TS 36.306 [12], shall indicate CCCH using LCID "01011", a BL UE with support for frequency hopping for unicast, as specified in TS 36.306 [12], and a UE in enhanced coverage with support for frequency hopping for unicast, as specified in TS 36.306 [12], shall if *unicastFreqHoppingInd-r13* is indicated in the BR version of SI message carrying *SystemInformationBlockType2* indicate CCCH using LCID "01100", otherwise the UE shall indicate CCCH using LCID "00000". A short DCQR may be included in the MAC PDU subheader with LCID set to "00000", "01011", "01100" or "01101". The LCID field size is 5 bits;

- eLCID: The extended Logical Channel ID field identifies the logical channel instance of the corresponding MAC SDU or the type of the corresponding MAC control element as described in tables 6.2.1-1a and 6.2.1-2a for the DL-SCH and UL-SCH respectively. The size of the eLCID field is 6 bits.

- L: The Length field indicates the length of the corresponding MAC SDU or variable-sized MAC control element in bytes. There is one L field per MAC PDU subheader except for the last subheader and subheaders corresponding to fixed-sized MAC control elements. The size of the L field is indicated by the F field and F2 field;

- F: The Format field indicates the size of the Length field as indicated in table 6.2.1-3. There is one F field per MAC PDU subheader except for the last subheader and subheaders corresponding to fixed-sized MAC control elements and except for when F2 is set to 1. The size of the F field is 1 bit. If the F field is included; if the size of the MAC SDU or variable-sized MAC control element is less than 128 bytes, the value of the F field is set to 0, otherwise it is set to 1;

- F2: Except when this field is used for short DCQR, the Format2 field indicates the size of the Length field as indicated in table 6.2.1-3. For short DCQR, the mapping of F2 field to short DCQR value is described in table 6.2.1-5. There is one F2 field per MAC PDU subheader. The size of the F2 field is 1 bit. Except when this field is used for short DCQR, if the size of the MAC SDU or variable-sized MAC control element is larger than 32767 bytes, and if the corresponding subheader is not the last subheader, the value of the F2 field is set to 1, otherwise it is set to 0;

- E: The Extension field is a flag indicating if more fields are present in the MAC header or not. The E field is set to "1" to indicate another set of at least R/F2/E/LCID fields. The E field is set to "0" to indicate that either a MAC SDU, a MAC control element or padding starts at the next byte;

- R: Except when this field is used for short DCQR, reserved bit, set to "0". For short DCQR, the mapping of R field to short DCQR value is described in table 6.2.1-5.

The MAC header and subheaders are octet aligned.

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

|  |  |
| --- | --- |
| **Codepoint/Index** | **LCID values** |
| 00000 | CCCH |
| 00001-01010 | Identity of the logical channel |
| 01011-01100 | Reserved |
| 01101 | UL Transmission Extension Update |
| 01110 | GNSS Measurement Command |
| 01111 | Differential Koffset |
| 10000 | Extended logical channel ID field |
| 10001 | DCQR Command |
| 10010 | Activation/Deactivation of PDCP Duplication |
| 10011 | Hibernation (1 octet) |
| 10100 | Hibernation (4 octets) |
| 10101 | Activation/Deactivation of CSI-RS |
| 10110 | Recommended bit rate |
| 10111 | SC-PTM Stop Indication |
| 11000 | Activation/Deactivation (4 octets) |
| 11001 | SC-MCCH, SC-MTCH (see note) |
| 11010 | Long DRX Command |
| 11011 | Activation/Deactivation (1 octet) |
| 11100 | UE Contention Resolution Identity |
| 11101 | Timing Advance Command |
| 11110 | DRX Command |
| 11111 | Padding |
| NOTE: Both SC-MCCH and SC-MTCH cannot be multiplexed with other logical channels in the same MAC PDU except for Padding and SC-PTM Stop Indication |

**Table 6.2.1-1a Values of eLCID for DL-SCH**

|  |  |  |
| --- | --- | --- |
| **Codepoint** | **Index** | **LCID values** |
| 000000-000110 | 32-38 | Identity of the logical channel |
| 000111-111111 | 39-95 | Reserved |

For NB-IoT only the following LCID values for DL-SCH are applicable: CCCH, Identity of the logical channel, DCQR Command, SC-PTM Stop Indication, SC-MCCH/SC-MTCH, UE Contention Resolution Identity, Timing Advance Command, DRX Command, Differential Koffset, GNSS Measurement Command, UL Transmission Extension Update and Padding.

**Table 6.2.1-2 Values of LCID for UL-SCH**

|  |  |
| --- | --- |
| **Codepoint/Index** | **LCID values** |
| 00000 | CCCH |
| 00001-01010 | Identity of the logical channel |
| 01011 | CCCH |
| 01100 | CCCH |
| 01101 | CCCH and Extended Power Headroom Report |
| 01110 | GNSS Validity Duration Report |
| 01111 | Timing Advance Report |
| 10000 | Extended logical channel ID field |
| 10001 | DCQR and AS RAI |
| 10010 | AUL confirmation (4 octets) |
| 10011 | AUL confirmation (1 octet) |
| 10100 | Recommended bit rate query |
| 10101 | SPS confirmation |
| 10110 | Truncated Sidelink BSR |
| 10111 | Sidelink BSR |
| 11000 | Dual Connectivity Power Headroom Report |
| 11001 | Extended Power Headroom Report |
| 11010 | Power Headroom Report |
| 11011 | C-RNTI |
| 11100 | Truncated BSR |
| 11101 | Short BSR |
| 11110 | Long BSR |
| 11111 | Padding |

**Table 6.2.1-2a Values of eLCID for UL-SCH**

|  |  |  |
| --- | --- | --- |
| **Codepoint** | **Index** | **LCID values** |
| 000000-000110 | 32-38 | Identity of the logical channel |
| 000111-111111 | 39-95 | Reserved |

For NB-IoT only the following LCID values for UL-SCH are applicable: CCCH (LCID "00000"), Identity of the logical channel, CCCH and Extended Power Headroom Report, DCQR and AS RAI, SPS confirmation, C-RNTI, Short BSR, Timing Advance Report, GNSS Validity Duration Report and Padding.

**Table 6.2.1-3 Values of F and F2 fields:**

|  |  |  |
| --- | --- | --- |
| **Index of F2** | **Index of F** | **Size of Length field (in bits)** |
| 0 | 0 | 7 |
| 1 | 15 |
| 1 | - | 16 |

**Table 6.2.1-4 Values of LCID for MCH**

|  |  |
| --- | --- |
| **Index** | **LCID values** |
| 00000 | MCCH (see note) |
| 00001-11100 | MTCH |
| 11101 | Reserved |
| 11110 | MCH Scheduling Information or Extended MCH Scheduling Information |
| 11111 | Padding |
| NOTE: If there is no MCCH on MCH, an MTCH could use this value. |

**Table 6.2.1-5: Values of R and F2 fields for short DCQR**

|  |  |  |
| --- | --- | --- |
| **Index of R** | **Index of F2** | **Short DCQR value** |
| 0 | 0 | No short DCQR |
| 0 | 1 | Short DCQR 1 |
| 1 | 0 | Short DCQR 2 |
| 1 | 1 | Short DCQR 3 |

6.2.2 MAC header for Random Access Response

The MAC header is of variable size and consists of the following fields:

- E: The Extension field is a flag indicating if more fields are present in the MAC header or not. The E field is set to "1" to indicate at least another set of E/T/RAPID fields follows. The E field is set to "0" to indicate that a MAC RAR or padding starts at the next byte;

- T: The Type field is a flag indicating whether the MAC subheader contains a Random Access ID or a Backoff Indicator. The T field is set to "0" to indicate the presence of a Backoff Indicator field in the subheader (BI). The T field is set to "1" to indicate the presence of a Random Access Preamble ID field in the subheader (RAPID);

- R: Reserved bit, set to "0";

- BI: The Backoff Indicator field identifies the overload condition in the cell. The size of the BI field is 4 bits;

- RAPID: The Random Access Preamble IDentifier field identifies the transmitted Random Access Preamble (see clause 5.1.3). The size of the RAPID field is 6 bits.

The MAC header and subheaders are octet aligned.

NOTE: For NB-IoT, the Random Access Preamble IDentifier field corresponds to the start subcarrier index.

6.2.3 MAC payload for Random Access Response

The MAC RAR is of fixed size and consists of the following fields:

- R: Reserved bit, set to "0". For a BL UE or a UE in CE, this bit is set to "1" to indicate that an UL Grant in Random Access Response is for EDT;

- Timing Advance Command: The Timing Advance Command field indicates the index value *TA* (0, 1, 2… 1282) used to control the amount of timing adjustment that the MAC entity has to apply (see clause 4.2.3 of TS 36.213 [2]), except for NB-IoT UEs using preamble format 2, where the Timing Advance Command field indicates the index value *TA* (0, 1, 2… 1536). The size of the Timing Advance Command field is 11 bits;

- UL Grant: The Uplink Grant field indicates the resources to be used on the uplink (see clause 6.2 of TS 36.213 [2], or for NB-IoT UEs, see clause 16.3.3 of TS 36.213 [2]). The size of the UL Grant field is 20 bits, except for NB-IoT UEs, where the size of UL grant field is 15 bits, and except for BL UEs and UEs in enhanced coverage level 2 or 3, where the size of the UL grant field is 12 bits.

- ER: Extended RAPID bits, indicating the two least significant bits of extended RAPID used when PRACH preamble format 2 is transmitted.

- Temporary C-RNTI: The Temporary C-RNTI field indicates the temporary identity that is used by the MAC entity during Random Access. The size of the Temporary C-RNTI field is 16 bits.

The MAC RAR is octet aligned.

6.2.4 MAC header for SL-SCH

The MAC header is of variable size and consists of the following fields:

- V: The MAC PDU format version number field indicates which version of the SL-SCH subheader is used. In this version of the specification three format versions are defined, and this field shall therefore be set to "0001", "0010", and "0011". If the DST field is 24 bits this field shall be set to "0011". The V field size is 4 bits;

- SRC: The Source Layer-2 ID field carries the identity of the source. It is set to the ProSe UE ID. The SRC field size is 24 bits;

- DST: The DST field can be 16 bits or 24 bits. If it is 16 bits, it carries the 16 most significant bits of the Destination Layer-2 ID. If it is 24 bits, it is set to the Destination Layer-2 ID. For sidelink communication, the Destination Layer-2 ID is set to the ProSe Layer-2 Group ID or Prose UE ID. For V2X sidelink communication, the Destination Layer-2 ID is set to the identifier provided by upper layers as defined in TS 23.285 [14]. If the V field is set to "0001", this identifier is a groupcast identifier. If the V field is set to "0010", this identifier is a unicast identifier;

- LCID: The Logical Channel ID field uniquely identifies the logical channel instance within the scope of one Source Layer-2 ID and Destination Layer-2 ID pair of the corresponding MAC SDU or padding as described in table 6.2.4-1. There is one LCID field for each MAC SDU or padding included in the MAC PDU. In addition to that, one or two additional LCID fields are included in the MAC PDU, when single-byte or two-byte padding is required but cannot be achieved by padding at the end of the MAC PDU. The values of LCID from "01011" to "10100" identify the logical channels used to send duplicated RLC SDUs from logical channels of which the values of LCID from "00001" to "01010" respectively in sequential order. The LCID field size is 5 bits;

- L: The Length field indicates the length of the corresponding MAC SDU in bytes. There is one L field per MAC PDU subheader except for the last subheader. The size of the L field is indicated by the F field;

- F: The Format field indicates the size of the Length field as indicated in table 6.2.4-2. There is one F field per MAC PDU subheader except for the last subheader. The size of the F field is 1 bit. If the size of the MAC SDU is less than 128 bytes, the value of the F field is set to 0, otherwise it is set to 1;

- E: The Extension field is a flag indicating if more fields are present in the MAC header or not. The E field is set to "1" to indicate another set of at least R/R/E/LCID fields. The E field is set to "0" to indicate that either a MAC SDU or padding starts at the next byte;

- R: Reserved bit, set to "0".

The MAC header and subheaders are octet aligned.

**Table 6.2.4-1 Values of LCID for SL-SCH**

|  |  |
| --- | --- |
| **Index** | **LCID values** |
| 00000 | Reserved |
| 00001-01010 | Identity of the logical channel |
| 01011-10100 | Identity of the logical channel which is used for duplication |
| 10101-11011 | Reserved |
| 11100 | PC5-S messages that are not protected |
| 11101 | PC5-S messages "Direct Security Mode Command" and "Direct Security Mode Complete" |
| 11110 | Other PC5-S messages that are protected |
| 11111 | Padding |

**Table 6.2.4-2 Values of F field:**

|  |  |
| --- | --- |
| **Index** | **Size of Length field (in bits)** |
| 0 | 7 |
| 1 | 15 |

<Skip>

6.2.x MAC header for CB-MSG4

The MAC header is of variable size and consists of the following fields:

- E: The Extension field is a flag indicating if more fields are present in the MAC header or not. The E field is set to "1" to indicate at least another subheader follows. The subsequent subheader can be E/T/R/BI MAC subheader, E/T/R/R/T2/T3/T4 MAC subheader or E/T/LCID/(L) MAC subheader. The E field is set to "0" to indicate that either a MAC CBR, a MAC SDU or padding starts at the next byte;

- T: The Type field is a flag indicating the type of the MAC subheader. The T field is set to "00" to indicate the presence of a Backoff Indicator field in the subheader (BI). The T field is set to "01" to indicate the presence of T2 in the subheader. The T field is set to "10" to indicate the presence of a Logical Channel ID field (LCID) in the subheader. The Type field is 2bits;

- T2: The Type2 field is a flag indicating the presence of the HARQ ACK resource field in the corresponding MAC CRB. For NB-IoT, it aslo inidcate the presence of the 4-bit R fields preceding the HARQ ACK resource field in the same MAC CRB;

- T3: The Type3 field is a flag indicating the presence of the Timing Advance Command field in the corresponding MAC CRB. For NB-IoT, it aslo inidcate the presence of the 2-bit R fields preceding the Timing Advance Command field in the same MAC CRB;

- T4: The Type4 field is a flag indicating the presence of the C-RNTI field in the corresponding MAC CRB;

- R: Reserved bit, set to "0";

- BI: The Backoff Indicator field identifies the overload condition in the cell. The size of the BI field is 4 bits;

- LCID: The Logical Channel ID field identifies the logical channel instance of the corresponding MAC SDU or padding as described in tables 6.2.1-1 for the DL-SCH. There is one LCID field for each MAC SDU, or padding included in the MAC PDU. In addition to that, one or two additional LCID fields are included in the MAC PDU, when single-byte or two-byte padding is required but cannot be achieved by padding at the end of the MAC PDU. The LCID field size is 5 bits.

The MAC header and subheaders are octet aligned.

6.2.y MAC payload for CB-MSG4

The MAC CBR is of fixed size and consists of the following fields:

- UE Contention Resolution Identity: This field contains the first 48 bits of the uplink CCCH SDU;

- R: Reserved bit, set to "0";

- HARQ ACK resource: This field indicate the resource used for HARQ ACK resource. For BL UEs and UEs in enhanced coverage, the length of this field is 2 bit (see HARQ-ACK resource offset in clause 5.3.3.1.13 of TS 36.212). For NB-IoT, the length of this field is 4 bit (see HARQ-ACK resource in clause 6.4.3.2 of TS 36.212);

- Timing Advance Command: The Timing Advance Command field indicates the index value *TA* (0, 1, 2… 63) used to control the amount of timing adjustment that the MAC entity has to apply (see clause 4.2.3 of TS 36.213 [2]). The size of the Timing Advance Command field is 6 bits;

- C-RNTI: This field contains the C-RNTI of the MAC entity. The length of the field is 16 bits.