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| Project | **IEEE 802.16 Broadband Wireless Access Working Group <**<http://ieee802.org/16>**>** | |
| Title | **MAC Layer Amendments to Section 6 for channel bandwidth below 1.25 MHz (v1.1)** | |
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| Re: | Call for Contributions: IEEE 802.16 Working Group on Broadband Wireless Access GRIDMAN Task Group: Project 802.16s  IEEE 802.16-16-0035-01-000s | |
| Abstract | Describes proposed amendments to Section 6 for channel bandwidth below 1.25 MHz. Updated to include Section 6.3.3.5 | |
| Purpose | For consideration during Working Group Session #107 | |
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1. ***RESERVED***
2. **Data/Control plane**

**6.3.1 Addressing and connections**

**6.3.1.1 Point-to-multipoint (PMP)**

Each air interface in an SS shall have a 48-bit universal MAC address, as defined in IEEE Std 802 . This address uniquely defines the air interface of the SS. It is used during the initial ranging process to establish the appropriate connections for an SS. It is also used as part of the authentication process by which the BS and SS each verify the identity of the other. The definition and usage of the MAC address defined above for the SS and the BS shall be applicable for the RS and the MR-BS, respectively.

Connections are identified by a 16-bit CID. At SS initialization, two pairs of management connections, basic connections (UL and DL) and primary management connections (UL and DL), shall be established between the SS and the BS, and a third pair of management connections (secondary management, DL and UL) may be optionally generated. The three pairs of management connections reflect the fact that there are inherently three different levels of QoS for management traffic between an SS and the BS. The basic connection is used by the BS MAC and SS MAC to exchange short, time-urgent MAC management messages. The primary management connection is used by the BS MAC and SS MAC to exchange longer, more delay-tolerant MAC management messages. Table 6-51 specifies which MAC management messages are transferred on which of these two connections. In addition, it also specifies which MAC management messages are transported on the broadcast connection. Finally, the secondary management connection is used by the BS and SS to transfer delay-tolerant, standards-based [Dynamic Host Configuration Protocol (DHCP), Trivial File Transfer Protocol (TFTP), SNMP, etc.] messages. Messages carried on the secondary management connection may be packed and/or fragmented. For the OFDM, and OFDMA PHYs, management messages shall have CRC. Use of the secondary management connection is required only for managed SS. The identification, establishment, and usage of the connection defined above for the SS and the BS shall be applicable for the RS and the MR-BS, respectively. In addition, the multicast management connection is used by the MR-BS to transfer MAC management messages to a group of RSs.

The CIDs for these connections shall be assigned in the RNG-RSP, REG-RSP, RS\_Config-CMD (RS only), or MOB\_BSHO-REQ/RSP for pre-allocation in handover. When CID pre-allocation is used during HO, a primary management CID may be derived based on Basic CID without assignment in the messages (see 6.3.20.2.11). The message dialogs provide three CID values. The same CID value is assigned to both members (UL and DL) of each connection pair.

For bearer services, the BS and the SS may initiate the set-up of service flows based upon the provisioning information. The registration of an SS, or the modification of the services contracted at an SS, stimulates the higher layers of the BS and/or the SS to initiate the setup of the service flows. When admitted or active, service flows are uniquely associated with transport connections. MAC management messages shall never

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be transferred over transport connections. Bearer or data services shall never be transferred on the basic, primary, or secondary management connections.

Bearer connection CID reassignments during handover or network reentry shall be sent using the REG-RSP encodings TLV in the RNG-RSP message, the REG-RSP message, or reassigned autonomously without explicit assignment in any message (see 6.3.20.2.11).

Requests for transmission are based on these CIDs, since the allowable bandwidth may differ for different connections, even within the same service type. For example, an SS unit serving multiple tenants in an office building would make requests on behalf of all of them, though the contractual service limits and other connection parameters may be different for each of them.

Many higher layer sessions may operate over the same wireless CID. For example, many users within a company may be communicating with Transmission Control Protocol (TCP)/IP to different destinations, but since they all operate within the same overall service parameters, all of their traffic is pooled for request/ grant purposes. Since the original local area network (LAN) source and destination addresses are encapsulated in the payload portion of the transmission, there is no problem in identifying different user sessions.

The type of service and other current parameters of a service are implicit in the CID; they may be accessed by a lookup indexed by the CID.

**6.3.1.2 Multihop relay**

Addressing and connections as perceived by an SS served by an RS or MR-BS are defined in the same manner as in 6.3.1.1. This subclause specifies the additional addressing and connection definitions that apply to multihop relay systems. A non-transparent RS shall be assigned a Base Station ID. The format of the Base Station ID is defined in 6.3.2.3.2.

Connections may span multiple hops and may pass through one or more intermediate RSs. These connections shall be identified by the connection ID (CID) as specified in 6.3.1.1 and the CIDs shall be unique within an MR cell. All the CID connection types specified in PMP mode shall be supported between the MR-BS and MS.

An additional type of connection called a tunnel connection may be established between the MR-BS and an access RS, or between the MR-BS and a superordinate station of an RS group (see 6.3.33). Tunnel connections shall be used for transporting relay MAC PDUs from one or more connections between the MR-BS and an access RS and may pass through one or more intermediate RSs. It is not required that all connections shall pass through a tunnel connection. MAC PDUs from connections that do not pass through a tunnel are forwarded based on the CID of the connection. There shall be two types of tunnel connections. Management tunnel connections, identified using the MT-CID, shall be used exclusively for transporting MAC PDUs from management (basic, primary, or secondary) connections. Transport tunnel connections, identified using the T-CID, shall be used exclusively for transporting MAC PDUs from transport connections. The MR-BS shall allocate the T-CID and MT-CID using the DSA messages. MT-CID is bidirectional and T-CID is unidirectional.

**6.3.1.2.1 Addressing scheme for relaying**

In the procedure of network entry and initialization for a new RS, the MR-BS may pre-allocate a range of management CIDs to an RS. The operation for pre-allocation of these CIDs is described in 6.3.9.18.2.One or more BS in an area of the network may be grouped into an M2M zone and identified by an M2M GROUP ZONE ID. A BS may belong to at most one M2M group zone. The BS may broadcast the M2M GROUP ZONE ID of the zone to which it belongs in the DCD message.

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The M2M multicast connection ID (M2MCID) uniquely identifies a downlink multicast service flow shared by a group of M2M devices within an M2M zone. Implicitly, it is also used to identify the group of M2M devices that share the downlink multicast service flow. An M2M device may share more than one downlink multicast service flow each identified by an M2MCID. All M2MCIDs that are assigned to an M2M device belong to the same M2M group zone.

The M2MCID is assigned to a service flow of an M2M device during the DSA procedure and released during the DSD procedure or an explicit network exit (e.g., power down location update). The assigned M2MCID shall be retained by an M2M device even in idle mode unless the M2M device exits from the net-work or the network explicitly deletes the service flow associated with the M2MCID. The M2MCID may be reassigned during normal operation mode and idle mode. During normal operation, the M2MCID may be changed and deleted by DSC and DSD procedures respectively.

During idle mode, the M2MCID may be changed by a location update procedure or during network reentry through the RNG-RSP message. The BS may trigger the group location update via paging message. In normal operation, the BS may update the M2MCID for a M2M device group using the MAC Group Man-agement Control (MGMC) message.

When the M2M device performs the timer-based location update, if the BS needs to update the M2MCID of M2M device, the BS may send a RNG-RSP message with an M2MCID Update TLV, which contains a new M2MCID value in response to the RNG-REQ message.

A BS may use the MOB\_PAG-ADV message to indicate the update of the M2MCID and its new value to all the M2M devices in a group. When an idle mode M2M device that belongs to the M2M device group (identified by its M2MCID) receives a paging message containing an M2MCID TLV identifying one of its service flows and an Action Code TLV with value set to 0b11, this M2M device shall update the M2MCID based on the value indicated by M2MCID reassignment TLV (see 11.17.5).

After receiving the updated M2MCID value, the M2M device shall send an acknowledgement (ACK) to the BS.

If the BS does not receive an acknowledgement from some of the M2M devices, it may trigger location update in the next paging cycle of those M2M devices by sending MOB\_PAG-ADV message containing MS MAC Address hash and it may send a RNG-RSP message with an M2MCID Update TLV containing the new M2MCID to each of them during the location update procedure.

The BS may use the M2M Group MAC Control (MGMC) message with the M2MCIDs to send the informa-tion to multiple M2M devices. The M2M device shall respond to acknowledge this message with M2M ACK MAC Control (MAMC) message.

The information of the neighboring M2M Group Zones may be advertised by BSs of a given M2M Group Zone in MOB\_NBR-ADV message. Neighboring M2M Group Zones implies the M2M Group Zones to which the neighboring BSs belong are different from the M2M Group Zone to which the serving BS belongs.

The MOB\_NBR-ADV message contains M2M\_GROUP\_ZONE\_ID of the neighboring M2M Group Zones along with the mappings of M2MCID from the M2M Group Zone of the serving BS to one or more neigh-boring M2M Group Zones. When an M2M device changes its preferred or serving BS to a BS that belongs to a different M2M Group Zone than the current serving BS, it may have the M2MCID mapping information for the M2M Group Zone of that BS, if it has already received the MOB\_NBR-ADV.

The MOB\_NBR-ADV message including M2M Group Zone information should be transmitted by the BSs that are situated at the M2M Group Zone boundaries.

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**6.3.2 MAC PDU formats**

MAC PDUs shall be of the form illustrated in Figure 6-1. Each PDU shall begin with a fixed-length MAC header. The header may be followed by the Payload of the MAC PDU. If present, the Payload shall consist of zero or more subheaders and zero or more MAC SDUs and/or fragments thereof. The payload information may vary in length, so that a MAC PDU may represent a variable number of bytes. This allows the MAC to tunnel various higher layer traffic types without knowledge of the formats or bit patterns of those messages.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| MSB |  |  |  | LSB |
|  |  |  |  |  |
| MAC header | Payload (optional) | | | CRC (optional) |
|  |  |  |  |  |



**Figure 6-1—MAC PDU formats**

A MAC PDU may contain a CRC, as described in 6.3.3.5. Implementation of CRC capability is mandatory for OFDM and OFDMA PHYs. All reserved fields shall be set to zero on transmission and ignored on reception.

MAC PDUs sent on a relay link through a tunnel shall be constructed into a relay MAC PDU of the form illustrated in Figure 6-2. Each relay MAC PDU shall begin with a fixed length relay MAC header (see 6.3.2.1.1.1). The relay MAC header shall be followed by zero or more extended subheaders and the payload. The payload shall consist of zero or more subheaders and zero or more MAC PDUs as defined in Figure 6-1. In the case of management tunnel, the payload may consist of zero or more subheaders and one MT\_Transfer MAC message. A relay MAC PDU may contain a CRC as described in 6.3.3.5.2. Implementation of CRC capability is mandatory for MR systems and the presence of a CRC is indicated in the relay MAC header. When a relay MAC PDU contains a CRC, the CRCs of individual MAC PDUs within the payload shall be omitted but the CI bit setting and LEN values are retained. If omitted, the egress station of the tunnel shall calculate the CRCs and attach them to the individual MAC PDUs if the CI bit of the MAC PDU header within the relay MAC PDU is set.

|  |  |  |
| --- | --- | --- |
| **Relay MAC** | **Payload** | **CRC** |
| **Header** | **(optional)** |
|  |
|  |  |  |

**Figure 6-2—Relay MAC PDU format**

**6.3.2.1 MAC header formats**

The MAC header formats are defined in Table 6-1 except for the MAC header formats for DL MAP and UL MAP MAC messages for channel bandwidth below 1.25 MHz in which case the MAC header formats are defined in paragraph 6.3.2.1.1.2.

There is one defined DL MAC header, which is the Generic MAC header, which begins each DL MAC PDU containing either MAC management messages or CS data. There are two defined UL MAC header formats. The first is the generic MAC header that begins each MAC PDU containing either MAC management messages or CS data, where the header type (HT) is set to 0 as shown in Table 6-2. The second is the MAC header format without payload where HT is set to 1 as shown in Table 6-2. For the latter format, the header is not followed by any MAC PDU payload and CRC.

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**Table 6-1—MAC header formats**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| MAC Header() { | — | — |
|  |  |  |
| **HT** | 1 | 0 = Generic MAC header |
|  |  | 1 = Bandwidth request (BR) header |
|  |  |  |
| **EC** | 1 | If HT = 1, EC = 0 |
|  |  |  |
| if (HT == 0) { | — | — |
|  |  |  |
| **Type** | 6 | — |
|  |  |  |
| *Reserved* | 1 | Shall be set to zero |
|  |  |  |
| **CI** | 1 | — |
|  |  |  |
| **EKS** | 2 | — |
|  |  |  |
| *Reserved* | 1 | Shall be set to zero |
|  |  |  |
| **LEN** | 11 | — |
|  |  |  |
| } | — | — |
|  |  |  |
| else { | — | — |
|  |  |  |
| **Type** | 3 | — |
|  |  |  |
| **BR** | 19 | — |
|  |  |  |
| } | — | — |
|  |  |  |
| **CID** | 16 | — |
|  |  |  |
| **HCS** | 8 | — |
|  |  |  |
| } | — | — |
|  |  |  |

**Table 6-2—MAC header HT and EC fields encoding**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **HT** | **ECa** | **MAC PDU type** | **Reference figure** | **Reference table** |
|  |  |  |  |  |
| 0 | 0 | Generic MAC header for DL and UL. | Figure 6-3 | Table 6-3 |
|  |  | MAC PDU with data payload, no |  |  |
|  |  | encryption, with a 6-bit type field, see |  |  |
|  |  | Table 6-4 for its type field encodings. |  |  |
|  |  |  |  |  |
| 0 | 1 | Generic MAC header for DL and UL. | Figure 6-3 | Table 6-3 |
|  |  | MAC PDU with data payload, with |  |  |
|  |  | encryption with a 6-bit type field, see |  |  |
|  |  | Table 6-4 for its type field encodings. |  |  |
|  |  |  |  |  |

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**Table 6-2—MAC header HT and EC fields encoding *(CONTINUED)***

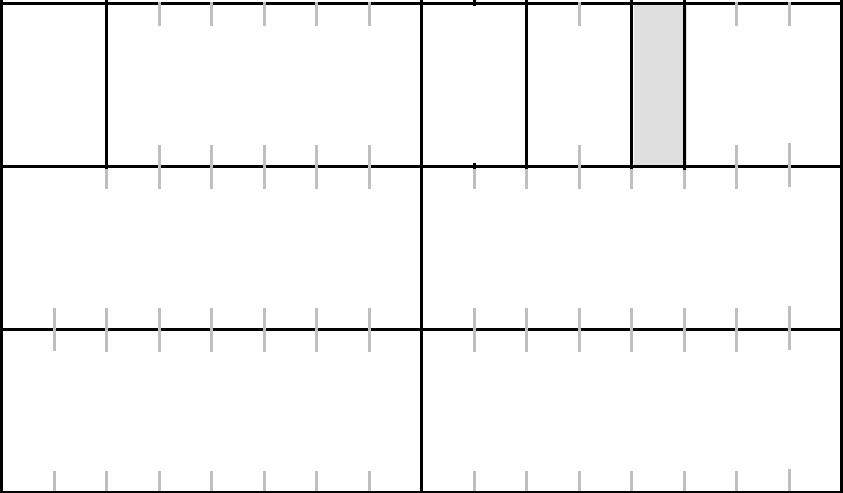
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **HT** | **ECa** | **MAC PDU type** | **Reference figure** | **Reference table** |
|  |  |  |  |  |
| 1 | 0 | DL: DL M2M MAC signaling header | Figure 6-5, | Table 6-6, Table 6-7, |
|  |  | type I. MAC PDU without data | Figure 6-6, | Table 6-8– |
|  |  | payload, with a 3-bit type field, see | Figure 6-7– | Table 6-13 |
|  |  | Table 6-27c for type encoding | Figure 6-12 | Table 6-27c, |
|  |  | definitions. |  | Table 6-27d |
|  |  |  |  |  |
| 1 | 1 | DL: Compressed/Reduced Private | Figure 6-13– | Table 6-14, |
|  |  | DL-MAPb | Figure 6-15 | Table 6-15 |
|  |  | UL: MAC signaling header type II. |  |  |
|  |  | MAC PDU without data payload, with |  |  |
|  |  | 1-bit type field, see Table 6-14 for type |  |  |
|  |  | encoding definitions. |  |  |
|  |  |  |  |  |

aHeaders with HT = 1 shall not be encrypted. Thus the EC field is used to distinguish between feedback MAC header (UL)/Compress MAP (DL), and all other type headers.

bCompressed DL-MAP and Reduced Private MAP do not use MAC headers as defined in 6.3.2.1; however, the first two bits of these maps replace the HT/EC fields and are always set to 0b11 to identify them as such (see 8.3.6.3, 8.3.6.7, 8.4.5.6, and 8.4.5.8). If the most significant bit of the Type field is set to 0, it indicates the presence of a com-pressed/reduced private DL-MAP. If the most significant bit of the Type field is set to 1, it indicates the presence of a SUB-DL-UL-MAP.

**6.3.2.1.1 Generic MAC header**

The generic MAC header is illustrated in Figure 6-3.



|  |  |
| --- | --- |
| = 0 (1) | (1) |
| HT | EC |
|  |  |
|  |  |

Type (6)

|  |  |
| --- | --- |
| ESF (1) | CI (1) |
|  |  |

EKS

(2)

|  |
| --- |
| Rsv (1) |

LEN

MSB (3)

|  |  |
| --- | --- |
| LEN LSB (8) | CID MSB (8) |

|  |  |
| --- | --- |
| CID LSB (8) | HCS (8) |

**Figure 6-3—Generic MAC header format**

The fields of the generic MAC header are defined in Table 6-3. Every header is encoded, starting with the HT and encryption control (EC) fields. The coding of these fields is such that the first byte of a MAC header shall never have the value of 0xFX, where “X” means “do not care.” This prevents false detection on the stuff byte used in the transmission convergence sublayer (TCS).

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|  |  |  |
| --- | --- | --- |
|  |  | **Table 6-3—Generic MAC header fields** |
|  |  |  |
| **Name** | **Length** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| CI | 1 | CRC indicator. |
|  |  | 1 = CRC is included in the PDU by appending it to the PDU payload after encryption, |
|  |  | if any. |
|  |  | 0 = No CRC is included. |
|  |  |  |
| CID | 16 | Connection identifier. |
|  |  |  |
| EC | 1 | Encryption control. |
|  |  | 0 = Payload is not encrypted or payload is not included. |
|  |  | 1 = Payload is encrypted. |
|  |  |  |
| EKS | 2 | Encryption key sequence. The index of the traffic encryption key (TEK) and initialization |
|  |  | vector (IV) used to encrypt the payload. This field is only meaningful if the EC field is set to 1. |
|  |  |  |
| ESF | 1 | Extended Subheader field. If ESF = 0, the extended subheader is absent. If ESF = 1, the |
|  |  | extended subheader is present and shall follow the generic MAC header immediately. (See |
|  |  | 6.3.2.2.7.) The ESF is applicable both in the DL and in the UL. |
|  |  |  |
| HCS | 8 | Header check sequence. An 8-bit field used to detect errors in the header. The transmitter shall |
|  |  | calculate the HCS value for the first five bytes of the cell header, and insert the result into the |
|  |  | HCS field (the last byte of the MAC header). It shall be the remainder of the division (Modulo |
|  |  | 2) by the generator polynomial g(D = D8 + D2 + D + 1 of the polynomial D8 multiplied by the |
|  |  | content of the header excluding the HCS field. (Example: [HT EC Type] = 0x80, BR = |
|  |  | 0xAAAA, CID = 0x0F0F; HCS would then be set to 0xD5). |
|  |  |  |
| HT | 1 | Header type. Shall be set to zero. |
|  |  |  |
| LEN | 11 | Length. The length in bytes of the MAC PDU including the MAC header and the CRC if |
|  |  | present. |
|  |  |  |
| Type | 6 | This field indicates the subheaders and special payload types present in the message payload. |
|  |  |  |

The ESF bit in the Generic MAC header indicates that the extended subheader is present. Using this field, a number of additional subheaders can be used within a PDU. The extended subheader shall always appear immediately after the Generic MAC header and before all other subheaders. Contrary to the other subheaders, extended subheaders are not considered part of the MAC PDU payload and, hence are not encrypted. When an entity transmits a MAC PDU without a payload, it shall set the EC bit in the Generic MAC header to 0, even if the connection on which it transmits the MAC PDU is associated with data encryption. When an entity receives a MAC PDU that does not contain a payload, it shall process this MAC PDU if the EC bit is set to 0, and should discard this MAC PDU if the EC bit is set to 1.

The definition of the Type field is indicated in Table 6-4.

|  |  |
| --- | --- |
|  | **Table 6-4—Type encodings** |
|  |  |
| **Type bit** | **Value** |
|  |  |
| #5 | *Reserved* |
| most significant bit (MSB) |  |
|  |  |
| #4 | ARQ feedback payload |
|  | 1 = present, 0 = absent |
|  |  |

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**Table 6-4—Type encodings *(CONTINUED)***

|  |  |  |
| --- | --- | --- |
| **Type bit** |  | **Value** |
|  |  | |
| #3 | Extended type | |
|  | Indicates whether the present packing subheader (PSH) or fragmentation | |
|  | subheader (FSH) is extended for non-ARQ-enabled connections | |
|  | 1 | = Extended |
|  | 0 | = Not extended |
|  | For ARQ-enabled connections, this bit shall be set to 1. | |
|  |  | |
| #2 | Fragmentation subheader (FSH) | |
|  | 1 | = present, 0 = absent |
|  |  | |
| #1 | Packing subheader (PSH) | |
|  | 1 | = present, 0 = absent |
|  |  | |
| #0 | DL: Fast-feedback allocation subheader (FFSH) | |
| least significant bit (LSB) | UL: Grant management subheader (GMSH) | |
|  | 1 | = present, 0 = absent |
|  |  |  |

**6.3.2.1.1.1 Relay MAC header format**

The header of the relay MAC PDU shall be of the format defined in Table 6-5 and further illustrated in Figure 6-4.

**Table 6-5—Description of relay MAC header fields**

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bits)** |
|  |  |
|  |  |  |
| HT | 1 | Shall be set to zero. |
|  |  |  |
| EC/AC | 1 | Encryption control if CID in the relay MAC header is T- |
|  |  | CID. |
|  |  | 0 = Payload is not encrypted |
|  |  | 1 = Payload, except subheaders inserted on the relay link, |
|  |  | is encrypted. |
|  |  | Authentication control if CID in the relay MAC header is |
|  |  | MT-CID. |
|  |  | 0 = Payload starting with MAC header defined in |
|  |  | Table 6-1. |
|  |  | 1 = Payload starting with MT\_Transfer message defined in |
|  |  | Table 6-240. |
|  |  |  |
| RMI | 1 | Relay Mode Indicator |
|  |  | Shall be set to 1. |
|  |  |  |
| ASH | 1 | Allocation subheader |
|  |  | 1=present; 0=absent |
|  |  |  |
| GMSH | 1 | UL: grant management subheader (GMSH) |
|  |  | 1 = present, 0 = absent |
|  |  | DL: *Reserved;* shall be set to 0. |
|  |  |  |
| FSH | 1 | Fragmentation subheader (FSH) |
|  |  | 1=present; 0=absent |
|  |  |  |
| PSH | 1 | Packing subheader (PSH) |
|  |  | 1=present; 0=absent |
|  |  |  |

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**Table 6-5—Description of relay MAC header fields *(CONTINUED)***

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bits)** |
|  |  |
|  |  |  |
| QSH | 1 | QoS subheader (QSH) |
|  |  | 1=present; 0=absent |
|  |  |  |
| ESF | 1 | Extended subheader field |
|  |  | If ESF=0, the extended subheader is absent. |
|  |  | If ESF=1, the extended subheader is present and |
|  |  | immediately follows the relay MAC header. |
|  |  | The ESF is applicable in both the DL and UL. |
|  |  |  |
| CI | 1 | CRC indicator. |
|  |  | 1 = CRC is included in the relay MAC PDU by appending |
|  |  | it to the relay MAC PDU payload after encryption, if any. |
|  |  | 0 = No CRC is included. |
|  |  |  |
| EKS | 2 | Encryption key sequence. The index of the traffic |
|  |  | encryption key (TEK) of the access RS operating in |
|  |  | distributed security mode and initialization vector (IV) |
|  |  | used to encrypt the payload. This field is only meaningful |
|  |  | if the EC/AC field is set to 1; otherwise, it shall be set to |
|  |  | zero. |
|  |  |  |
| LEN | 12 | Length. The length in bytes of the relay MAC PDU |
|  |  | including the relay MAC header and the CRC if present. |
|  |  |  |
| CID | 16 | T-CID or MT-CID. |
|  |  |  |
| HCS | 8 | Header Check Sequence. |
|  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| HT = 0 (1) | EC/AC (1) | RMI (1) |  | ASH (1) |  | GMSH (UL)(1) |  | FSH (1) | PSH (1) | QSH (1) | ESF (1) | CI (1) |  |  |  |  |  |  |
|  |  |  | EKS (2) | |  | LEN (4) | | |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  | LEN LSB(8) | | | | |  |  |  |  |  | CID (MSB) (8) | | | | | |
|  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  | |  |  | |  |  |  |  |  |  |  |  |  |  |
|  |  |  | CID (LSB) (8) | | | | | |  |  |  |  |  | HCS (8) | |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Figure 6-4—Header format of relay MAC PDU with payload**

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**6.3.2.1.1.2 MAC header format for DL MAP and UL MAP MAC messages when the channel bandwidth is below 1.25 MHz**

The header of the DLMAP MAC message shall be of the format defined in Table 6-X. the DLMAP is always the first burst in the DLSF so it can be identified as DLMAP directly. CID indication is therefore not needed at the receiver side .The modified GMAC header consists of 1 byte length field and 1 byte for HCS field.

Table 6-X - Modified DLMAP header for channel bandwidth below 1.25 MHz

|  |  |
| --- | --- |
| LEN (8) | HCS (8) |

The header of the ULMAP MAC message shall be of the format defined in Table 6-Y. The ULMAP, if present, is the first data burst in the DLSF after DL-MAP, but it may not always be present in a frame in which case, the first burst may carry data traffic. Conflict will be avoided by setting HT = 1 to identify the burst as ULMAP.

The modified UL MAP has reserved 7 bits for ULMAP length indication as it cannot exceed 128 bytes.

Table 6-Y: Modified ULMAP header for channel bandwidth below 1.25 MHz

|  |  |  |
| --- | --- | --- |
| HT (1) | LEN (7) | HCS(8) |

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**6.3.2.1.2 MAC header without payload**

This MAC header format is applicable to UL only. The MAC header is not followed by any MAC PDU payload and CRC.

**6.3.2.1.2.1 MAC signaling header type I**

For this MAC header format, there is no payload following the MAC header. The MAC signaling header type I is illustrated in Figure 6-5. Table 6-6 describes the encoding of the 3-bit Type field following the EC field.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| HT=1(1) | EC=0(1) | Type (3) | | |  |  |  | Header Content MSB (11) | | | | | | | |
|  |  |  | |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Header Content LSB (8) | | | | | |  |  |  | CID MSB (8) | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | CID LSB (8) | | | | | |  |  |  |  | HCS (8) | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |



**Figure 6-5—MAC signaling header type I format**

**Table 6-6—Type field encodings for MAC signaling header type I**

|  |  |  |  |
| --- | --- | --- | --- |
| **Type field** | **MAC header type (with HT/EC = 0b10)** | **Reference** | **Reference** |
| **(3 bits)** | **figure** | **table** |
|  |
|  |  |  |  |
| 000 | BR incremental | Figure 6-6 | Table 6-7 |
|  |  |  |  |
| 001 | BR aggregate | Figure 6-6 | Table 6-7 |
|  |  |  |  |
| 010 | PHY channel report | Figure 6-10 | Table 6-11 |
|  |  |  |  |
| 011 | BR with UL Tx power report | Figure 6-7 | Table 6-8 |
|  |  |  |  |
| 100 | BR and CINR report | Figure 6-8 | Table 6-9 |
|  |  |  |  |
| 101 | BR with UL sleep control | Figure 6-11 | Table 6-12 |
|  |  |  |  |
| 110 | SN Report | Figure 6-12 | Table 6-13 |
|  |  |  |  |
| 111 | CQICH allocation request | Figure 6-9 | Table 6-10 |
|  |  |  |  |

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**6.3.2.1.2.1.1 Bandwidth request (BR) header**

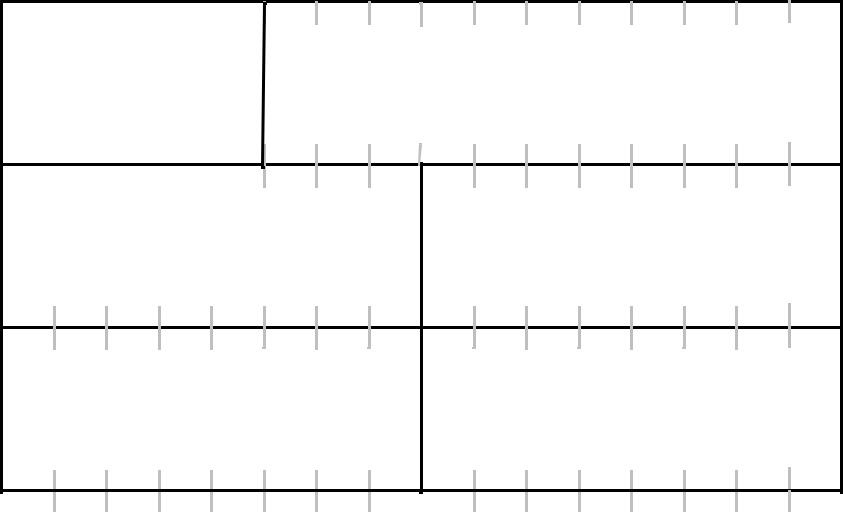
The BR PDU shall consist of BR header alone and shall not contain a payload. The BR header is illustrated in Figure 6-6. An MS receiving a BR header on the DL shall discard the PDU.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| MSB |  |  |  |  |  |
| 1 (1) |  | 0 (1) |  |  |  |
|  |  |  |  |
|  | Type (3) | | |
| HT = |  | EC = |
|  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

BR LSB (8)

CID LSB (8)

BR MSB (11)



CID MSB (8)

HCS (8)

|  |
| --- |
| LSB |

**Figure 6-6—BR header format**

The BR header shall have the following properties:

1. It is a MAC signaling header type I.
2. The CID shall indicate the connection for which UL bandwidth is requested.
3. The BR field shall indicate the number of bytes requested.
4. The allowed types of BRs are defined in Table 6-6.

An SS receiving a BR header on the DL shall discard the PDU.

The fields of the BR header are defined in Table 6-7.

|  |  |  |
| --- | --- | --- |
|  |  | **Table 6-7—BR header fields** |
|  |  |  |
| **Name** | **Length** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| BR | 19 | Bandwidth request. The number of bytes of UL bandwidth requested by the SS. The BR is |
|  |  | for the CID. The request shall be independent of the physical layer modulation and coding. |
|  |  | In case of the Extended rtPS, the BS changes its grant size to the value specified in this field |
|  |  | if the request is granted. |
|  |  |  |
| CID | 16 | Connection identifier. |
|  |  |  |
| EC | 1 | Always set to zero. |
|  |  |  |
| HCS | 8 | Header check sequence. Same usage as HCS entry in Table 6-3. |
|  |  |  |
| HT | 1 | Header type = 1. |
|  |  |  |
| Type | 3 | Indicates the type of BR header. In the case of the Extended rtPS, both Type 0 and Type 1 |
|  |  | adhere to the BR definition above (change in grant size). |
|  |  |  |
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**6.3.2.1.2.1.2 Bandwidth request and UL Tx power report header**

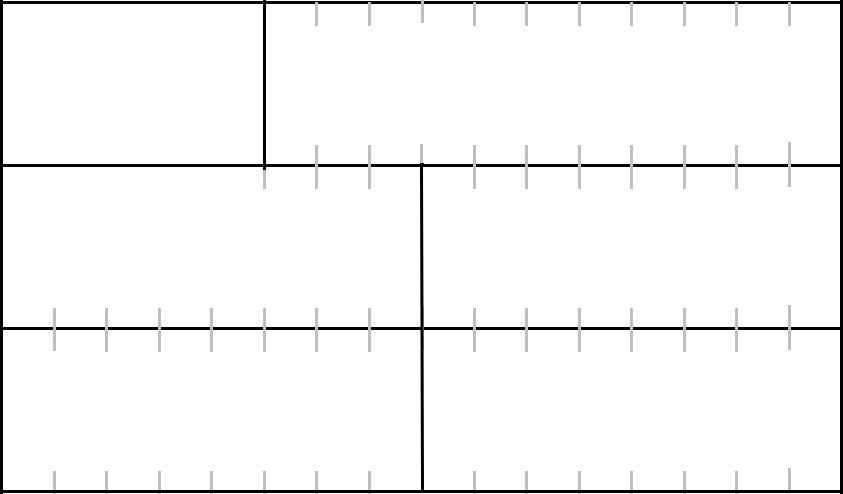
The BR and UL Tx power report PDU shall consist of BR and UL Tx power report header alone and shall not contain a payload. The BR and UL Tx power report header is illustrated in Figure 6-7.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| MSB |  |  |  |  |
| 1(1) |  | 0(1) |  |  |
|  |  |  |
|  | Type (3) | |
|  |  |  |
| = |  | = | = 0b011 | |
| HT |  | EC |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

UL TX Power (8)

CID LSB (8)

BR (11)



CID MSB (8)

HCS (8)

|  |
| --- |
| LSB |

**Figure 6-7—BR and UL Tx power report header format**

The BR and UL Tx power report header shall have the following properties:

1. This is a MAC signaling header type I.
2. The CID shall indicate the connection for which UL bandwidth is requested.
3. The allowed type for BR and UL Tx power report is defined in Table 6-6. The requested bandwidth is incremental.

The fields of the BR and UL Tx power report header are defined in Table 6-8.

**Table 6-8—Description of fields BR and UL Tx power report header**

|  |  |  |
| --- | --- | --- |
| **Name** | **Size** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| Type | 3 | The type of BR and UL Tx power report header is defined in Table 6-6. |
|  |  |  |
| BR | 11 | Bandwidth request. The number of bytes of UL bandwidth requested by the MS. The |
|  |  | BR is for the CID. The request shall be independent of the physical layer modulation |
|  |  | and coding. It is an incremental BR. In case of the Extended rtPS, the BS changes its |
|  |  | grant size to the value specified in this field. |
|  |  |  |
| UL Tx power | 8 | UL Tx power level in dBm for the burst that carries this header (as described in 11.1.1). |
|  |  | The value shall be estimated and reported for the burst. |
|  |  |  |
| CID | 16 | The connection identifier that shall indicate the connection for which UL bandwidth is |
|  |  | requested. |
|  |  |  |
| HCS | 8 | Header check sequence (same usage as HCS entry in Table 6-3). |
|  |  |  |

Support of this subheader shall be negotiated between the BS and MS as part of the registration dialog (REG-REQ/RSP).

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**6.3.2.1.2.1.3 BR and CINR report header**

BR and CINR report PDU shall consist of BR and CINR report header alone, and shall not contain a payload (see Figure 6-8).

|  |
| --- |
| MSB |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 0 | Type | | |  | | |  |  | BR (11) | | | | | | |
| = 0b100 | | |  |  |  |  |  |
| = | = |  | | |  |  |  |  |  |  |  |  |  |
| HT | EC |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | DCDChange | Indication(1) |  |  |  |  |  |  |  |  |
|  |  |  | CINR (7) | | | |  | CID MSB (8) | | | | | |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | CID LSB (8) | | | | | |  |  |  |  | HCS (8) | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |



**Figure 6-8—BR and CINR report**

|  |
| --- |
| LSB |

The BR and CINR report header shall have the following properties:

1. This is a MAC signaling header type I.
2. The CID shall indicate the connection for which UL bandwidth is requested.
3. The allowed type for BR and CINR report header is defined in Table 6-6. The requested bandwidth is incremental.

The fields of the BR and CINR report header are defined in Table 6-9.

**Table 6-9—Description of the fields of BR and CINR report header**

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| Type | 3 | The type of BR and CINR report header is defined in Table 6-6. |
|  |  |  |
| BR | 11 | Bandwidth request: The number of bytes of UL bandwidth requested by the MS. |
|  |  | The BR is for the CID. The request shall not include any PHY overhead. It is an |
|  |  | incremental BR. In the case of Extended rtPS, the BS changes its grant size to the |
|  |  | value specified in this field. |
|  |  |  |
| CINR | 7 | — |
|  |  |  |
| DCD Change | 1 | — |
| Indications |  |  |
|  |  |  |
| CID | 16 | The connection identifier that shall indicate the connection for which UL |
|  |  | bandwidth is requested. |
|  |  |  |
| HCS | 8 | Header check sequence (same usage as HCS entry in Table 6-3). |
|  |  |  |

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**CINR**

This parameter indicates the CINR measured by the MS from the BS. It shall be interpreted as a single value from –16.0 dB to 47.5 dB in units of 0.5 dB.

**DCD Change Indication**

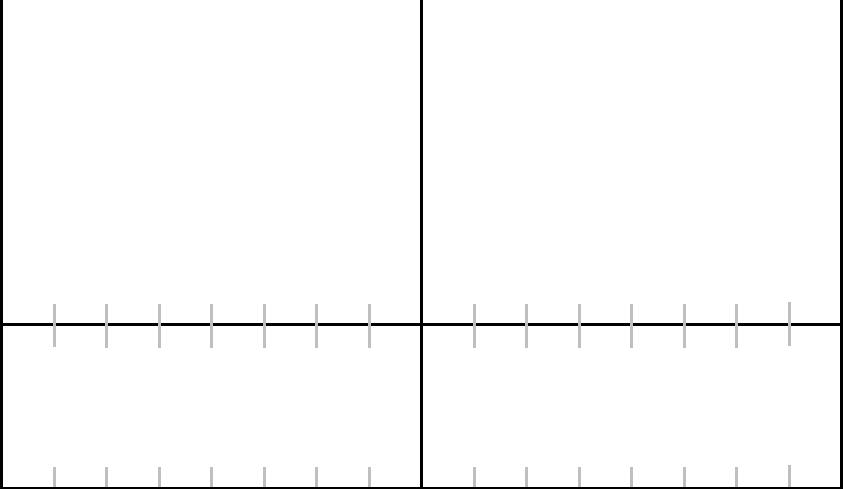
This parameter is set to 1 if the DCD change count stored at the MS is not equal to that in the received DL-MAP message. Otherwise, it is set to 0.

Support of this subheader shall be negotiated between the BS and MS as part of the registration dialog (REG-REQ/RSP).

**6.3.2.1.2.1.4 CQICH allocation request header**

The CQICH allocation request PDU shall consist of a CQICH allocation request header alone and shall not contain a payload. This header is sent by the MS to request the allocation of a CQICH. The CQICH allocation request header is illustrated in Figure 6-9.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| HT=1(1) | EC=0(1) | Type(3) | | |  | Feedback | | | FBSSI(1) | Preferred- | | | *RESERVED* (4) | | | |
|  |  | = 0b111 | | |  | Type (3) | | |  | Period (3) | | |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | *RESERVED* (8) | | | |  |  |  |  |  | CID MSB (8) | | | | | |



|  |  |
| --- | --- |
| CID LSB (8) | HCS (8) |

**Figure 6-9— CQICH allocation request**

The CQICH allocation request header shall have the following properties:

1. This is a MAC signaling header type I.
2. The CID shall indicate the MS Basic CID.
3. The allowed type for CQICH allocation request is defined in Table 6-6.

The fields of the CQICH allocation request header are defined in Table 6-10.

**Table 6-10—Description of the fields of CQICH allocation request header**

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| Type | 3 | The type of CQICH allocation request header is defined in Table 6-6. |
|  |  |  |
| Feedback Type | 3 | Set according to feedback type defined in Table 8-191. When FBSSI is set |
|  |  | to 1, this field is neglected. |
|  |  |  |
| FBSSI | 1 | FBSS Indicator: Set when MS request CQICH during FBSS HO. |
|  |  |  |

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**Table 6-10—Description of the fields of CQICH allocation request header *(CONTINUED)***

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| Preferred-Period(=p) | 3 | CQICH allocation period MS prefers. The value is defined in units of |
|  |  | frames. When FBSSI is set to 1, the value contained in this field shall be |
|  |  | neglected. |
|  |  |  |
| *Reserved* | 12 | Shall be set to zero. |
|  |  |  |
| CID | 16 | MS basic connection identifier. |
|  |  |  |
| HCS | 8 | Header check sequence (same usage as HCS entry in Table 6-3). |
|  |  |  |

Support of this subheader shall be negotiated between the BS and MS as part of the registration dialog (REG-REQ/RSP).

**6.3.2.1.2.1.5 PHY channel report header**

The PHY channel report PDU shall consist of a PHY channel report header alone and shall not contain a payload. The PHY channel report header is illustrated in Figure 6-10.



|  |  |  |
| --- | --- | --- |
| HT = 1 (1) | | EC=0 (1) |
| UL TX PowerLSB(1) |  |  |
|  |  |
|  |  |
|  |  |  |
|  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Type(3) | | | Preferred-DIUC | | |
| = 0b010 | | |  | (4) | |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| UL Headroom | | | |  | (1) |
|  | *RESERVED* |
| (6) | | |  |  |
|  |  |  |
|  |  |  |  |  |  |

UL TX Power MSB (7)

CID MSB (8)

|  |  |
| --- | --- |
| CID LSB (8) | HCS (8) |

**Figure 6-10—PHY channel report header**

The PHY channel report shall have the following properties:

1. This is a MAC signaling header type I.
2. The CID shall indicate the MS Basic CID.
3. The allowed type for PHY channel report is defined in Table 6-6.

An MS receiving a PHY channel report header on the DL shall discard the PDU.

The fields of the PHY channel report header are defined in Table 6-11.

Support of this subheader shall be negotiated between the BS and MS as part of the registration dialog (REG-REQ/RSP).

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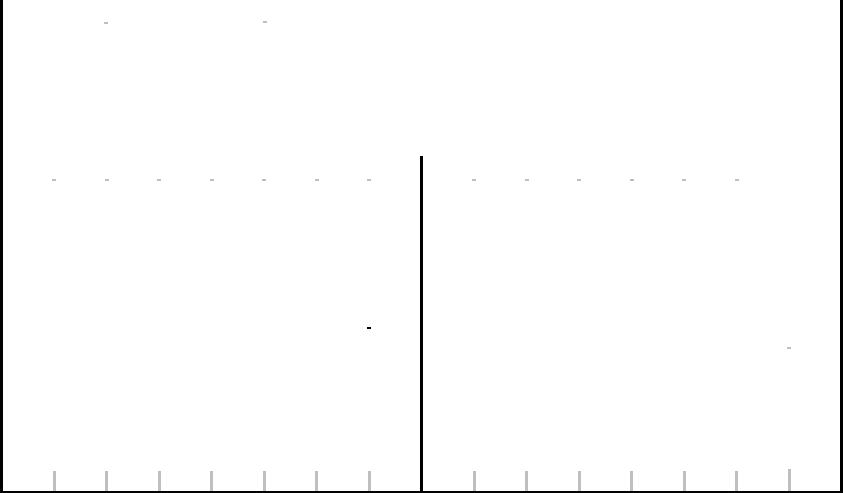
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**Table 6-11—PHY channel report header fields**

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| Type | 3 | The type of PHY channel report header is defined in Table 6-6. |
|  |  |  |
| PREFERRED-DIUC | 4 | Index of the DIUC preferred by the MS. |
|  |  |  |
| UL-TX-POWER | 8 | UL Tx power level in dBm for the burst that carries this header (11.1.1). |
|  |  | The value shall be estimated and reported for the burst. |
|  |  |  |
| UL-HEADROOM | 6 | Headroom to UL maximum power level in dB, for the burst that carries this |
|  |  | header, from 0 to 63 in 1 dB steps. Should the headroom exceed 63 dB, the |
|  |  | value 63 shall be used. The reported value shall represent the difference |
|  |  | between the maximum output power and the maximum power transmitted |
|  |  | during the burst. |
|  |  |  |
| *Reserved* | 1 | Set to zero. |
|  |  |  |
| CID | 16 | MS basic connection identifier. |
|  |  |  |
| HCS | 8 | Header check sequence (same usage as HCS entry in Table 6-3). |
|  |  |  |

**6.3.2.1.2.1.6 BR and UL sleep control header**

The BR and UL sleep control header is sent by the MS to request activation/deactivation of certain power saving class. The header also indicates incremental transmission demand. The BR and UL sleep control PDU shall consist of a BR and UL sleep control header alone and shall not contain a payload. The BR and UL sleep control header is illustrated in Figure 6-11.



|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| HT = 1 (1) |  | EC=0 (1) |  | Type(3) | | |  |  |  | BR MSB (11) | | | | | | |
|  |  |  |  |  |
|  |  | = 0b101 | | |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  | Operation (1) | (1)*RESERVED* |  |  |  |  |  |  |  |
|  |  | Power Saving | | | | | |  | CID MSB (8) | | | | | |
|  |  |  | Class ID(6) | | | | |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

|  |  |
| --- | --- |
| CID LSB (8) | HCS (8) |

**Figure 6-11—BR and UL sleep control header**

The BR and UL sleep control header shall have the following properties:

1. This is a MAC signaling header type I.
2. The CID shall indicate the connection for which the uplink bandwidth is requested.
3. The allowed type for BR and UL sleep control is defined in Table 6-6.

An MS receiving a BR and UL sleep control header on the DL shall discard the PDU.

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The fields of the BR and UL sleep control header are defined in Table 6-12.

**Table 6-12—BR and UL sleep control header fields**

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| Type | 3 | The type of BR and UL sleep control header is defined in Table 6-6. |
|  |  |  |
| BR | 11 | Bandwidth request: The number of bytes of UL bandwidth requested by |
|  |  | the MS. The BR is for the CID. The request shall not include any PHY |
|  |  | overhead. It is an incremental BR. In the case of Extended rtPS, the BS |
|  |  | changes its grant size to the value specified in this field. |
|  |  |  |
| Power\_Saving\_Class\_ID | 6 | Power saving class identifier. |
|  |  |  |
| Operation | 1 | 1: Activate power saving class. |
|  |  | 0: Deactivate power saving class. |
|  |  |  |
| *Reserved* | 1 | Shall be set to zero. |
|  |  |  |
| CID | 16 | The CID shall indicate the connection for which uplink bandwidth is |
|  |  | requested. |
|  |  |  |
| HCS | 8 | Header check sequence (same usage as HCS entry in Table 6-3). |
|  |  |  |

Support of this subheader shall be negotiated between the BS and MS as part of the registration dialog (REG-REQ/RSP).

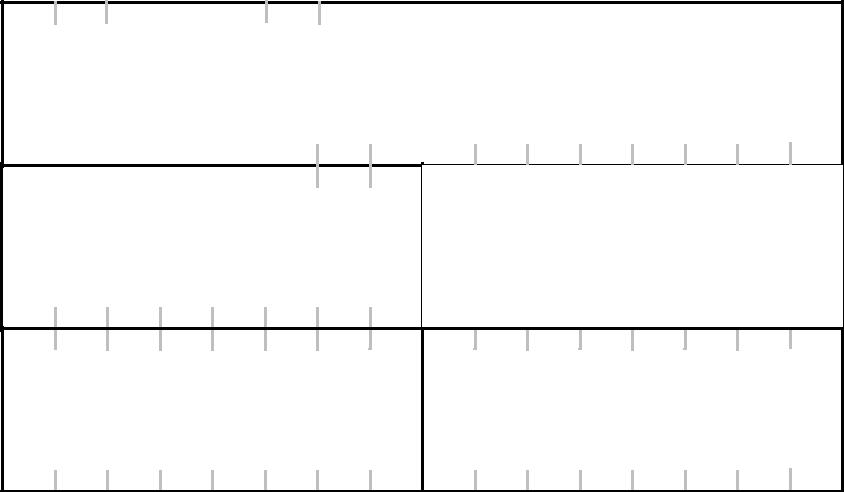
**6.3.2.1.2.1.7 SN report header**

The SN report header is sent by the MS to report the LSB of the next ARQ BSN or the virtual MAC SDU Sequence number for the active connections with SN Feedback enabled. The SN report header is illustrated in Figure 6-12.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| HT=1(1) | EC=0(1) | Type(3) | | |  |
|  |  |  |
|  |  | = 0b110 | | |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  | *RESERVED* (8) | | | |

CID LSB (8)

SDU SN (11)



**C**ID **MSB** ((**8**))

HCS (8)

**Figure 6-12—SN report header format**

The SN report header shall be of the form illustrated in Figure 6-12. The SN report header shall have the following properties:

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1. This is a MAC signaling header type I.
2. The CID shall indicate the basic connection of the MS for which the SN Report is being sent.
3. The allowed type for SN report header is defined in Table 6-6.
4. The SDU SN field shall indicate the next ARQ BSN or the virtual MAC SDU Sequence number for the active connections with SN Feedback enabled. In the latter case, the 8-bit virtual MAC SDU Sequence number shall be mapped into the LSBs of the SDU SN and the three MSBs of the SDU SN shall be set to zero.

An MS receiving a SN report header on the DL shall discard the PDU.

The fields of the SN report header are defined in Table 6-13.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  | **Table 6-13—SN report header fields** |
|  |  |  |  |  |
| **Name** | | | **Length** | **Description** |
| **(bit)** |
|  |  |  |  |
|  | | |  |  |
| Type | | | 3 | Set to 0b110. Indicates that it is a SN report header. |
|  | | |  |  |
| SDU SN | | | 11 | The ARQ BSN or MAC SDU SN for the Service Flow addressed in this header. |
|  |  |  |  |  |
| *Reserved* | | | 8 | Shall be set to zero. |
|  | | |  |  |
| CID | | | 16 | Connection identifier. |
|  | | |  |  |
| HCS | | | 8 | Header check sequence. |
|  |  |  |  |  |

Support of this subheader shall be negotiated between the BS and MS as part of the registration dialog (REG-REQ/RSP).

**6.3.2.1.2.2 MAC signaling header type II**

This type of MAC header is UL-specific. There is no payload following the MAC header. The MAC signaling header type II is illustrated in Figure 6-13. Table 6-14 describes the encoding of the 1-bit type field following the EC field. The description of DL MAC header format with HT/EC = 0b11, defined as the Compressed DL-MAP, is not part of this subclause. The detailed description can be found in 8.4.5.6.1.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 (1) | 1 (1) | (1) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | Header Content MSB (13) | | | | | | |  |  |  |  |  |
| HT = | EC = | Type |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  | Header Content (16) | | | | | | |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Header Content LSB (8) | | | | | | |  | | | | HCS (8) | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |



**Figure 6-13—MAC signaling header type II format**

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**Table 6-14—Type field encodings for MAC signaling header type II**

|  |  |  |  |
| --- | --- | --- | --- |
| **Type field** | **MAC header type (with HT/EC = 0b11)** | **Reference** | **Reference** |
| **figure** | **table** |
|  |  |
|  |  |  |  |
| 0 | Feedback header, with another 4-bit type field; see Table 6-16 | Figure 6-14, | Table 6-15 |
|  | for its type encodings. | Figure 6-15 |  |
|  |  |  |  |
| 1 | Extended relay MAC Signaling Header Type II | Figure 6-18 | Table 6-18 |
|  | Extended M2M device MAC Signaling Header Type II (M2M) |  | Table 6-27a |
|  |  |  |  |

**6.3.2.1.2.2.1 Feedback header**

The feedback header is sent by an MS/RS either as a response to a Feedback Polling IE (see 8.4.5.4.26) or as an unsolicited feedback. When sent as a response to a Feedback Polling IE, the MS/RS shall send a feedback header using the assigned resource indicated in the Feedback Polling IE. When sent as unsolicited feedback, the MS/RS can either send the feedback header on currently allocated UL resource or request additional UL resource by sending an Indication flag on the fast-feedback channel or the enhanced fast-feedback channel (refer to 8.4.11.11) or by sending a BR ranging code.

The feedback PDU shall consist of the feedback header alone and shall not contain a payload. The feedback header with and without the CID field are illustrated in Figure 6-14 and Figure 6-15. The feedback header with the CID field shall be used when the UL resource used to send the feedback header is requested through BR ranging. Otherwise, the feedback header without the CID field shall be used.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (1) | (1) | 0 (1) | (1) |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 1 | = | 1 |  | Feedback | | |  | Feedback Content MSB (8) | | | | | | |
| HT = | EC = | Type | CII = |  |  |
|  | Type (4) | | |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Feedback Content LSB (8) | | | | | | |  |  | CID MSB (8) | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  | | | |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | CID LSB (8) | | | |  |  |  |  |  |  | HCS (8) | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Figure 6-14— Feedback header with CID field**

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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| HT = 1 (1) | EC = 1 (1) | Type = 0 (1) | CII = 0 (1) |  |  |  |  |  |  |  |  |  |  |  |  |
| Feedback | | |  | Feedback Content MSB (8) | | | | | | | |
|  | Type (4) | |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  | Feedback Content (16) | | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Feedback Content LSB (8) | | | | | |  |  |  |  | HCS (8) | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Figure 6-15—Feedback header without CID field**

The fields of feedback header are defined in Table 6-15.

**Table 6-15—Description of the fields of feedback header**

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| CII | 1 | CID inclusion indication. Set to 1 for a feedback header with the CID field; |
|  |  | set to 0 for a feedback header without the CID field. |
|  |  |  |
| Feedback Type | 4 | Set according to Table 6-16. |
|  |  |  |
| Feedback Content | 16 or 32 | Set according to Table 6-16. Length of 16 bits for a feedback header with |
|  |  | the CID field and length of 32 bits for a feedback header without the CID |
|  |  | field. |
|  |  |  |
| CID | 16 | (optional) Basic CID |
|  |  |  |
| HCS | 8 | Header check sequence (same usage as HCS entry in Table 6-3). |
|  |  |  |

The feedback header shall have the following properties:

1. This is a MAC signaling header type II. The length of the header shall always be 6 bytes.
2. The allowed type for feedback header is defined in Table 6-14.
3. The Feedback Type field shall be set according to Table 6-16.
4. The CII field (CID Inclusion Indication) shall be set to 1 for the header with CID field and set to 0 for the header without CID field.
5. The Feedback Content field shall be set accordingly based on the value of the feedback type field.
6. When the size of the defined content, as given in Table 6-16, for any Feedback type is less than the size of the Feedback Contents field, the defined content shall be bit-aligned to the LSB of the Feedback Contents field and all unused bits of the Feedback Contents field shall be set to a value of ‘0’.

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The feedback header may be used by the MS/RS to provide its feedback(s). An MS/RS receiving a feedback header on the DL shall discard the PDU.

The support of feedback header is OFDMA-PHY-specific and shall be negotiated between the BS and SS (or between the MR-BS and RS) as part of the registration dialog (REG-REQ/RSP).

**Table 6-16—Feedback type and feedback content**

|  |  |  |
| --- | --- | --- |
| **Feedback type** | **Feedback contents** | **Description** |
| **(binary)** |
|  |  |
|  |  |  |
| 0000 | MIMO feedback type (3 bits) + | CQI and MIMO feedback. The definition of MIMO |
|  | feedback payload (6 bits) | feedback type (3 bits) and the corresponding |
|  |  | feedback payload (6 bits) are the same as that |
|  |  | defined in Table 8-191 and in 8.4.11.4, 8.4.11.5, |
|  |  | 8.4.11.6, 8.4.11.7, 8.4.11.8, 8.4.11.9, and 8.4.11.10 |
|  |  | for the enhanced fast-feedback channel. |
|  |  |  |
| 0001 | DL average CINR (5 bits) | DL average CINR of the serving or anchor BS (for |
|  |  | the case of FBSS), with 5-bit payload encoding as |
|  |  | defined in 8.4.5.4.11. |
|  |  |  |
| 0010 | Number of index, *L* (2 bits) + *L* | MIMO coefficients feedback for up to four |
|  | occurrences of Antenna index (2 bits) + | antennas. |
|  | MIMO coefficients (5 bits, see |  |
|  | definition in 8.4.11.7) |  |
|  |  |  |
| 0011 | Preferred-DIUC (4 bits) + DCD change | Preferred DL channel DIUC feedback. |
|  | count (4 bits) |  |
|  |  |  |
| 0100 | UL-TX-Power (8 bits) (see Table 6-8 | UL transmission power. |
|  | for definition) |  |
|  |  |  |
| 0101 | PREFERRED DIUC (4 bits) + UL TX- | PHY channel feedback. |
|  | POWER (8 bits) + UL-HEADROOM |  |
|  | (6 bits) (see Table 6-11 for definitions) |  |
|  |  |  |
| 0110 | AMC band indication bitmap (12 bits, | CQIs of up to three (N ≤ 3) AMC bands. The 1 bit |
|  | see 6.3.2.3.38.2) + N CQI (N × 5 bits). | rank/band (or number of streams) for N bands are |
|  | N is the number of ones in the AMC | indicated as follows: '0' for rank 1 and 1 for rank 2. |
|  | band indication bitmap + CL-MIMO |  |
|  | type (2 bits) + 1 bit rank information |  |
|  | per band for N best bands (N × 1 bits). |  |
|  |  |  |
| 0111 | Life span of short-term precoding feed- | The recommended number of frames for which the |
|  | back (4 bits) according toTable 8-289. | short-term precoding feedback can be used. |
|  |  |  |
| 1000 | Number of feedback types, *0* (2 bits) + | Multiple types of feedback. |
|  | *0* occurrences of “feedback type (4 bits) |  |
|  | + feedback content (variable)” |  |
|  |  |  |

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**Table 6-16—Feedback type and feedback content *(CONTINUED)***

|  |  |  |
| --- | --- | --- |
| **Feedback type** | **Feedback contents** | **Description** |
| **(binary)** |
|  |  |
|  |  |  |
| 1001 | Feedback of index to long-term | Long-term precoding feedback. |
|  | precoding matrix in codebook (6 bits), |  |
|  | rank of precoding codebook (2 bits) and |  |
|  | FEC and QAM feedback (6 bits) |  |
|  | according to Table 8-288. |  |
|  |  |  |
| 1010 | Combined DL average CINR of active | Combined DL average CINR of all active BSs |
|  | BSs (5 bits). | within the diversity set, with 5-bit payload encoding |
|  |  | as defined in 8.4.5.4.13. |
|  |  |  |
| 1011 | MIMO channel feedback (see Table 6- | MIMO mode channel condition feedback. |
|  | 17 for description of feedback content |  |
|  | fields). |  |
|  |  |  |
| 1100 | CINR Mean (8 bits) + CINR Standard | CINR Feedback (values and coding defined in |
|  | Deviation (8 bits) | 8.4.12.3). |
|  |  |  |
| 1101 | CL MIMO type (2 bits) | Closed-loop MIMO feedback CL MIMO type: |
|  | If (CL MIMO type == 0b00 | 0b00: antenna grouping |
|  | {Antenna grouping index (4 bits) + | 0b01: antenna selection |
|  | average CQI (5 bits) } | 0b10: codebook |
|  | Elseif ( CL MIMO type == 0b01 | 0b11: indication of transition from closed-loop |
|  | {Number of streams (2 bits) + Antennas | MIMO to open-loop MIMO |
|  | selection option index (3 bits) + average |  |
|  | CQI (5 bits) of the selected antennas} | Antenna grouping index: 0b0000 ~ 0b1001 = |
|  | Elseif (CL MIMO type == 0b10) | 0b101110 ~ 0b110110 in Table 8-337 |
|  | {Codebook index for N best AMC | Antenna selection option index: 0b000 ~ 0b010 = |
|  | bands (N × 6 bits)+ 2 bits differential | 0b110000 ~ 0b110010 in Table 8-286 for 3 Tx |
|  | CQI per band for the N best bands | antenna 0b000 ~ 0b101 = 0b110000 ~ 0b110101 in |
|  | (N × 2 bits) } | Table 8-287 for 4 Tx antenna |
|  | Codebook index: (See 8.4.8.3.6.) |
|  |  |
|  |  | The 2 bit differential CQI denotes +2, +1, –1, –2 dB. |
|  |  | The number of best bands is up to three (N ≤ 3). |
|  |  | A BS may issue the Feedback\_Polling \_IE to request |
|  |  | feedback header type 1101 without requesting feed- |
|  |  | back type 0110 to trigger the AMC CL MIMO oper- |
|  |  | ation, in this case, a MS shall over ride the feedback |
|  |  | type 1101 by 0110 for the first report and may over |
|  |  | ride the type 1101 whenever necessary. The BS may |
|  |  | use the previously reported PMIs and differential |
|  |  | CQIs when the MS over ride the feedback type to |
|  |  | 0110. |
|  |  |  |

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**Table 6-16—Feedback type and feedback content *(CONTINUED)***

|  |  |  |
| --- | --- | --- |
| **Feedback type** | **Feedback contents** | **Description** |
| **(binary)** |
|  |  |
|  |  |  |
| 1110 | Early/Late Indication (1bit) + | Access link transmission status feedback |
|  |  | This feedback header type is sent by RS to MR-BS |
|  |  | to provide access link transmission status for data. |
|  |  | The feedback is used when MR-BS provides a target |
|  |  | transmission time of the MAC PDU and the RS |
|  |  | detects any abnormality in transmitting the MAC |
|  |  | PDU. The RS may report missed transmission due |
|  |  | to late arrival of a MAC PDU or abnormal early |
|  |  | arrival of a MAC PDU in respect to transmission |
|  |  | time. |
|  |  | Early/Late Indication: |
|  |  | 0: Early Indication |
|  |  | 1: Late Indication |
|  | Arrival Delta (8 bits) + | Arrival Delta: |
|  |  | Number of frames RS received frames early or late |
|  |  | based on Early/Late Indication. For Late indication, |
|  |  | this value is the difference in frame number between |
|  |  | the target transmission time and frame in which the |
|  |  | MAC PDU arrives at the RS. For Early indication, |
|  |  | this value is the difference between the transit delay |
|  |  | of the MAC PDU through the RS and the early |
|  |  | detection threshold as set by the “Relay Data Early |
|  |  | Arrival Report Threshold” TLV in the SBC-RSP. |
|  | CID (16 bits) | CID: |
|  |  | CID of transport connection between RS and MR- |
|  |  | BS |
|  |  |  |
| 1111 | Aggregated MS CQI parameters, in the | Aggregated MSs CQICH codewords relayed by RS. |
|  | form of either: |  |
|  |  | N\_agg is defined in MR-Fast-Feedback region |
|  | Full CQICH reporting: 6×5 bits | allocation IE. |
|  | or |  |
|  | Differential CQICH reporting: |  |
|  | if N\_agg = 0 then 10×3 bits |  |
|  | if N\_agg = 1 then 16×2 bits |  |
|  |  |  |

**6.3.2.1.2.2.1.1 MIMO channel feedback header**

The MIMO channel feedback header is used for MS to provide DL MIMO channel quality feedback to the BS. The MIMO channel feedback header can be used to provide a single or composite channel feedback. The MIMO channel feedback header with or without Basic CID field is illustrated in Figure 6-16 and Figure 6-17, respectively.

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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (1) | (1) | 0 (1) |  | (1) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  | Preferred-DIUC | | | |  |  | PBWI | | |
| 1 | 1 | = |  | 1 | Feedback | | | |  |  | |
|  |  |  |  |  |  |  |  |  |  |  |
| HT = | EC = | Type |  | CII = | Type = 0b1011 (4) | | | | | (4) | | |  |  |  | (4) | |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  | (1) |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  | SLPB (7) | | | | |  | BPRI |  |  | CID MSB (8) | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  | |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | CID LSB (8) | | | | | | |  |  |  |  | HCS (8) | | |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |



**Figure 6-16—MIMO channel feedback header with CID field**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (1) |  | (1) | 0 (1) |  | (1) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  | Preferred-DIUC | | | |  |  | PBWI | | |
| 1 |  | 1 | = |  | 0 | Feedback | | | |  |  |  | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| HT = |  | EC = | Type |  | CII = | Type = 0b1011 (4) | | | | |  | (4) | | |  |  |  | (4) | |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  | (2) | |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  | SLPB (7) | | | | |  | BPRI | |  | CTI(3) | | |  | | AI (4) | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  | CT (1) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | MI (2) | |  |  | CQI (5) | | | |  |  |  |  |  | HCS (8) | | |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |



**Figure 6-17—MIMO channel feedback header without CID field**

The fields of MIMO channel feedback header are defined in Table 6-17.

**Table 6-17—Description of MIMO channel feedback header fields**

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| Feedback Type | 4 | Feedback type of MIMO channel feedback header is defined in Table 6-16. |
|  |  |
|  |  |  |
| PREFERRED-DIUC | 4 | Index of the preferred DIUC suggested by the MS. |
|  |  |  |

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**Table 6-17—Description of MIMO channel feedback header fields *(CONTINUED)***

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| PBWI | 4 | Preferred bandwidth index. This field provides the size of the preferred |
|  |  | bandwidth, which can be used for DIUC transmission. |
|  |  | PBWI indicates the ratio of the preferred bandwidth over used channel |
|  |  | bandwidth: |
|  |  | 0b0000: 1 |
|  |  | 0b0001: 3/4 |
|  |  | 0b0010: 2/3 |
|  |  | 0b0011: 1/2 |
|  |  | 0b0100: 1/3 |
|  |  | 0b0101: 1/4 |
|  |  | 0b0110: 1/5 |
|  |  | 0b0111: 1/6 |
|  |  | 0b1000: 1/8 |
|  |  | 0b1001: 1/10 |
|  |  | 0b1010: 1/12 |
|  |  | 0b1011: 1/16 |
|  |  | 0b1100: 1/24 |
|  |  | 0b1101: 1/32 |
|  |  | 0b1110: 1/48 |
|  |  | 0b1111: 1/64 |
|  |  | where |
|  |  | Ratio = BWpreferred/BWused, |
|  |  | BWpreferred: Preferred bandwidth for DIUC transmission, |
|  |  | BWused: Actual used channel bandwidth (excluding guard bands). |
| SLPB | 7 | Starting location of preferred bandwidth: 0–127. |
|  |  | This field points to the starting preferred bandwidth location. This field, |
|  |  | combined with the PBWI field, tells the BS the exact size and location of the |
|  |  | preferred bandwidth in the channel. |
|  |  | The effective bandwidth (used bandwidth) is divided into 128 intervals |
|  |  | numbered 0 to 127 counting from the lower to the higher band. SLPB |
|  |  | indicates the starting location of preferred bandwidth for the DIUC burst |
|  |  | profile. |
|  |  |  |
| BPRI | 1/2 | Burst profile ranking indicator. This field can be used to rank up to four |
|  |  | preferred burst profiles within the DL channel. |
|  |  | BPRI (without Basic CID) indicates the ranking for DL channel condition of |
|  |  | the preferred bandwidth as reported in the current header where 0 is the most |
|  |  | preferred bandwidth: |
|  |  | 0b00: 1st preferred burst profile |
|  |  | 0b10: 2nd preferred burst profile |
|  |  | 0b01: 3rd preferred burst profile |
|  |  | 0b11: 4th preferred burst profile |
|  |  | BPRI (including Basic CID): |
|  |  | 0b0: 1st preferred burst profile |
|  |  | 0b1: 2nd preferred burst profile |
|  |  | This field is 1 bit when CII is set to 1; otherwise, this field is 2 bits. |
|  |  |  |
| CTI | 3 | Coherent time index. This field provides coherent time information. |
|  |  | CTI indicates the estimated duration of the valid MIMO channel conditions: |
|  |  | 0b000: Infinite |
|  |  | 0b001: 1 frame |
|  |  | 0b010: 2 frames |
|  |  | 0b011: 3 frames |
|  |  | 0b100: 4 frames |
|  |  | 0b101: 8 frames |
|  |  | 0b110: 14 frames |
|  |  | 0b111: 24 frames |
|  |  | This field is present only when CII is set to 0. |
|  |  |  |

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**Table 6-17—Description of MIMO channel feedback header fields *(CONTINUED)***

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| AI | 4 | Antenna index. This field is for antenna indication. It can support up to four |
|  |  | antennas. |
|  |  | This feedback header can report a composite channel condition; each bit |
|  |  | represents for each antenna: “1” is applicable, “0” is not applicable. |
|  |  | AI: |
|  |  | Bit 0 (MSB)– Antenna 0 |
|  |  | Bit 1 – Antenna 1 |
|  |  | Bit 2 – Antenna 2 |
|  |  | Bit 3 (LSB) – Antenna 3 |
|  |  | This field is present only when CII is set to 0. |
|  |  |  |
| MI | 2 | Matrix indicator. This field suggests the preferred STC/MIMO matrix for |
|  |  | the MS: |
|  |  | 0b00: No STC |
|  |  | 0b01: Matrix A |
|  |  | 0b10: Matrix B |
|  |  | 0b11: Matrix C |
|  |  | This field is present only when CII is set to 0. |
|  |  |  |
| CT | 1 | CQI type. This field indicates the type of CQI feedback in the CQI field: |
|  |  | 0: DL average CQI feedback |
|  |  | 1: CQI feedback for the preferred bandwidth indicated in the current |
|  |  | header |
|  |  | This field is present only when CII is set to 0. |
|  |  |  |
| CQI | 5 | CQI feedback. |
|  |  | This field is present only when CII is set to 0. |
|  |  |  |
| CID | 16 | MS basic connection identifier. |
|  |  | This field is present only when CII is set to 1. |
|  |  |  |
| HCS | 8 | Header check sequence (same usage as HCS entry in Table 6-3). |
|  |  |  |

**6.3.2.1.2.2.1.2 Fast feedback reporting in an MR system**

In a multihop relay system with RSs operating in centralized scheduling mode, an MR-BS may configure an RS to report on the relay link either full or differential fast feedback reporting using the feedback header defined in 6.3.2.1.2.2.1. Differential fast feedback reporting uses fewer bits; therefore the RS can map multiple MS’s fast feedback information on to the feedback header defined by Figure 6-13.

Differential feedback reporting can be used to report either physical CINR feedback or effective CINR feedback. If differential feedback reporting is performed on effective CINR, then the RS shall perform the differential operation based on the “label” of Table 8-229.

If an access RS receives a codeword other than physical or effective CINR feedback (e.g., indication flag feedback, MIMO mode feedback or AMC mode transition) on the CQICH channel or Feedback Header from an MS, then the access RS shall not perform the differential operation on the special codeword and shall send the special codeword indication to the MR-BS. The access RS stores the received special codeword and forwards the latest received special codeword to the MR-BS when the MR-BS requests full feedback reporting. When a CINR codeword is followed by a special codeword, differential operation shall be resumed. When an MR-BS receives a special codeword indication, the MR-BS may request full feedback reporting from the RS. An MR-BS may also request full feedback reporting periodically.

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An MR-BS may allocate resources on the relay link for forwarding MS CQI parameter reports using a Feedback polling IE as defined in Table 8-125.

An MR-BS configures the RSs type of reporting (full or differential) using the RS\_CQICH\_Control IE (see 8.4.5.10.9). An access RS performs differential feedback reporting on behalf of an MS. An access RS extracts the MS’s fast feedback channel information from either the CQICH\_Allocation\_IE or CQICH\_enhanced\_allocation\_IE transmitted in the UL-MAP. When an access RS performs differential feedback reporting, it uses the N\_agg field of the RS\_CQICH\_Control IE for aggregating differential feedback reporting.

The 32-bits payload of “feedback header without CID field” defined in Figure 6-15 is constructed by aggregating the payload bits from Table 6-18 or Table 6-19, starting from the most significant bits to the least significant bits. The payloads 0b100 and 0b10, respectively, are used to indicate that the access RS received special codewords from the MS. The access RS aggregates the payloads of the corresponding MSs in the 32-bits feedback header in the UL relay zone, starting with the MSB and ending with LSB. The aggregation is performed in the order of the feedback information received in the UL access zone by the RS. Dummy payload bits corresponding to dummy MSs are set to zero, and these bits may be used to fill the payload of the feedback header.

**Table 6-18—Three-bit differential fast feedback encoding per differential CQI report with seven levels of quantization**

|  |  |
| --- | --- |
| **Quantization step** | **Payload bits** |
|  |  |
| +3 | 0b000 |
|  |  |
| +2 | 0b001 |
|  |  |
| +1 | 0b010 |
|  |  |
| 0 | 0b011 |
|  |  |
| –1 | 0b101 |
|  |  |
| –2 | 0b110 |
|  |  |
| –3 | 0b111 |
|  |  |
| Special codeword indication | 0b100 |
|  |  |

**Table 6-19—Two-bit differential feedback encoding per differential CQI report with three levels of quantization**

|  |  |
| --- | --- |
| **Quantization step** | **Payload bits** |
|  |  |
| +1 | 0b00 |
|  |  |
| 0 | 0b01 |
|  |  |
| –1 | 0b11 |
|  |  |
| Special codeword indication | 0b10 |
|  |  |

An access RS stores the last received full feedback information of the MSs and performs differential feedback reporting based on the received feedback information and last stored full feedback information. An access RS quantizes the difference into either seven or three steps according to Table 6-18 or Table 6-19,

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respectively. If the difference of the two full feedback information is outside the range of the differential quantization steps, then the RS reports the closest quantization step.

When an access RS is requested to transmit differential feedback reporting, it transmits the differential feedback information to the superordinate RS according to the same order in which it receives the fast feedback reporting from the MSs in the fast feedback region of the UL access zone.

Intermediate RSs simply forward to the superordinate station the fast feedback information received in the relay zone. When an RS forwards the fast feedback information to a superordinate station, it puts the differential fast feedback information corresponding to its access zone before the fast feedback information received in the relay zone.

**6.3.2.1.2.2.2 Extended MAC signaling header type II**

This type of MAC header is only supported on the R-UL. There is no payload following the MAC header. The Extended MAC signaling header type II is illustrated in Figure 6-18. Table 6-20 describes the encoding of the 3-bit extended type field following the type field.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (1) | (1) |  | 1 (1) |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Extended | | |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 1 |  | = | Type (3) | | |  |  | Header Content MSB (10) | | | | | | | |
| HT = | EC = |  | Type |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  | Header Content (16) | | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | Header Content LSB (8) | | | | | |  |  |  | HCS (8) | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Figure 6-18—Extended MAC signaling header type II format**

**Table 6-20—Extended Type field encodings for extended MAC signaling header type II**

|  |  |  |  |
| --- | --- | --- | --- |
| **Extended Type field** | **MAC header type** | **Reference figure** | **Reference table** |
|  |  |  |  |
| 0 | RS BR header | Figure 6-19 | Table 6-21 |
|  |  |  |  |
| 1 | RS UL\_DCH signaling header | Figure 6-20 | Table 6-22 |
|  |  |  |  |
| 2 | MR Acknowledgment header | Figure 6-21 | Table 6-23 |
|  |  |  |  |
| 3 | MR HARQ error report header | Figure 6-22 | Table 6-24 |
|  |  |  |  |
| 4 | MR Code-REP header | Figure 6-23 | Table 6-25 |
|  |  |  |  |
| 5 | *Reserved* | — | — |
|  |  |  |  |
| 6 | Tunnel BR header | Figure 6-24 | Table 6-26 |
|  |  |  |  |
| 7 | DL Flow Control Header | Figure 6-25 | Table 6-27 |
|  |  |  |  |

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**6.3.2.1.2.2.2.1 RS bandwidth request header (RS BR)**

The RS BR header may be sent by a non-transparent RS operating in centralized scheduling mode to the MR-BS to request bandwidth on its access link for the purposes of transmitting messages composed by the RS (such as RNG-RSP, MOB\_NBR-ADV, DCD, and UCD). This header shall not be transmitted by a scheduling RS. The RS BR header is illustrated in Figure 6-19.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | HT=1(1) | EC=1(1) | Type=1(1) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | Extended | | | | |  |  |  |  |  |  |  |  | BR | |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  | Type = 0 (3) | | | | |  | TID (4) | |  |  | DIUC (4) | | | MSB(2) | |  |
|  |  |  |  |  |  |  | | |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  | BR LSB (8) | | | | | | |  |  |  | CID MSB (8) | | | |  |  |  |
|  |  |  |  |  |  |  | | |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | | |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  | CID LSB (8) | | | | | |  |  |  |  | HCS (8) | | |  |  |  |
|  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Figure 6-19—RS BR header format** | | | | | | | | | | |  |  |  |
|  |  |  | **Table 6-21—Description of fields in RS BR header** | | | | | | | | | | | | | | |  |  |  |
|  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Name** | |  |  | **Length** | | |  |  |  |  |  | **Description** | | | | |  |  |  |
|  |  |  | **(bit)** | |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| TID | |  |  | 4 | |  |  | Transaction Identifier. MR-BS when allocating resources in response to | | | | | | | | | | | | |
|  |  |  |  |  |  |  |  | an RS BR header shall include the same TID in the RS\_BW\_Alloc\_IE | | | | | | | | | | | | |
|  |  |  |  |  |  |  |  | as in the RS BR header. The counter used to generate the transaction ID | | | | | | | | | | | | |
|  |  |  |  |  |  |  |  | shall be unique per CID per MR-BS. | | | | | | | | | |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| DIUC | |  |  | 4 | |  |  | Indicates the DIUC used by RS to transmit the message. The MR-BS | | | | | | | | | | | | |
|  |  |  |  |  |  |  |  | shall allocate sufficient resources based on the indicated DIUC to send | | | | | | | | | | | | |
|  |  |  |  |  |  |  |  | the message from the RS using RS\_BW\_Alloc\_IE. | | | | | | | | | |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| BR | |  |  | 10 | |  |  | Requested amount of bandwidth in unit of bytes. | | | | | | | | | |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| CID | |  |  | 16 | |  |  | Basic CID of the RS for which the RS bandwidth request header is sent. | | | | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| HCS | |  |  | 8 | |  |  | Header Check Sequence (same usage as HCS entry in Table 6-3). | | | | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**6.3.2.1.2.2.2.2 RS UL DCH signaling header (RS UL\_DCH)**

A non-transparent RS may request dedicated uplink resources for signaling and data transmissions instead of explicit BW request and allocation for each transmission. The dedicated uplink channel is allocated after receiving the RS\_UL\_DCH assignment IE. The assignment is a periodic allocation of uplink bandwidth and no subsequent periodic UL-MAP IE is needed in UL-MAP or R-MAP. For the rate based DCH request, the RS only specifies an average required data rate without a specific allocation frequency. The MR-BS or superordinate station determines a specific BW size and frequency configuration in response to the rate based request.

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The RS requests a dedicated uplink resource by specifying Relay Link DCH Request through the RS UL\_DCH signaling header. The RS confirms the successful reception of the RS\_UL\_DCH assignment IE by specifying DCH Assignment Acknowledgment (ACK).

It may also be used by an intermediate RS operating in centralized scheduling mode to request HARQ retransmission resource from the MR-BS by specifying HARQ Retransmission Request. The MR-BS responds with RS\_UL\_DCH HARQ RETX IE.

The format of this header is illustrated in Figure 6-20 and described in Table 6-22.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | HT=1(1) |  | EC=1(1) | Type=1(1) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | Extended | | |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  | Type = 1 (3) | | | DCH TYPE (4) | | | |  |  | Header Content (6) | | | | |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  | Header Content (16) | | | | |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  | Header Content (8) | | | |  |  |  |  |  |  | HCS (8) | | | | |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  | **Figure 6-20—RS UL\_DCH signaling header format** | | | | | | | | | | | | | | | |
|  |  | **Table 6-22—Description of fields in RS UL\_DCH signaling header** | | | | | | | | | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Name** | | |  |  | **Length** | |  |  |  |  |  | **Description** | | | | | | |
|  |  |  | **(bits)** | |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **HT** | | |  |  |  | 1 | | Shall be set to 1 | | | | |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **EC** | | |  |  |  | 1 | | Shall be set to 1 | | | | |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Type** | | |  |  |  | 1 | | Shall be set to 1 | | | | |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |
| **Extended Type** | | |  |  |  | 3 | | Shall be set to 001 for RS UL\_DCH signaling header | | | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |
| **DCH TYPE** | | |  |  |  | 4 | | 0000 = Relay Link DCH Request | | | | | | | | | | | |
|  |  |  |  |  |  |  |  | 0001 = DCH Assignment Acknowledgment (ACK) | | | | | | | | | | | |
|  |  |  |  |  |  |  |  | 0010 = HARQ retransmission request | | | | | | | | | | | |
|  |  |  |  |  |  |  |  | 0011–1111 = *Reserved* | | | | |  |  |  |  |  |  |  |
|  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| if (DCH TYPE == 0000){ | | | | |  | — | | Relay Link DCH Request | | | | |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |
| **Request Type** | | |  |  |  | 2 | | 00 = DCH Request Incremental | | | | | | | | | | | |
|  |  |  |  |  |  |  |  | 01 = DCH Request Aggregate | | | | | | | | | | | |
|  |  |  |  |  |  |  |  | 10 = DCH Request Rate Based | | | | | | | | | | | |
|  |  |  |  |  |  |  |  | 11 = *Reserved* | | | | |  |  |  |  |  |  |  |
|  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| if(Request Type == 00){ | | | | |  | — | | DCH Request Incremental | | | | |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

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**Table 6-22—Description of fields in RS UL\_DCH signaling header *(CONTINUED)***

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bits)** |
|  |  |
|  |  |  |
| **Bandwidth request** | 16 | Number of bytes requested by the RS |
|  |  |  |
| **N** | 4 | Allocation repeats once every N frames |
|  |  |  |
| }elseif (Request Type == 01){ |  | DCH Request Aggregate |
|  |  |  |
| **Bandwidth Request** | 16 | Number of bytes requested by the RS. Zero in this field indicates |
|  |  | DCH release request |
|  |  |  |
| **N** | 4 | Allocation repeats once every N frames |
|  |  |  |
| }elseif (Request Type == 10){ | — | DCH Request Rate Based |
|  |  |  |
| **Average rate** | 20 | Average data rate in units of bytes per second |
|  |  | 18 MSB bits: magnitude |
|  |  | 2 LSB bits: base-10 exponent |
|  |  |  |
| } | — | — |
|  |  |  |
| **RS CID** | 8 | 8 LSBs of Basic CID of RS |
|  |  |  |
| } else if (DCH TYPE == 0001) | — | DCH Assignment Acknowledgment (ACK) |
| { |  |  |
|  |  |  |
| **Frame Number** | 8 | 8-bit LSBs of the frame in which the RS\_UL\_DCH assignment IE is |
|  |  | received |
|  |  |  |
| **DCH resource ID** | 3 | The value of DCH resource ID in the corresponding RS\_UL\_DCH |
|  |  | assignment IE |
|  |  |  |
| **RS CID** | 8 | 8 LSBs of Basic CID of RS |
|  |  |  |
| *Reserved* | 11 | Shall be set to 0 |
|  |  |  |
| } else if (DCH TYPE == 0010) | — | HARQ retransmission request |
| { |  |  |
|  |  |  |
| **RS CID** | 8 | 8 LSB of Basic CID of the RS requiring HARQ retransmission |
|  |  |  |
| **Number of bursts** | 2 | — |
|  |  |  |
| for (i=0;i< Number of bursts; | — | — |
| i++) { |  |  |
|  |  |  |
| **DCH resource ID** | 3 | ID of the DCH resource that needs HARQ retransmission |
|  |  |  |
| **DCH ACID** | 4 | HARQ channel require retransmission |
|  |  |  |
| *Reserved* | 1 | Shall be set to 0 |
|  |  |  |
| } | — | — |
|  |  |  |
| **Padding** | *variable* | Shall be set to 0 |
|  |  |  |
| } | — | — |
|  |  |  |
| **HCS** | 8 | Header check sequence |
|  |  |  |

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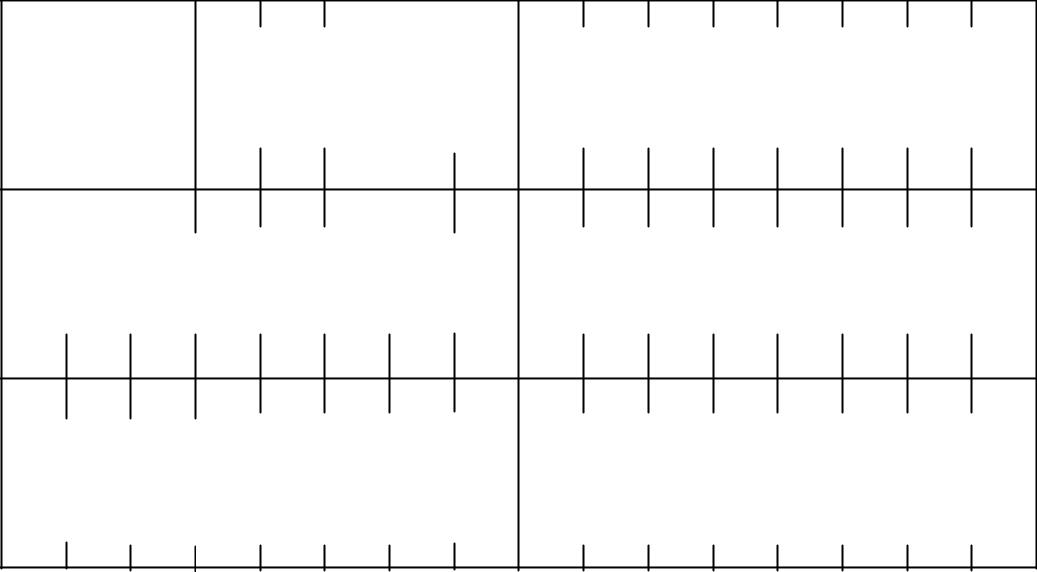
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**6.3.2.1.2.2.2.3 MR Acknowledgment header**

An MR acknowledgment header may be sent by an RS as a response to a MAC management message received from the MR-BS or its superordinate RS that requires acknowledgment. When an acknowledgment is required, unsolicited uplink bandwidth may be provided to the RS to send this header to the MR-BS or its superordinate RS as an indication of the message reception. The MR acknowledgment header shall be sent on the same CID as the received MAC management message. The MR acknowledgment header is illustrated in Figure 6-21. The support of MR acknowledgment header is optional for both MR-BS and RS and shall be negotiated during network entry of an RS using REG-REQ and REG-RSP message.



|  |  |  |
| --- | --- | --- |
| HT = 1 (1) | EC = 1 (1) | Type = 1 (1) |
|  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Extended |  |  |  |
| Rsv | |  |
| Type = 2 (3) | ACK Message Type (8) |
| (2) | |
|  |  |
|  |  |  |  |

|  |  |
| --- | --- |
| Transaction ID (8) | CID MSB (8) |

|  |  |
| --- | --- |
| CID LSB (8) | HCS (8) |

**Figure 6-21—MR Acknowledgment header format**

**Table 6-23—Description of fields in MR acknowledgment header**

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bits)** |
|  |  |
|  |  |  |
| Rsv | 2 | *Reserved* |
|  |  |  |
| ACK Message Type | 8 | The MAC message type of the message received by the RS from the MR- |
|  |  | BS or its superordinate RS. |
|  |  |  |
| Transaction ID | 8 | 8 LSB of the Transaction ID included in the MAC management message re- |
|  |  | ceived from the MR-BS. If Transaction ID is not included, set this field to |
|  |  | zero. The counter used to generate the transaction ID shall be unique per |
|  |  | CID per MR-BS. |
|  |  |  |
| CID | 16 | The same CID as the received MAC management message. |
|  |  |  |
| HCS | 8 | Header Check Sequence (same usage as HCS entry in Table 6-3). |
|  |  |  |

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**6.3.2.1.2.2.2.4 MR HARQ error report header**

In case of centralized scheduling, the MR HARQ Error Report header may be transmitted by RS to provide ACK/NAK to MR-BS when RS is unable to decode the HARQ DL data successfully. The RS may send this header to MR-BS or superordinate RS as an unsolicited feedback in UL relay zone. Intermediate RS forwards the MR HARQ Error report header toward the MR-BS. The header format is illustrated in Figure 6-22.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | HT=1(1) |  | EC=1(1) |  | Type=1(1) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  | Extended | | | |  |  | Frame | | |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | Type =3 (3) | | | |  |  | Number | | |  | DL HARQ ACK/NAK | | | | |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  | LSB (4) | | |  | Bitmap MSB (6) | | | | |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | DL HARQ ACK/NAK Bitmap LSB (8) | | | | | | | | | | | |  | | | CID MSB (8) | | | | |  |
|  |  |  |  |  |  |  |  | | | | |  |  |  |  |  |  | | | | |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | CID LSB (8) | | | | |  |  |  |  |  | HCS (8) | | | | |  |
|  |  |  |  |  |  |  |  |  | |  |  | |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  | **Figure 6-22—MR HARQ error report header format** | | | | | | | | | | | | | | | | |
|  |  |  | **Table 6-24—Description of fields in MR HARQ error report header** | | | | | | | | | | | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  | **Name** | |  |  |  |  | **Length** | | |  |  |  |  |  | **Description** | | | | | |
|  |  |  |  |  |  |  |  | **(bit)** | |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Frame Number | | | | |  |  |  |  | 4 | |  |  | Least significant 4 bits of frame number where the DL HARQ | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  | burst is received by the RS | | | | | | | | | |
|  |  | |  |  | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| DL HARQ ACK/NAK bitmap | | | | | | | | | 14 | |  |  | RS transmits ACK/NAK Bitmap of DL HARQ data of previous | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  | frame. The order of Bitmap from MSB to LSB follows the order | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  | of DL HARQ sub-burst | | | |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| CID | |  |  |  |  |  |  |  | 16 | |  |  | Basic CID of the RS | | | |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| HCS | |  |  |  |  |  |  |  | 8 | |  |  | Header Check Sequence (same usage as HCS entry in Table 6-3) | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

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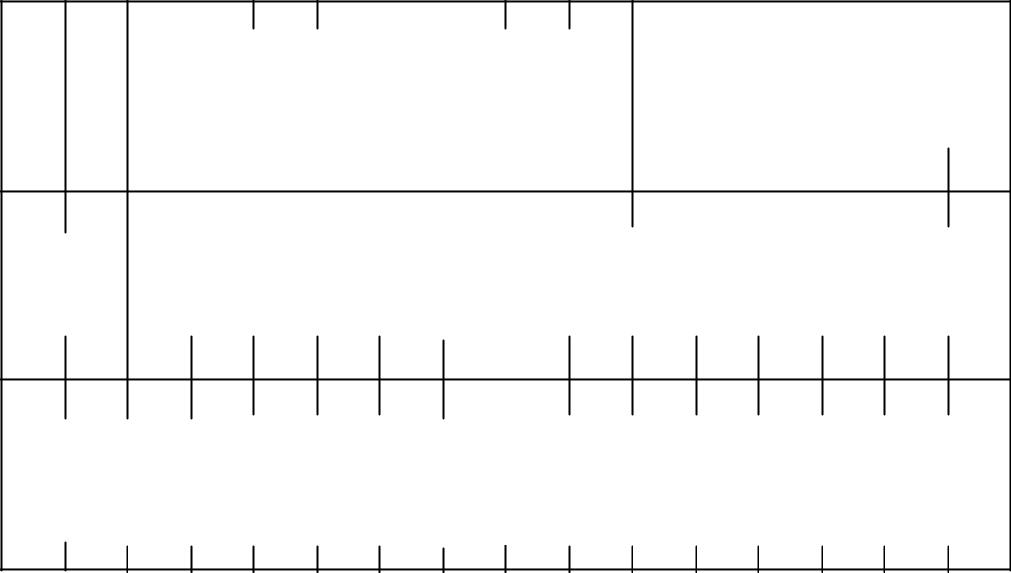
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**6.3.2.1.2.2.2.5 MR Code-REP header**

MR Code-REP header, illustrated in Table 6-25, is used by a non-transparent RS operating in centralized scheduling mode to request the MR-BS to generate CDMA Allocation IEs with the following fields set to zero: Frame Number Index, Ranging Code, Ranging Symbol, and Ranging Subchannel. This header may also be used for requesting permission from the MR-BS to accept MSs attempting network entry.



|  |  |
| --- | --- |
| HT = 1 (1) | EC = 1 (1) |

Number of

Received

HR CDMA

Codes LSB

(2)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (1) |  | Extended | | |  |  |  |  |
|  |  |  |  |  |
|  |  | Frame Number | | |
| = 1 |  |  |
|  | Type = 4 (3) | | |  |  | Index (4) | |
| Type |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  | |  |  |
|  | Number of Received BR | | | | | | | |
|  |  | CDMA Codes (6) | | | |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |
|  | Number of | | | Number of | |
|  | Received | |
| Received IR CDMA | | | | HR CDMA | |
|  | Codes (4) | | | Codes MSB | |
|  |  |  |  | (2) | |
|  |  |  |  |  |  |

CID MSB (8)

|  |  |
| --- | --- |
| CID LSB (8) | HCS (8) |

**Figure 6-23—MR Code-REP header format**

**Table 6-25—Description of fields in MR Code-REP header**

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bits)** |
|  |  |
|  |  |  |
| Frame Number Index | 4 | LSBs of relevant frame number |
|  |  |  |
| Number of Received IR | 4 | Number of CDMA initial ranging code that requires no |
| CDMA Codes |  | correction |
|  |  |  |
| Number of Received HR | 4 | Number of CDMA handover ranging code that requires no |
| CDMA Codes |  | correction |
|  |  |  |
| Number of Received BR | 6 | Number of CDMA bandwidth request ranging codes |
| CDMA Codes |  |  |
|  |  |  |
| Basic CID | 16 | RS basic CID |
|  |  |  |
| HCS | 8 | Header Check Sequence (same usage as HCS entry in Table 6-3) |
|  |  |  |

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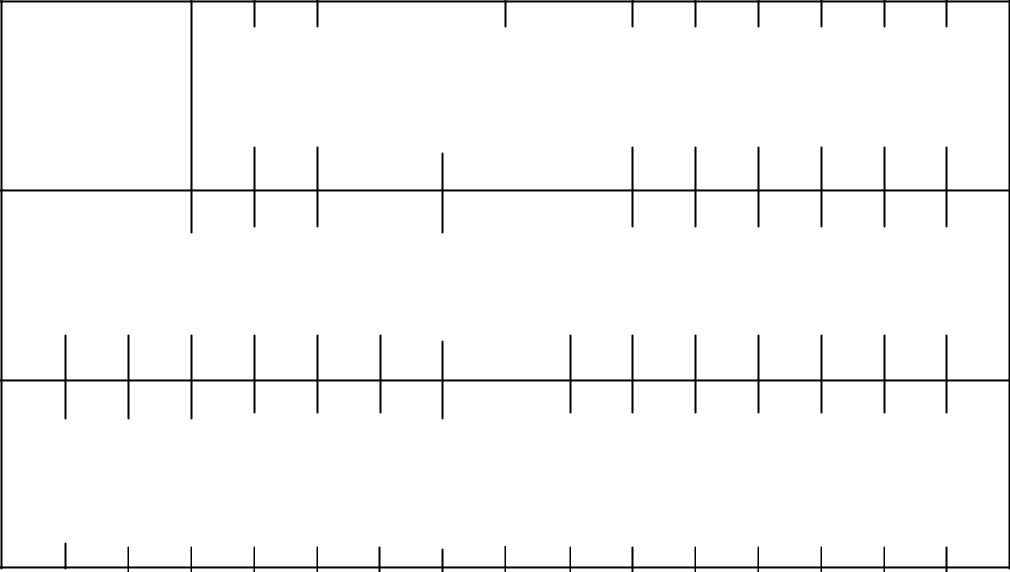
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**6.3.2.1.2.2.2.6 Tunnel BR header**

When tunnel mode is used by scheduling RSs and when QoS subheader is used, the RS may send tunnel BR (Bandwidth Request) to the superordinate scheduling station to request bandwidth. The scheduling type field and priority field are used to indicate the QoS type of bandwidth requested, and the CID field is tunnel CID.

The tunnel BR header is illustrated in Figure 6-24.



|  |  |  |
| --- | --- | --- |
| HT = 1 (1) | EC = 1 (1) | Type = 1 (1) |
|  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
|  |  |  |  |  |
| Extended | Data delivery | | Priority | BR MSB |
| service | |
| Type = 6 (3) | (3) | (4) |
| type (3) | |
|  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

|  |  |
| --- | --- |
| BR LSB (8) | CID MSB (8) |

|  |  |
| --- | --- |
| CID LSB (8) | HCS (8) |

**Figure 6-24—Tunnel BR header format**

**Table 6-26—Description of fields in Tunnel BR header**

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| Data delivery service type | 3 | 0: UGS; 1: RT-VR; 2: NRT-VR; 3:BE; 4:ERT-VR; 5–7: *Reserved* |
|  |  |  |
| Priority | 3 | Priority defined in 11.13.5 |
|  |  |  |
| BR | 12 | Requested amount of bandwidth (128 byte/bit) |
|  |  |  |
| CID | 16 | Tunnel CID which requires the bandwidth |
|  |  |  |
| HCS | 8 | Header check sequence (same usage as HCS entry in Table 6-3) |
|  |  |  |

**6.3.2.1.2.2.2.7 DL flow control header**

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The DL flow control header is used to perform DL flow control between a scheduling RS and its scheduling station. This header is sent by an RS to its superordinate RS or MR-BS to report the number of bytes that the RS can receive in the DL direction. See 6.3.6.8 for the usage of this message.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| HT = 1 (1) | EC = 1 (1) | Type = 1 (1) |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Extended | | | Reserved | |  |  |  | Credit (8) | | | | |
| Type = 7 (3) | | | = 0 (2) | |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | Reserved = 0 (8) | | | |  |  |  |  | Basic CID MSB (8) | | | | | |
|  |  |  | | | |  |  |  |  |  |  | | |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | Basic CID LSB (8) | | | |  |  |  |  |  | HCS (8) | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Figure 6-25—DL flow control header format**

**Table 6-27—Description of fields in DL Flow Control header**

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| *Reserved* | 2 | Set to 0. |
|  |  |  |
| Credit | 8 | Indicates the state of the flow control protocol and number |
|  |  | of bytes of DL traffic that the superordinate RS or MR-BS |
|  |  | can send to the subordinate RS. |
|  |  | 0–254: Flow control is in controlled state. The value |
|  |  | indicates the number of bytes of DL traffic that can be |
|  |  | safely received according to the following formula: Credit × |
|  |  | 256 |
|  |  | 255: Flow control is in the uncontrolled state. |
|  |  |  |
| *Reserved* | 8 | Set to 0. |
|  |  |  |
| Basic CID MSB | 8 | MSB of Basic CID of the station whose traffic is to be flow |
|  |  | controlled. |
|  |  |  |
| Basic CID LSB | 8 | LSB of Basic CID of the station whose traffic is to be flow |
|  |  | controlled. |
|  |  |  |
| HCS | 8 | Header Check Sequence. |
|  |  |  |

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**6.3.2.1.2.2.3 Extended M2M device MAC signaling header type II**

This type of MAC header is UL-specific. There is no payload following the MAC header. The Extended M2M device MAC signaling header type II is illustrated in Figure 6-18. Table 6-27a describes the encoding of the 3-bit extended type field following the type field.

**Table 6-27a—Extended Type field encodings for extended M2M device MAC signaling header type II**

|  |  |  |
| --- | --- | --- |
| **Extended Type field** | **MAC header type** | **Reference table** |
|  |  |  |
| 0 | M2M abnormal power down report header | Table 6-27b |
|  |  |  |
| 1 ~ 7 | *Reserved* |  |
|  |  |  |

**6.3.2.1.2.2.3.1 M2M abnormal power down report header**

When an M2M device in normal operation mode detects an abnormal power down event, it sends an M2M abnormal power down report signaling header indicating that an abnormal or involuntary power down has occurred. The M2M abnormal power down report signaling header is defined in Table 6-27b.

**Table 6-27b—Description of fields in M2M abnormal power down report header**

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| CID | 16 | M2M device’s basic connection identifier. |
|  |  |  |
| Emergency Type | 1 | 0b0: power outage |
|  |  | 0b1: *Reserved* |
|  |  |  |
| *Reserved* | 17 | Set to 0. |
|  |  |  |
| HCS | 8 | Header Check Sequence (same usage as HCS |
|  |  | entry in Table 6-3). |
|  |  |  |

**6.3.2.1.3 DL MAC header without payload**

This MAC header format is applicable to DL only. The MAC header is not followed by any MAC PDU pay-load and CRC.

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**6.3.2.1.3.1 DL M2M MAC signaling header type I**

For this MAC header format, there is no payload following the MAC header. The DL M2M MAC signaling header type I is illustrated in Figure 6-5. Table 6-27c describes the encoding of the 3-bit Type field follow-ing the EC field.

**Table 6-27c—Type field encodings for DL M2M MAC signaling header type I**

|  |  |  |
| --- | --- | --- |
| **Type field** | **MAC header type (with HT/EC = 0b10)** | **Reference table** |
| **(3 bits)** |
|  |  |
|  |  |  |
| 0 | M2M abnormal power down confirmation header | Table 6-27d |
|  |  |  |
| 1 ~ 7 | *Reserved* |  |
|  |  |  |

**6.3.2.1.3.1.1 M2M abnormal power down confirmation header**

An M2M abnormal power down confirmation signaling header shall be transmitted by the BS in response to a received abnormal power down report. The M2M abnormal power down confirmation signaling header is defined in Table 6-27d.

**Table 6-27d—Description of fields in M2M abnormal power down confirmation header**

|  |  |  |
| --- | --- | --- |
| **Name** | **Length (bit)** | **Description** |
|  |  |  |
| Type | 3 | The type of M2M abnormal power down confirma- |
|  |  | tion header is defined in Table 6-27c. |
|  |  |  |
| *Reserved* | 35 | Set to 0. |
|  |  |  |
| HCS | 8 | Header Check Sequence (same usage as HCS entry |
|  |  | in Table 6-3). |
|  |  |  |

**6.3.2.2 MAC subheaders and special payloads**

Five types of subheaders may be present in a MAC PDU with generic MAC header; four per-PDU subheader types and one per-SDU subheader type. The per-PDU subheaders (i.e., extended subheaders, FSH, FFSH, and GMSH) may be inserted in the MAC PDUs immediately following the generic MAC header. If both the FSH and GMSH are indicated, the GMSH shall come first. In the DL, the FFSH shall always appear as the last per-PDU subheader. The ESF bit in the generic MAC header indicates that one or more extended subheaders are present in the PDU. The extended subheaders shall always appear immediately after the generic MAC header and before all other subheaders. All extended subheaders are not encrypted. (See 6.3.2.2.7.)

The only per-SDU subheader is the PSH. It may be inserted before each MAC SDU if so indicated by the Type field. The PSH and FSH are mutually exclusive and shall not both be present within the same MAC PDU.

When present, per-PDU subheaders shall always precede the first per-SDU subheader.

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**6.3.2.2.1 Fragmentation subheader (FSH)**

The FSH is shown in Table 6-28.

**Table 6-28—FSH format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| Fragmentation Subheader() { | — | — |
|  |  |  |
| **FC** | 2 | Indicates the fragmentation state of the payload: |
|  |  | 00 = No fragmentation |
|  |  | 01 = Last fragment |
|  |  | 10 = First fragment |
|  |  | 11 = Continuing (middle) fragment |
|  |  |  |
| if (ARQ-enabled Connection) | — | — |
|  |  |  |
| **BSN** | 11 | Sequence number of the first block in the current |
|  |  | SDU fragment. |
|  |  |  |
| else { | — | — |
|  |  |  |
| if (**Type** bit **Extended Type**) | — | See Table 6-4. |
|  |  |  |
| **FSN** | 11 | Sequence number of the current SDU fragment. |
|  |  | The FSN value increments by one (modulo 2048) |
|  |  | for each fragment, including unfragmented |
|  |  | SDUs. |
|  |  |  |
| else | — | — |
|  |  |  |
| **FSN** | 3 | Sequence number of the current SDU fragment. |
|  |  | The FSN value increments by one (modulo 8) for |
|  |  | each fragment, including unfragmented SDUs. |
|  |  |  |
| } | — | — |
|  |  |  |
| *Reserved* | 3 | Shall be set to zero. |
|  |  |  |
| } | — | — |
|  |  |  |

**6.3.2.2.2 Grant management subheader (GMSH)**

The GMSH is 2 bytes in length and is used by the SS to convey bandwidth management needs to the BS. This subheader is encoded differently based upon the type of UL scheduling service for the connection (as given by the CID). The use of this subheader is defined in 6.3.6. The GMSH is shown in Table 6-29. Its fields are defined in Table 6-30. The capability of GMSH at both BS and SS is optional.

**6.3.2.2.3 Packing subheader (PSH)**

When packing (see 6.3.3.4) is used, the MAC may pack multiple SDUs into a single MAC PDU. When packing variable-length MAC SDUs, the MAC precedes each one with a PSH. The PSH is defined in Table 6-31.

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**Table 6-29—GMSH format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| Grant Management Subheader { | — | — |
|  |  |  |
| if (scheduling service type == UGS) { | — | — |
|  |  |  |
| **SI** | 1 |  |
|  |  |  |
| **PM** | 1 |  |
|  |  |  |
| **FLI** | 1 | — |
|  |  |  |
| **FL** | 4 | — |
|  |  |  |
| *Reserved* | 9 | Shall be set to zero |
|  |  |  |
| } else if (scheduling service type == Extended rtPS) { | — | — |
|  |  |  |
| **Extended piggyback request** | 11 | — |
|  |  |  |
| **FLI** | 1 | — |
|  |  |  |
| **FL** | 4 | — |
|  |  |  |
| } else { | — | — |
|  |  |  |
| **PiggyBack Request** | 16 | — |
|  |  |  |
| } | — | — |
|  |  |  |
| } | — | — |
|  |  |  |

|  |  |  |
| --- | --- | --- |
|  |  | **Table 6-30—GMSH fields** |
|  |  |  |
| **Name** | **Length** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| FLI | 1 | Frame latency indication |
|  |  | 0 = FL field disabled for this grant |
|  |  | 1 = FL field enabled for this grant |
|  |  |  |
| FL | 4 | Frame latency. The number of frames previous to the current one in which the |
|  |  | transmitted data was available. |
|  |  | When the latency is greater than 15 then the FL field shall be set to 15. |
|  |  |  |
| Extended Piggyback | 11 | The number of bytes of UL bandwidth requested by the MS. The BR is for the |
| Request |  | CID. The request shall not include any PHY overhead. In case of Extended rtPS, |
|  |  | the BS changes its grant size to the size specified in this field. |
|  |  |  |
| PBR | 16 | Piggyback request. The number of bytes of UL bandwidth requested by the SS. |
|  |  | The BR is for the CID. The request shall not include any PHY overhead. The |
|  |  | request shall be incremental. |
|  |  |  |
| PM | 1 | Poll me |
|  |  | 0 = No action |
|  |  | 1 = Used by the SS to request a bandwidth poll. |
|  |  |  |

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**Table 6-30—GMSH fields *(CONTINUED)***

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Length** |  | **Description** |
| **(bit)** |  |
|  |  |  |
|  |  |  |  |
| *Reserved* | 9 | — |  |
|  |  |  | |
| SI | 1 | Slip indicator | |
|  |  | 0 | = No action |
|  |  | 1 | = Used by the SS to indicate a slip of UL grants relative to the UL queue |
|  |  | depth. | |
|  |  |  |  |

**Table 6-31—PSH format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| Packing Subheader() { | — | — |
|  |  |  |
| **FC** | 2 | Indicates the fragmentation state of the payload: |
|  |  | 00 = no fragmentation |
|  |  | 01 = last fragment |
|  |  | 10 = first fragment |
|  |  | 11 = continuing (middle) fragment |
|  |  |  |
| if (ARQ-enabled Connection) | — | — |
|  |  |  |
| **BSN** | 11 | Sequence number of the first block in the current |
|  |  | SDU fragment. |
|  |  |  |
| else { | — | — |
|  |  |  |
| if (**Type** bit **Extended Type**) | — | See Table 6-4. |
|  |  |  |
| **FSN** | 11 | Sequence number of the current SDU fragment. The |
|  |  | FSN value shall increment by one (modulo 2048) |
|  |  | for each fragment, including unfragmented SDUs |
|  |  | and unpacked SDU or SDU fragments. |
|  |  |  |
| else | — | — |
|  |  |  |
| **FSN** | 3 | Sequence number of the current SDU fragment. The |
|  |  | FSN value shall increment by one (modulo 8) for |
|  |  | each fragment, including unfragmented SDUs and |
|  |  | unpacked SDU or SDU fragments. |
|  |  |  |
| } | — | — |
|  |  |  |
| **Length** | 11 | Length of the SDU fragment in bytes including the |
|  |  | PSH. |
|  |  |  |
| } | — | — |
|  |  |  |

**6.3.2.2.4 ARQ feedback**

If the ARQ Feedback Payload bit in the MAC Type field (see Table 6-4) is set, the ARQ Feedback Payload shall be transported. If packing is used, it shall be transported as the first packed payload. See 6.3.3.4.3. Note that this bit does not address the ARQ Feedback payload contained inside an ARQ Feedback message.

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1. ***RESERVED***
2. **Fast-feedback allocation subheader (FFSH)**

The format of the FFSH is specified in Table 6-32. The FFSH, when used, shall always be the last per-PDU subheader as specified in 6.3.2.2. The support of the FFSH is PHY-specification-specific.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Table 6-32—FFSH format** | | | |
|  |  |  |  |  |
| **Syntax** |  | **Size** |  | **Notes** |
|  | **(bit)** |  |
|  |  |  |  |
|  |  |  |  |  |
| Fast-Feedback Allocation Subheader { |  |  |  |  |
|  |  |  |  |  |
| **Allocation offset** |  | 6 |  |  |
|  |  |  |  |  |
| **Feedback type** |  | 2 | 00 | – Fast DL measurement |
|  |  |  | 01 | – Fast MIMO feedback, antenna #0 |
|  |  |  | 10 | – Fast MIMO feedback, antenna #1 |
|  |  |  | 11 – MIMO mode and permutation mode feedback | |
|  |  |  |  |  |
| } |  |  |  |  |
|  |  |  |  |  |

**Allocation offset**

Defines the offset, in units of slots, from the beginning of the fast-feedback UL bandwidth allocation (8.4.5.4.9), of the slot in which the SS servicing the CID appearing in the generic MAC header shall send a fast-feedback message. Range of values is 0 to 63. The allocation applies to the UL subframe two frames after the frame including the FFSH.

**6.3.2.2.7 Extended subheader format**

The extended subheader group (see Figure 6-26), when used, shall always appear immediately after the generic MAC header and before all subheaders, and, if the MAC PDU contains an encrypted payload (i.e.,

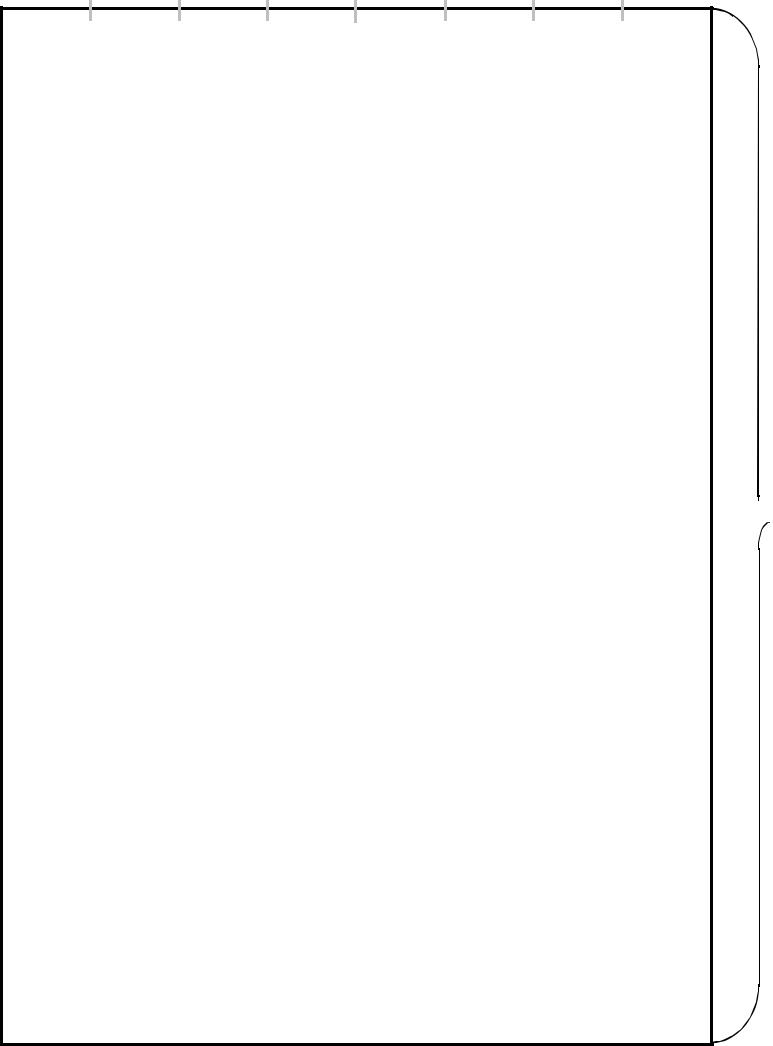
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the EC bit is set to 1), the packet number (PN), as described in 6.3.2.2. The extended subheader group format is specified in Table 6-33, Table 6-34, and Table 6-35. Extended subheaders shall not be encrypted.



Extended subheader group length (8 bits)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |
| Rsv=0 |  |  |  |  |  |  |  |
|  | Extended subheader type I (7 bits) | | | | | |
| (1 bit) |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  | Extended subheader body 1 | | | | | |
|  |  |  | (variable length) | | | | |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| Rsv=0 |  |  |  |  |  |  |  |
|  | Extended subheader type II (7 bits) | | | | | |
| (1 bit) |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  | Extended subheader body 2 | | | | | |
|  |  |  | (variable length) | | | | |
|  |  |  |  |  |  |  |  |
|  | . | | | |  |  |  |
|  | . | | | |  |  |  |
|  | . | | | |  |  |  |
|  |  |  |  |  |  |  |  |
| Rsv=0 |  |  |  |  |  |  |  |
|  | Extended subheader type n (7 bits) | | | | | |
| (1 bit) |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

 Length of extended subheader group

Extended subheader body n (variable length)

**Figure 6-26—Extended subheader group format**

The fields of the extended subheader group structure are described in Table 6-33.

**Table 6-33—Extended subheader group format**

|  |  |  |
| --- | --- | --- |
| **Name** | **Size** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| Extended Subheader Group | 8 | The Extended Subheader Group Length field indicates the |
| Length |  | total length of the subheader group, including all the extended |
|  |  | subheaders and the length byte. |
|  |  |  |
| for (i=1; i < Extended Subheader |  |  |
| Group Length; i++) { |  |  |
|  |  |  |
| *Reserved* | 1 | *Reserved* = 0 |
|  |  |  |
| Extended Subheader Type | 7 | Type of subheader as defined in Table 6-34 and Table 6-35. |
|  |  |  |

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**Table 6-33—Extended subheader group format *(CONTINUED)***

|  |  |  |
| --- | --- | --- |
| **Name** | **Size** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| Extended Subheader Body | *variable* | The size of the extended subheader is determined by extended |
|  |  | subheader type as specified in Table 6-34 and Table 6-35. The |
|  |  | size of the extended subheader body is byte aligned. |
|  |  |  |
| } |  |  |
|  |  |  |

The extended subheader group starts with an 8-bit Extended Subheader Group Length field that is followed by one or multiple extended subheaders. The length field specifies the total length in bytes of the subheader group, including all the extended subheaders and the length byte. Each extended subheader consists of a reserved bit, a 7-bit Extended Subheader Type field, and a variable-size extended subheader body. The size of each extended subheader is determined by the extended subheader type as specified in Table 6-34.

The list of defined extended subheaders is given in Table 6-34 for the DL and in Table 6-35 for the UL. The support of each extended subheader shall be negotiated between the BS and the MS as part of the registration dialog (REG-REQ/RSP).

**Table 6-34—Description of extended subheader types (DL)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Extended** |  | **Extended subheader** |  |
| **Name** | **body size** | **Description** |
| **subheader type** |
|  | **(byte)** |  |
|  |  |  |
|  |  |  |  |
| 0 | SDU\_SN extended subheader | 1 | See 6.3.2.2.7.1 |
|  |  |  |  |
| 1 | DL sleep control extended subheader | 3 | See 6.3.2.2.7.2 |
|  |  |  |  |
| 2 | Feedback request extended subheader | 3 | See 6.3.2.2.7.3 |
|  |  |  |  |
| 3 | SN request extended subheader | 1 | See 6.3.2.2.7.7 |
|  |  |  |  |
| 4 | PDU SN(short) extended subheader | 1 | See 6.3.2.2.7.8 |
|  |  |  |  |
| 5 | PDU SN(long) extended subheader | 2 | See 6.3.2.2.7.8 |
|  |  |  |  |
| 6–127 | *Reserved* | — | — |
|  |  |  |  |

**Table 6-35—Description of extended subheader types (UL)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Extended** |  | **Extended subheader** |  |
| **Name** | **body size** | **Description** |
| **subheader type** |
|  | **(byte)** |  |
|  |  |  |
|  |  |  |  |
| 0 | MIMO mode feedback extended | 1 | See 6.3.2.2.7.4 |
|  | subheader |  |  |
|  |  |  |  |
| 1 | UL Tx power report extended | 1 | See 6.3.2.2.7.5 |
|  | subheader |  |  |
|  |  |  |  |
| 2 | Mini-feedback extended subheader | 2 | See 6.3.2.2.7.6 |
|  |  |  |  |
| 3 | PDU SN(short) extended subheader | 1 | See 6.3.2.2.7.8 |
|  |  |  |  |

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**Table 6-35—Description of extended subheader types (UL) *(CONTINUED)***

|  |  |  |  |
| --- | --- | --- | --- |
| **Extended** |  | **Extended subheader** |  |
| **Name** | **body size** | **Description** |
| **subheader type** |
|  | **(byte)** |  |
|  |  |  |
|  |  |  |  |
| 4 | PDU SN(long) extended subheader | 2 | See 6.3.2.2.7.8 |
|  |  |  |  |
| 5 | Persistent Allocation Error Event | 1 | See 6.3.2.2.7.10 |
|  |  |  |  |
| 6 | ertPS resumption bitmap extended | 1 | See 6.3.2.2.7.9 |
|  | subheader |  |  |
|  |  |  |  |
| 7–127 | *Reserved* | — | — |
|  |  |  |  |

**6.3.2.2.7.1 SDU SN extended subheader**

The SDU SN extended subheader shall only be sent by the BS if SDU SN extended subheader capability is supported (negotiated through REG-REQ/RSP) and if SDU\_SN Feedback is enabled for a DL connection (negotiated through DSA-REQ/RSP). The SDU SN extended subheader shall contain the last virtual MAC SDU sequence number of current MAC PDU. The format of the SDU SN extended subheader is as described in Table 6-36.

**Table 6-36—SDU SN extended subheader format**

****

**Size**

**Name** **Description**

**(bit)**

|  |  |  |
| --- | --- | --- |
| SDU sequence number | 8 | Last virtual MAC SDU sequence number in the current MAC PDU. |

**6.3.2.2.7.2 DL sleep control extended subheader**

The DL sleep control extended subheader is sent by the BS to activate/deactivate certain power saving class. The requested operation is effective from the start frame carried in the DL sleep control extended subheader according to the format defined in Table 6-37. The format of DL sleep control extended subheader is as described in Table 6-37. The BS may transmit this message to reactivate the Power Saving Class after the BS determines the end of data transmission.

**Table 6-37—DL sleep control extended subheader format**

|  |  |  |
| --- | --- | --- |
| **Name** | **Size** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| Power\_Saving\_Class\_ID | 6 | Indicates the power saving class ID to which this command |
|  |  | refers. |
|  |  |  |
| Operation | 1 | 1 = Activate power saving class. |
|  |  | 0 = Deactivate power saving class. |
|  |  |  |
| Final\_Sleep\_Window\_Exponent | 3 | For power saving class type III only: assigned factor by which |
|  |  | the final-sleep window base is multiplied in order to calculate the |
|  |  | duration of single sleep window requested by the message. |
|  |  |  |

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**Table 6-37—DL sleep control extended subheader format *(CONTINUED)***

|  |  |  |
| --- | --- | --- |
| **Name** | **Size** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| Final\_Sleep\_Window\_Base | 7 | For power saving class type III only: the base for duration of |
|  |  | single sleep window requested by the message. |
|  |  |  |
| Stop\_CQI\_Allocation\_Flag | 1 bit | 1 = Any CQICH allocations to this MS are cancelled. |
|  |  | 0 = CQICH allocations to this MS are still allocated and the MS |
|  |  | shall continue to transmit channel quality information on them |
|  |  | during its availability intervals. |
|  |  |  |
| Start frame | 6 bits | 6 LSB of frame number to start activation of PSC. |
|  |  |  |

**6.3.2.2.7.3 Feedback request extended subheader**

Feedback request extended subheader shall only be sent by the BS to provide a UL allocation for a fast-feedback channel transmission (see 8.4.11). The BS shall indicate in the fast-feedback request subheader transmission the applied frame for the UL allocation.

The format of the feedback request extended subheader is as described in Table 6-38.

**Table 6-38—Feedback request extended subheader format**

|  |  |  |
| --- | --- | --- |
| **Name** | **Size** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| UIUC | 4 | — |
|  |  |  |
| Feedback type | 4 | Shall be set according to Table 6-16. |
|  |  |  |
| OFDMA Symbol | 6 | The offset is relevant to the Allocation Start Time field given in the UL-MAP |
| offset |  | message. |
|  |  |  |
| Subchannel offset | 6 | The lowest index subchannel used for carrying the burst, starting from |
|  |  | subchannel 0. |
|  |  |  |
| No. slot | 3 | The number of slots allocated for the burst. |
|  |  |  |
| Frame offset (F) | 1 | Indicate to report at the frame. If F == 0, the allocation applies to the UL |
|  |  | subframe two frames ahead of the current frame. If F == 1, four frames ahead |
|  |  | of the current frame. |
|  |  |  |

**6.3.2.2.7.4 MIMO mode feedback extended subheader**

An MS uses the MIMO feedback extended subheader to provide its feedback in terms of MIMO mode feedback. When there is an UL MAC PDU payload to be transmitted at the same time. The format of the MIMO mode feedback extended subheader is as described in Table 6-39.

For each MS, if a MIMO mode feedback extended subheader is present, it shall only appear in the first unicast PDU transmitted by that MS in that frame.

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**Table 6-39—MIMO mode feedback extended subheader format**

|  |  |  |
| --- | --- | --- |
| **Name** | **Length** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| Feedback Type | 2 | 0b00: feedback type 0b000 as defined in Table 8-191 |
|  |  | 0b01: feedback type 0b001 as defined in Table 8-191 |
|  |  | 0b10: feedback type 0b010 as defined in Table 8-191 |
|  |  | 0b11: feedback type 0b011 as defined in Table 8-191 |
|  |  |  |
| Feedback Content | 6 | Feedback contents and the corresponding feedback payload |
|  |  | (6 bits) are the same as that defined in Table 8-191 and in |
|  |  | 8.4.11.4, 8.4.11.5, 8.4.11.6, 8.4.11.7, 8.4.11.8, 8.4.11.9, and |
|  |  | 8.4.11.10 for the enhanced fast-feedback channel. |
|  |  |  |

**6.3.2.2.7.5 UL Tx power report extended subheader**

This subheader is sent from MS to BS to report the Tx power of the burst that carries this subheader. The format of the UL Tx power report extended subheader is as described in Table 6-40.

**Table 6-40—UL Tx power report extended subheader format**

|  |  |  |
| --- | --- | --- |
| **Name** | **Size** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| UL Tx Power | 8 | Tx power level for the burst carries this |
|  |  | header (11.1.1). The value shall be estimated |
|  |  | and reported for the burst. |
|  |  |  |

**6.3.2.2.7.6 Mini-feedback extended subheader**

The format of the mini-feedback extended subheader is shown in Table 6-41.

**Table 6-41—Description of mini-feedback extended subheaders (UL)**

|  |  |  |
| --- | --- | --- |
| **Name** | **Size** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| Feedback Type | 4 | Type of feedback: see Table 6-16 |
|  |  |  |
| Feedback Content | 12 | — |
|  |  |  |

**6.3.2.2.7.7 SN request extended subheader**

The SN request extended subheader is sent by the BS to request the MS to send the SN report header. The fields of the SN request extended subheader are defined in Table 6-42.

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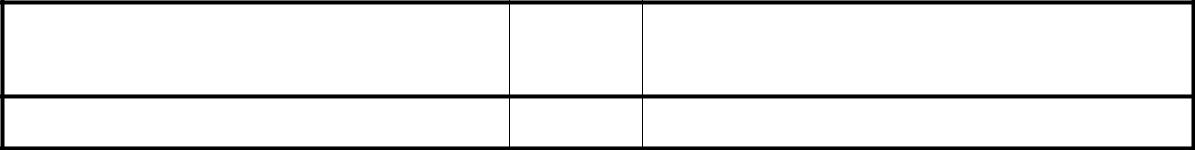
**Table 6-42—Description of SN request extended subheader**

|  |  |  |
| --- | --- | --- |
| **Name** | **Size** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| SN Report Indication | 1 | Bit 0: Set to 1 to request transmission |
|  |  |  |
| *Reserved* | 7 | Shall be set to zero |
|  |  |  |

**6.3.2.2.7.8 PDU SN extended subheader**

Specify the PDU sequence number in a monotonic increasing manner. The format of the PDU SN extended subheader is as described in Table 6-43 and Table 6-44.

**Table 6-43—PDU SN (short) extended subheader**

****

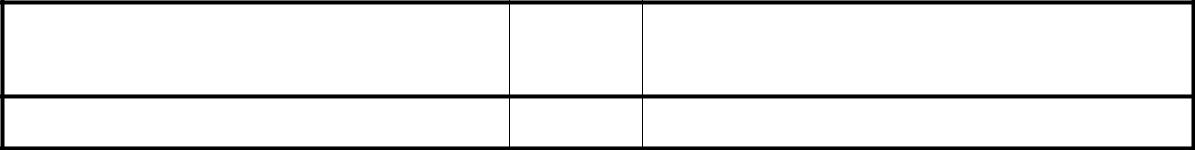
**Size**

**Name** **Description**

**(bit)**

|  |  |  |
| --- | --- | --- |
| PDU SN(short) | 8 | Specify the PDU SN number |

**Table 6-44—PDU SN (long) extended subheader**

****

**Size**

**Name** **Description**

**(bit)**

|  |  |  |
| --- | --- | --- |
| PDU SN(long) | 16 | Specify the PDU SN number |

**6.3.2.2.7.9 ertPS resumption bitmap extended subheader**

An MS may have multiple ertPS service flows that have been stopped by the MS by sending BR headers with BR = 0. When the MS has more than one ertPS service flow to resume at the same time, the MS may include the following extended subheader in a MAC PDU to request the serving BS to resume scheduling of the identified ertPS service flows. When the BS receives this extended subheader, the BS shall allocate a UL burst for each UL ertPS service flow identified by the extended subheader.

**Table 6-45—ertPS resumption bitmap extended subheader**

|  |  |  |
| --- | --- | --- |
| **Name** | **Size** | **Description** |
| **(bit)** |
|  |  |
|  |  |  |
| UL ertPS resumption bitmap | 8 | One bit is assigned to each UL ertPS service flow in descending order of |
|  |  | their SFID (i.e., bit 7 is mapped to the UL ertPS service flow with the highest |
|  |  | SFID, bit 6 is mapped to the UL ertPS service flow with the second highest |
|  |  | SF, etc.). |
|  |  | 1: Request for resumption of the corresponding ertPS service flow |
|  |  | 0: No request for resumption of the corresponding ertPS service flow |
|  |  |  |

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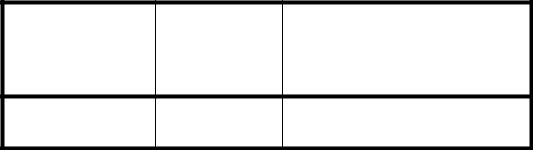
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**6.3.2.2.7.10 Persistent Allocation Error Event**

The Persistent Allocation Error Event is used by the MS to indicate failure with a persistent allocation. The fields of the Persistent Allocation Error Event extended subheader are defined in Table 6-46.

**Table 6-46—Persistent allocation error event extended subheader**

****

**Size**

**Name** **Description**

**(bit)**

|  |  |  |
| --- | --- | --- |
| CID | 16 | Basic CID |

**6.3.2.2.8 Relay MAC PDU subheaders**

Five types of subheaders may be present in a relay MAC PDU: Fragmentation subheader, Packing subheader, QoS subheader, Grant management subheader and Allocation subheader. The Packing and Fragmentation subheaders are mutually exclusive and shall not both be present within the same relay MAC PDU. When multiple subheaders are present in the same relay MAC PDU, they shall be ordered as follows: Grant management subheader, QoS subheader, Fragmentation or Packing subheader, and Allocation subheader. All subheaders in the relay MAC PDU are not encrypted.

Extended subheaders may also be present in a relay MAC PDU. When present, the extended subheader shall always appear immediately after the Relay MAC header, and before all other subheaders. All extended subheaders are not encrypted.

**6.3.2.2.8.1 QoS subheader (QSH)**

The QoS subheader is specified in Table 6-47. The QoS subheader may be used for relay MAC PDU on relay link in a transport tunnel.

**Table 6-47—QoS subheader format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| QoS Subheader() { | — | — |
|  |  |  |
| **Data delivery service** | 3 | 0:UGS; 1: RT-VR; 2: NRT-VR; 3:BE; 4:ERT-VR; 5– |
|  |  | 7: *Reserved* |
|  |  |  |
| **Priority** | 3 | Priority is as defined in 11.13.5 |
|  |  |  |
| *Reserved* | 2 | — |
|  |  |  |
| } | — | — |
|  |  |  |

**6.3.2.2.8.2 Allocation subheader**

The MR-BS may include the allocation subheader in a relay MAC PDU. When operating in centralized scheduling mode, the MR-BS shall use the Allocation subheader to indicate the frame in which the RS shall relay the MAC PDU. When included, the MR-BS shall use one allocation subheader per RS for the relay link, and one or more allocation subheader for the access link. The allocation subheaders corresponding to

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the relay link shall precede the ones for access link. If there are multiple intermediate RSs, the allocation subheader associated with the RS that is nearest to the MR-BS shall be included first. The access RS shall use the continuation bit in the allocation subheader to detect whether there is a subsequent allocation subheader.

When operating in distributed scheduling mode, the MR-BS may include the Allocation subheader to indicate the frame in which the RS shall transmit an MBS MAC PDU over the access link. When included, MR-BS shall use only one Allocation subheader per MBS MAC PDU. The access RS shall transmit the MBS MAC PDU over the access link in the target transmission frame specified in Allocation subheader.

The allocation subheader format is specified in Table 6-48. When used in distributed scheduling mode for MBS MAC PDU, only the target transmission frame field shall be used.

**Table 6-48—Allocation subheader format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bits)** |
|  |  |
|  |  |  |
| Allocation subheader{ | — | — |
|  |  |  |
| **Target Transmission Frame** | 6 | LSB 6 bits of frame number of the frame that RS shall |
|  |  | transmit the MAC PDU. |
|  |  |  |
| **Allocation Index** | 6 | Allocation Index pointing to DL-MAP\_IE in the RS\_Relay- |
|  |  | MAP and the RS\_Access-MAP message. |
|  |  |  |
| **Number of MAC PDUs** | 3 | Number of MAC PDUs in this allocation. |
|  |  |  |
| **Continuation** | 1 | 1: Another Allocation subheader follows |
|  |  | 0: This is the last Allocation subheader for the RS. |
|  |  |  |
| } | — | — |
|  |  |  |

**6.3.2.2.8.3 Fragmentation subheader (FSH)**

The FSH in a relay MAC PDU indicates the location of a fragment of a TDU originating from the ingress station of the tunnel. The format of the fragmentation subheader is specified in Table 6-49.

**Table 6-49—Fragmentation subheader format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bits)** |
|  |  |
|  |  |  |
| Fragmentation subheader{ | — | — |
|  |  |  |
| **More fragments (MF) flag** | 1 | MF is set for all fragments of the same TDU except the last one. |
|  |  |  |
| **TDU sequence number (TSN)** | 7 | The sequence number of the TDU to which this fragment belongs. |
|  |  |  |
| **Fragment offset (FO)** | 12 | The offset of the fragment relative to the beginning of the TDU. |
|  |  |  |
| *Reserved* | 4 | Shall be set to zero. |
|  |  |  |
| } | — | — |
|  |  |  |

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**6.3.2.2.8.4 Packing subheader (PSH)**

The PSH in a relay MAC PDU indicates the location and the length of a fragment of a TDU originating from the ingress station of the tunnel. The format of the packing subheader is specified in Table 6-50.

**Table 6-50—Packing subheader format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| Packing subheader{ | — | — |
|  |  |  |
| **More fragments (MF) flag** | 1 | MF is set for all fragments of the same TDU except the last one |
|  |  |  |
| **TDU sequence number (TSN)** | 7 | The sequence number of the TDU to which this fragment belongs |
|  |  |  |
| **Fragment offset (FO)** | 12 | The offset of the fragment relative to the beginning of the TDU |
|  |  |  |
| **Fragment Length** | 12 | The length of the fragment |
|  |  |  |
| } | — | — |
|  |  |  |

**6.3.2.3 MAC management messages**

A set of MAC management messages are defined. These messages shall be carried in the Payload of the MAC PDU. All MAC management messages except for DL MAP and UL MAP messages for channel bandwidth below 1.25 MHz, begin with a Management Message Type field and may contain additional fields. MAC management messages on the basic, broadcast, and initial ranging connections shall be neither fragmented nor packed. MAC management messages on the primary management connection may be packed and/or fragmented. MAC management messages on the fragmentable broadcast connection may be fragmented. For the OFDM, and OFDMA PHYs, management messages carried on the initial ranging, broadcast, fragmentable broadcast, basic, and primary management connections shall have CRC usage enabled. The format of the management messages except for DL MAP and UL MAP messages for channel bandwidth below 1.25 MHz is given in Figure 6-27. The DL MAP and UL MAP MAC messages for channel bandwidth below 1.25 MHz do not include a management type filed. The encoding of the Management Message Type field is given in Table 6-51. MAC management messages shall not be carried on transport connections. MAC management messages that have a Type value specified in Table 6-51 as reserved, or those not containing all required parameters or containing erroneously encoded parameters, shall be silently discarded. In case of MAC management messages with multiple presentations of the same TLV and/or encoded parameter information, the last presentation shall be used, unless otherwise specified that multiple presentations are allowed (e.g., Downlink\_Burst\_Profile TLV in DCD message), in which case all presentations shall be used.

|  |  |
| --- | --- |
| Management | Management Message Payload |
| Message Type |
|  |
|  |  |

**Figure 6-27—MAC management message format**

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**Table 6-51—MAC management messages**

|  |  |  |  |
| --- | --- | --- | --- |
| **Type** | **Message name** | **Message description** | **Connection** |
|  |  |  |  |
| 0 | UCD | UL channel descriptor | Fragmentable broadcast or RS |
|  |  |  | Primary Management or RS |
|  |  |  | Multicast Management |
|  |  |  |  |
| 1 | DCD | DL channel descriptor | Fragmentable broadcast or RS |
|  |  |  | Primary Management or RS |
|  |  |  | Multicast Management |
|  |  |  |  |
| 2 | DL-MAP | DL access definition | Broadcast |
|  |  |  |  |
| 3 | UL-MAP | UL access definition | Broadcast |
|  |  |  |  |
| 4 | RNG-REQ | Ranging request | Initial ranging, basic, or Primary |
|  |  |  | management |
|  |  |  |  |
| 5 | RNG-RSP | Ranging response | Initial ranging or basic |
|  |  |  |  |
| 6 | REG-REQ | Registration request | Primary management |
|  |  |  |  |
| 7 | REG-RSP | Registration response | Primary management |
|  |  |  |  |
| 8 | — | *Reserved* | — |
|  |  |  |  |
| 9 | PKM-REQ | Privacy key management request | Primary management |
|  |  |  |  |
| 10 | PKM-RSP | Privacy key management response | Primary management or |
|  |  |  | broadcasta |
| 11 | DSA-REQ | Dynamic service addition request | Primary management |
|  |  |  |  |
| 12 | DSA-RSP | Dynamic service addition response | Primary management |
|  |  |  |  |
| 13 | DSA-ACK | Dynamic service addition acknowledge | Primary management |
|  |  |  |  |
| 14 | DSC-REQ | Dynamic service change request | Primary management |
|  |  |  |  |
| 15 | DSC-RSP | Dynamic service change response | Primary management |
|  |  |  |  |
| 16 | DSC-ACK | Dynamic service change acknowledge | Primary management |
|  |  |  |  |
| 17 | DSD-REQ | Dynamic service deletion request | Primary management |
|  |  |  |  |
| 18 | DSD-RSP | Dynamic service deletion response | Primary management |
|  |  |  |  |
| 19 | — | *Reserved* | — |
|  |  |  |  |
| 20 | — | *Reserved* | — |
|  |  |  |  |
| 21 | MCA-REQ | Multicast assignment request | Primary management |
|  |  |  |  |
| 22 | MCA-RSP | Multicast assignment response | Primary management |
|  |  |  |  |
| 23 | DBPC-REQ | DL burst profile change request | Basic |
|  |  |  |  |
| 24 | DBPC-RSP | DL burst profile change response | Basic |
|  |  |  |  |
| 25 | RES-CMD | Reset command | Basic |
|  |  |  |  |
| 26 | SBC-REQ | SS basic capability request | Basic or Primary management |
|  |  |  |  |
| 27 | SBC-RSP | SS basic capability response | Basic |
|  |  |  |  |
| 28 | CLK-CMP | SS network clock comparison | Broadcast |
|  |  |  |  |
| 29 | DREG-CMD | De/Reregister command | Basic |
|  |  |  |  |

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**Table 6-51—MAC management messages *(CONTINUED)***

|  |  |  |  |
| --- | --- | --- | --- |
| **Type** | **Message name** | **Message description** | **Connection** |
|  |  |  |  |
| 30 | DSX-RVD | DSx received message | Primary management |
|  |  |  |  |
| 31 | TFTP-CPLT | Config file TFTP complete message | Primary management |
|  |  |  |  |
| 32 | TFTP-RSP | Config file TFTP complete response | Primary management |
|  |  |  |  |
| 33 | ARQ-Feedback | Stand-alone ARQ feedback | Basic |
|  |  |  |  |
| 34 | ARQ-Discard | ARQ discard message | Basic |
|  |  |  |  |
| 35 | ARQ-Reset | ARQ reset message | Basic |
|  |  |  |  |
| 36 | REP-REQ | Channel measurement report request | Basic |
|  |  |  |  |
| 37 | REP-RSP | Channel measurement report response | Basic |
|  |  |  |  |
| 38 | FPC | Fast power control | Broadcast |
|  |  |  |  |
| 39 | *Reserved* | — | — |
|  |  |  |  |
| 40 | *Reserved* | — | — |
|  |  |  |  |
| 41 | *Reserved* | — | — |
|  |  |  |  |
| 42 | *Reserved* | — | — |
|  |  |  |  |
| 43 | *Reserved* | — | — |
|  |  |  |  |
| 44 | AAS-FBCK-REQ | AAS feedback request | Basic |
|  |  |  |  |
| 45 | AAS-FBCK-RSP | AAS feedback response | Basic |
|  |  |  |  |
| 46 | AAS\_Beam\_Select | AAS beam select message | Basic |
|  |  |  |  |
| 47 | AAS\_BEAM\_REQ | AAS beam request message | Basic |
|  |  |  |  |
| 48 | AAS\_BEAM\_RSP | AAS beam response message | Basic |
|  |  |  |  |
| 49 | DREG-REQ | SS deregistration message | Basic |
|  |  |  |  |
| 50 | MOB\_SLP-REQ | Sleep request message | Basic |
|  |  |  |  |
| 51 | MOB\_SLP-RSP | Sleep response message | Basic or broadcast |
|  |  |  |  |
| 52 | MOB\_TRF-IND | Traffic indication message | Broadcast |
|  |  |  |  |
| 53 | MOB\_NBR-ADV | Neighbor advertisement message | Broadcast, |
|  |  |  | Primary management |
|  |  |  |  |
| 54 | MOB\_SCN-REQ | Scanning interval allocation request | Basic |
|  |  |  |  |
| 55 | MOB\_SCN-RSP | Scanning interval allocation response | Basic |
|  |  |  |  |
| 56 | MOB\_BSHO-REQ | BS HO request message | Basic |
|  |  |  |  |
| 57 | MOB\_MSHO-REQ | MS HO request message | Basic |
|  |  |  |  |
| 58 | MOB\_BSHO-RSP | BS HO response message | Basic |
|  |  |  |  |
| 59 | MOB\_HO-IND | HO indication message | Basic |
|  |  |  |  |
| 60 | MOB\_SCN-REP | Scanning result report message | Primary management |
|  |  |  |  |
| 61 | MOB\_PAG-ADV | BS broadcast paging message | Broadcast |
|  |  |  |  |

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**Table 6-51—MAC management messages *(CONTINUED)***

|  |  |  |  |
| --- | --- | --- | --- |
| **Type** | **Message name** | **Message description** | **Connection** |
|  |  |  |  |
| 62 | MBS\_MAP | Multicast and broadcast service MAP | — |
|  |  | message |  |
|  |  |  |  |
| 63 | PMC\_REQ | Power control mode change request | Basic |
|  |  | message |  |
|  |  |  |  |
| 64 | PMC\_RSP | Power control mode change response | Basic |
|  |  | message |  |
|  |  |  |  |
| 65 | PRC-LT-CTRL | Setup/Tear-down of long-term MIMO | Basic |
|  |  | precoding |  |
|  |  |  |  |
| 66 | MOB\_ASC-REP | Association result report message | Primary management |
|  |  |  |  |
| 67 | MOB\_MIH-MSG | MIH Payload Transfer message | Primary management |
|  |  |  |  |
| 68 | SII-ADV | Service Identity Information | Fragmentable broadcast |
|  | Advertisement broadcast message |  |
|  |  |  |
|  |  |  |  |
| 69 | LBS-ADV | Location information broadcast for LBS | Broadcast |
|  |  |  |
|  |  |  |  |
| 70 | RCD | R-link channel descriptor | RS Primary Management, RS |
|  |  |  | Multicast Management |
|  |  |  |  |
| 71 | MR\_NBR-INFO | MR\_NBR-INFO | RS Primary Management |
|  |  |  |  |
| 72 | MR\_RNG-REP | MR Ranging report | RS Basic |
|  |  |  |  |
| 73 | RS\_Config-CMD | RS configuration command | RS Primary Management |
|  |  |  |  |
| 74 | RS\_NBR\_MEAS- | RS neighbor station measurement report | RS Basic |
|  | REP |  |  |
|  |  |  |  |
| 75 | MR\_LOC-REQ | MR location information request | RS Primary Management |
|  |  |  |  |
| 76 | MR\_LOC-RSP | MR location information response | RS Primary Management |
|  |  |  |  |
| 77 | MS\_SCN-INF | MS scanning inform | RS Basic |
|  |  |  |  |
| 78 | MS\_SCN-CLT | MS scanning completion | RS Basic |
|  |  |  |  |
| 79 | MS\_INFO-DEL | MS context information delete | RS Basic |
|  |  |  |  |
| 80 | CLK-SYNC | RS clock synchronization | RS Multicast Management |
|  |  |  |  |
| 81 | MR\_ASC-REQ | MR association request | RS Basic |
|  |  |  |  |
| 82 | MR\_ASC-RSP | MR association report | RS Basic |
|  |  |  |  |
| 83 | RS\_MOB\_MEASR | RS group measurement request | RS Multicast Management |
|  | EQ |  |  |
|  |  |  |  |
| 84 | HARQ\_Chase\_ER- | RS chase HARQ error report | RS Basic |
|  | REP |  |  |
|  |  |  |  |
| 85 | HARQ\_IR\_ER- | RS IR HARQ error report | RS Basic |
|  | REP |  |  |
|  |  |  |  |
| 86 | MR\_SLP-INFO | MS sleep mode information | RS Basic |
|  |  |  |  |
| 87 | RS\_AccessRS-REQ | RS access station selection request | RS Basic |
|  |  |  |  |
| 88 | RS-SCH | RS scheduling information | RS Basic |
|  |  |  |  |

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**Table 6-51—MAC management messages *(CONTINUED)***

|  |  |  |  |
| --- | --- | --- | --- |
| **Type** | **Message name** | **Message description** | **Connection** |
|  |  |  |  |
| 89 | RS\_Member\_List\_ | RS group member list update | RS Multicast Management |
|  | Update |  |  |
|  |  |  |  |
| 90 | MR\_PBBR-INFO | MR piggybacked bandwidth request | RS Basic |
|  |  | information |  |
|  |  |  |  |
| 91 | MR\_Generic-ACK | Generic ACK of received message | RS Basic |
|  |  |  |  |
| 92 | RS\_Access-MAP | MAP information in centralized | RS Basic, RS Multicast |
|  |  | scheduling mode | Management |
|  |  |  |  |
| 93 | RS\_Relay-MAP | R-MAP information in centralized | RS Basic |
|  |  | scheduling mode |  |
|  |  |  |  |
| 94 | MOB\_INF-IND | Mobile information indication | RS Basic |
|  |  |  |  |
| 95 | MS\_Context-REQ | MS’s context request | RS Basic |
|  |  |  |  |
| 96 | MS\_Context-RSP | MS’s context response | RS Basic |
|  |  |  |  |
| 97 | MT\_Transfer | Transfer of MAC management messages | RS Management Tunnel |
|  |  | in management tunnel |  |
|  |  |  |  |
| 98 | CX-CCID-IND | Co-Channel Interference Detection Indi- | Basic |
|  |  | cation |  |
|  |  |  |  |
| 99 | CX-CCID-RES | Co-Channel Interference Detection Res- | Basic |
|  |  | olution |  |
|  |  |  |  |
| 100 | CX-FWD-REQ | Coexistence Forward Request message | Broadcast/Basic/Multicast |
|  |  |  |  |
| 101 | CX-FWD-RSP | Coexistence Forward Response message | Broadcast/Basic/Multicast |
|  |  |  |  |
| 102 | CX-FWD-ACK | Coexistence Forward Acknowledge mes- | Broadcast/Basic/Multicast |
|  |  | sage |  |
|  |  |  |  |
| 103 | CX-ACCESS-NBS- | Access neighbor BS request message | Basic |
|  | REQ |  |  |
|  |  |  |  |
| 104 | CX-ACCESS-NBS- | Access neighbor BS response message | Basic |
|  | RSP |  |  |
|  |  |  |  |
| 105 | CX-FWD-END- | Forward end request message | Basic |
|  | REQ |  |  |
|  |  |  |  |
| 106 | CX-CSI-MNTR- | CSI monitoring request message | Broadcast |
|  | CFG |  |  |
|  |  |  |  |
| 107 | CX-CSI-MNTR- | CSI monitoring response message | Basic |
|  | REP |  |  |
|  |  |  |  |
| 108 | CX-DL-MAP | Coexistence Downlink Map message | Broadcast |
|  |  |  |  |
| 109 | CX-UL-MAP | Coexistence Uplink Map message | Broadcast |
|  |  |  |  |
| 110 | MM-ADV | Multimode Advertisement message | Broadcast |
|  |  |  |  |
| 111 | MM-BS-REQ | Multimode Base station Request mes- | Primary |
|  |  | sage |  |
|  |  |  |  |

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**Table 6-51—MAC management messages *(CONTINUED)***

|  |  |  |  |
| --- | --- | --- | --- |
| **Type** | **Message name** | **Message description** | **Connection** |
|  |  |  |  |
| 112 | MM-BS-RSP | Multimode Base station Response mes- | Primary |
|  |  | sage |  |
|  |  |  |  |
| 113 | MM-BS-CMD | Multimode Base station Command mes- | Primary |
|  |  | sage |  |
|  |  |  |  |
| 114 | MM-RS-REQ | Multimode Relay Request message | Primary |
|  |  |  |  |
| 115 | MM-RS-RSP | Multimode Relay Response message | Primary |
|  |  |  |  |
| 116 | MM-RL-REQ | Multimode Release Request message | Primary |
|  |  |  |  |
| 117 | MM-RL-RSP | Multimode Release Response message | Primary |
|  |  |  |  |
| 118 | MM-STAT-REP | Multimode Status Report message | Primary |
|  |  |  |  |
| 119 | DC-LC-REQ | Direct Communication Link Creation | Primary |
|  |  | Request |  |
|  |  |  |  |
| 120 | DC-LC-RSP | Direct Communication Link Creation | Primary |
|  |  | Response |  |
|  |  |  |  |
| 121 | DC-LD-REQ | Direct Communication Link Deletion | Primary |
|  |  | Request |  |
|  |  |  |  |
| 122 | DC-LD-RSP | Direct Communication Link Deletion | Primary |
|  |  | Response |  |
|  |  |  |  |
| 123 | DC-LR-REQ | Direct Communication Link Report | Primary |
|  |  | Request |  |
|  |  |  |  |
| 124 | DC-LR-RSP | Direct Communication Link Report | Primary |
|  |  | Response |  |
|  |  |  |  |
| 125 | NCI | Network Configuration Information (for | Broadcast by forwarding HR- |
|  |  | BS-controlled FTN) | MS |
|  |  |  |  |
| 126 | PM-NBR-REQ | Neighboring Alternate Path Request | Primary |
|  |  | Message |  |
|  |  |  |  |
| 127 | PM-NBR-REP | Neighboring Alternate Path Response | Primary |
|  |  | Message |  |
|  |  |  |  |
| 128 | PM-SAC-REQ | Switched Access Control Request Mes- | Primary |
|  |  | sage |  |
|  |  |  |  |
| 129 | PM-SAC-RSP | Switched Access Control Response Mes- | Primary |
|  |  | sage |  |
|  |  |  |  |
| 130 | HR-RNG-CMD | Neighbor discovery command | Primary management |
|  |  |  |  |
| 131 | HR-RNG-REP | Neighbor discovery report | Primary management |
|  |  |  |  |
| 132 | FN-CONFIG-CMD | BS-controlled FTN configuration | Primary management |
|  |  |  |  |
| 133 | FN-RNG-FLU | Forwarding Ranging Follow-up | Primary |
|  |  |  |  |
| 134 | F-MAP | Forwarding MAP (for BS-controlled | Broadcast by forwarding HR- |
|  |  | FTN) | MS |
|  |  |  |  |
| 135 | HR-MG-IND | High Reliable Multicast Group Indica- | Broadcast |
|  |  | tion |  |
|  |  |  |  |

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**Table 6-51—MAC management messages *(CONTINUED)***

|  |  |  |  |
| --- | --- | --- | --- |
| **Type** | **Message name** | **Message description** | **Connection** |
|  |  |  |  |
| 136 | HR-MT-IND | High Reliable Multicast Traffic Indica- | Broadcast |
|  |  | tion |  |
|  |  |  |  |
| 137 | PI | Paging Indicator | Broadcast |
|  |  |  |  |
| 138 | MSPG-GRP | MS Paging Group List (to add/delete) | Primary |
|  |  |  |  |
| 139 | MSPG-PG | MS Paging Group Configuration | Multicast |
|  |  |  |  |
| 140 | HR-PCC | High Reliable Power Control Configura- | Primary |
|  |  | tion |  |
|  |  |  |  |
| 144 | IM\_CT-REQ | IM Multi-BS CT Request | Basic |
|  |  |  |  |
| 145 | IM\_CT-RSP | IM Multi-BS CT Response | Basic |
|  |  |  |  |
| 146 | IM\_CT-CH-REQ | IM Multi-BS CT PHY Channel | Basic |
|  |  | Measurement Request |  |
|  |  |  |  |
| 147 | IM\_CT-CH-RSP | IM Multi-BS CT PHY Channel | Basic |
|  |  | Measurement Response |  |
|  |  |  |  |
| 141–143 |  | *Reserved* |  |
| and 148– |  |  |  |
| 255 |  |  |  |
|  |  |  |  |

aFor SSs and BSs that support PKMv2, PKM-RSP is sometimes transmitted on the broadcast connection.

An extended set of MAC management messages specific to an MR system are defined and listed in Table 6-36. These messages may be exchanged between an RS and its superordinate station on either the RS’s primary management, RS’s basic or RS’s multicast management connections in addition to the non-MR system specific messages.

In general, the PKM-RSP messages are carried on the Primary Management connection. However, the PKMv2 Group-Key-Update-Command message for the GTEK update mode shall be carried on the Broadcast connection.

During the adaptive antenna system (AAS) portion of the frame, the DL-MAP, UL-MAP, DCD, UCD, MOB\_NBR-ADV, MOB\_TRF-IND, MOB\_PAG-ADV, and CLK-CMP messages may be sent using the Basic CID.

**6.3.2.3.1 DCD (DL channel descriptor) message**

A DCD shall be transmitted by the BS at a periodic interval (Table 10-1) to define the characteristics of a DL physical channel.

A BS shall generate DCDs in the format shown in Table 6-52, including all of the following parameters:

**Configuration Change Count**

Incremented by one (modulo 256) by the BS whenever any of the values of this channel descriptor change, except for the frame number for the OFDM PHY and the Available DL Radio Resources. If the value of this count in a subsequent DCD remains the same, the SS can quickly decide that the remaining fields have not changed and may be able to disregard the

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**Table 6-52—DCD message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| DCD\_Message\_Format() { | — | — |
|  |  |  |
| **Management Message Type = 1** | 8 | — |
|  |  |  |
| *Reserved* | 8 | Shall be set to zero |
|  |  |  |
| **Configuration Change Count** | 8 | — |
|  |  |  |
| **TLV Encoded information for the overall channel** | *variable* | TLV-specific |
|  |  |  |
| Begin PHY-specific section { | — | See applicable PHY subclause |
|  |  |  |
| for (*i* = 1; *i <= n*; *i*++) { | — | For each DL burst profile 1 to *n* |
|  |  |  |
| **Downlink\_Burst\_Profile** | — | PHY-specific |
|  |  |  |
| } | — | — |
|  |  |  |
| } | — | — |
|  |  |  |
| } | — | — |
|  |  |  |

remainder of the message. An SS performing initial network entry should decode the Available DL Radio Resources even if the DCD Configuration Change Count remains unchanged.

The following WirelessMAN-OFDM PHY-specific parameters shall be included in the DCD message:

**Frame Duration Code**

**Frame Number**

The message parameters following the Configuration Change Count shall be encoded in a TLV form (see 11.4). All channel encodings (see 11.4.1) shall appear first before the Downlink\_Burst\_Profile encodings.

The Downlink\_Burst\_Profile is a compound TLV encoding that defines, and associates with a particular DL interval usage code (DIUC), the PHY characteristics that shall be used with that DIUC. Within each Downlink\_Burst\_Profile shall be an unordered list of PHY attributes, encoded as TLV values (see 11.4.2). Each interval is assigned a DIUC by the DL-MAP message. A Downlink\_Burst\_Profile shall be included for each DIUC to be used in the DL-MAP unless the PHY’s Downlink\_Burst\_Profile is explicitly known.

Downlink\_Burst\_Profile contents are defined separately for each PHY specification in Clause 8.

For OFDMA PHY, the DCD message (if such exists) shall always be transmitted on a DL burst described by a DL-MAP IE with DIUC=0 and DIUC = 0 shall have burst profile parameters that are the same as those used for transmission of the DL-MAP message.

**6.3.2.3.2 DL-MAP (Downlink map) message**

The DL-MAP message defines the access to the DL information. If the length of the DL-MAP message is a nonintegral number of bytes, the LEN field in the MAC header is rounded up to the next integral number of bytes. The message shall be padded to match this length, but the SS shall disregard the 4 pad bits.

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**Table 6-53a—DL-MAP message format for channel bandwidth below 1.25 MHz**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| DL-MAP\_Message\_Format() { | — | — |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
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|  |  |  |
|  |  |  |
|  |  |  |
| for (*i* = 1; *i <= n*; *i*++) { | — | For each DL-MAP element 1 to *n*. |
|  |  |  |
| **DL-MAP\_IE()** | *variable* | See corresponding PHY specification. |
|  |  |  |
| } | — | — |
|  |  |  |
| } | — | — |
|  |  |  |
| if !(byte boundary) { | — | — |
|  |  |  |
| **Padding Nibble** | 4 | Padding to reach byte boundary. |
|  |  |  |
| } | — | — |
|  |  |  |
| } | — | — |
|  |  |  |

A BS shall generate DL-MAP messages in the format shown in Table 6-53a, including all of the following parameters:

**PHY Synchronization**

The PHY synchronization field is dependent on the PHY specification used. The encoding of this field is given in each PHY specification separately.

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The encoding of the remaining portions of the DL-MAP message is PHY-specification dependent and may be absent. Refer to the appropriate PHY specification.

The UL-MAP message (when present) shall be always transmitted in the first PDU on the burst described by the first DL-MAP IE of the DL-MAP (or, in the case of the OFDM PHY mode, of the DLFP).

The DL-MAP IEs in the DL-MAP shall be ordered in the increasing order of the transmission start time of the relevant PHY burst. The transmission start time is conveyed by the contents of the DL\_MAP IE in a manner that is PHY dependent.

The logical order in which MAC PDUs are mapped to the PHY bursts in the DL is defined as the order of DL-MAP IEs in the DL-MAP message.

**6.3.2.3.3 UCD (UL channel descriptor) message**

A UCD shall be transmitted by the BS at a periodic interval (Table 10-1) to define the characteristics of an UL physical channel.

**Table 6-54—UCD message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| UCD\_Message\_Format() { | — | — |
|  |  |  |
| **Management Message Type = 0** | 8 | — |
|  |  |  |
| **Configuration Change Count** | 8 | — |
|  |  |  |
| **Ranging Backoff Start** | 8 | — |
|  |  |  |
| **Ranging Backoff End** | 8 | — |
|  |  |  |
| **Request Backoff Start** | 8 | — |
|  |  |  |
| **Request Backoff End** | 8 | — |
|  |  |  |
| **TLV Encoded information for the overall channel** | *variable* | TLV-specific. |
|  |  |  |
| Begin PHY-specific section { | — | See applicable PHY subclause. |
|  |  |  |
| for (*i* = 1; *i <= n*; *i*++) { | — | For each UL burst profile 1 to *n*. |
|  |  |  |
| **Uplink\_Burst\_Profile** | *variable* | PHY-specific. |
|  |  |  |
| } | — | — |
|  |  |  |
| } | — | — |
|  |  |  |
| } | — | — |
|  |  |  |



15The IEEE Registration Authority is a committee of the IEEE Standards Association Board of Governors. General information as well as details on the allocation of IEEE 802.16 Operator ID can be obtained at http://standards.ieee.org/regauth.

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A BS shall generate UCDs in the format shown in Table 6-54, including all of the following parameters:

**Configuration Change Count**

Incremented by one (modulo 256) by the BS whenever any of the values of this channel descriptor change, except for the Available UL Radio Resources. If the value of this count in a subsequent UCD remains the same, the SS can quickly decide that the remaining fields have not changed and may be able to disregard the remainder of the message. An SS performing initial network entry should decode the Available UL Radio Resources even if the UCD Configuration Change Count remains unchanged. This value is also referenced from the UL-MAP messages.

**Ranging Backoff Start**

Initial backoff window size for initial ranging contention, expressed as a power of 2. Values of *n* range 0–15 (the highest order bits shall be unused and set to 0).

**Ranging Backoff End**

Final backoff window size for initial ranging contention, expressed as a power of 2. Values of *n* range 0–15 (the highest order bits shall be unused and set to 0).

**Request Backoff Start**

Initial backoff window size for contention BRs, expressed as a power of 2. Values of *n* range 0–15 (the highest order bits shall be unused and set to 0).

**Request Backoff End**

Final backoff window size for contention BRs, expressed as a power of 2. Values of *n* range 0–15 (the highest order bits shall be unused and set to 0).

To provide for flexibility, the remaining message parameters shall be encoded in a TLV form (see 11.3). All Channel encodings (see 11.3.1) shall appear first before the Uplink\_Burst\_Profile encodings.

The Uplink\_Burst\_Profile is a compound TLV encoding that defines, and associates with a particular UIUC, the PHY characteristics that shall be used with that UIUC. Within each Uplink\_Burst\_Profile shall be an unordered list of PHY attributes, encoded as TLV values (see 11.3.1.1 for an example applicable to the 10–66 GHz PHY specification). Each interval is assigned a UIUC by the UL-MAP message. An Uplink\_Burst\_Profile shall be included for each UIUC to be used in the UL-MAP.

Uplink\_Burst\_Profile contents are defined separately for each PHY specification in Clause 8.

When network reentry of M2M group based on group delegate is used, the following parameters should be included:

**Dedicated codes set for M2M group**

Number of dedicated codes for M2M group. Possible values are 0–255. Default value is 0.

**Probability threshold of M2M group delegate selection**

10 bits are used for probability threshold Value of quantized in 0.001 steps as from 0 to 1.

**Multiplexing factor of dedicated ranging code**

3 bits are used for indicating multiplexing ratio of dedicated ranging code including (1, 1/2, 1/4, 1/8, 1/16, 1/ 32, 1/64, 1/128).

**6.3.2.3.4 UL-MAP (UL map) message**

The UL-MAP message allocates access to the UL channel. The UL-MAP message shall be as shown in Table 6-55a.

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**Table 6-55a—UL-MAP message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| UL-MAP\_Message\_Format() { | — | — |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
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|  |  |  |
|  |  |  |
|  |  |  |
| for (*i* = 1; *i <= n*; *i*++) { | — | For each UL-MAP element 1 to *n*. |
|  |  |  |
| **UL-MAP\_IE()** | *variable* | See corresponding PHY specification. |
|  |  |  |
| } | — | — |
|  |  |  |
| } | — | — |
|  |  |  |
| if !(byte boundary) { | — | — |
|  |  |  |
| **Padding Nibble** | 4 | Padding to reach byte boundary. |
|  |  |  |
| } | — | — |
|  |  |  |
| } | — | — |
|  |  |  |

The BS shall generate the UL-MAP with the following parameters:

**Map IEs**

The contents of a UL-MAP IE is PHY-specification dependent.

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IEs define UL bandwidth allocations. Each UL-MAP message (except when the PHY is an OFDMA PHY) shall contain at least one information element (IE) that marks the end of the last allocated burst. Ordering of IEs carried by the UL-MAP is PHY-specific.

The CID represents the assignment of the IE to either a unicast, multicast, or broadcast address. When specifically addressed to allocate a bandwidth grant, the CID shall be the Basic CID of the SS. A UIUC shall be used to define the type of UL access and the UL burst profile associated with that access. An Uplink\_Burst\_Profile shall be included in the UCD for each UIUC to be used in the UL-MAP.

For SC, and OFDMA PHYs, the UL-MAP message (if such exists) shall always be transmitted on the burst described by the first DL-MAP IE (and following the HARQ MAP Pointer IE, if such exists in the OFDMA PHY) of the DL-MAP message. If there are multiple PDUs in the burst described by the first DL-MAP IE, the UL-MAP message shall be the first one.

The logical order in which MAC PDUs are mapped to the PHY bursts in the UL is defined as the order of UL-MAP IEs in the UL-MAP message.

**6.3.2.3.5 RNG-REQ (ranging request) message**

An RNG-REQ shall be transmitted by the SS at initialization and periodically to determine network delay and to request power and/or DL burst profile change. The format of the RNG-REQ message is shown in Table 6-56. The RNG-REQ message may be sent in initial ranging and data grant intervals.

**Table 6-56—RNG-REQ message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| RNG-REQ\_Message\_Format() { | — | — |
|  |  |  |
| **Management Message Type = 4** | 8 | — |
|  |  |  |
| *Reserved* | 8 | Shall be set to zero |
|  |  |  |
| **TLV Encoded Information** | *variable* | TLV-specific |
|  |  |  |
| } | — | — |
|  |  |  |

The CID field in the MAC header shall assume the following values when sent in an initial ranging interval:

1. Initial Ranging CID if the SS is attempting to join the network.
2. Initial Ranging CID if the SS has not yet registered and is changing DL (or both DL and UL) channels.
3. In all other cases, the Basic CID is used as soon as one is assigned in the RNG-RSP message.

If sent in a data grant interval, the CID is always equal to the Basic CID.

An SS shall generate RNG-REQ messages in the format shown in Table 6-56.

All parameters are coded as TLV tuples as defined in 11.5.

TLV message elements shall only be included in RNG-REQ messages of adequate UL bandwidth. In OFDMA, when the MS transmits the HO CDMA ranging code, the BS shall provide for initial UL

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bandwidth allocation of size at least sufficient for transmission of RNG-REQ message with MS MAC address TLV and GMSH. If required TLV message elements cannot be accommodated in the UL bandwidth of a current RNG-REQ message, after the MS obtains a Basic CID from the BS, the MS shall make UL BR of sufficient size to conduct additional RNG-REQ including all required message elements, at the first available opportunity.

The following parameter may be included in the RNG-REQ message when the SS is attempting initial entry to the network:

**Requested Downlink Burst Profile**

The following parameter shall be included in the RNG-REQ message when the SS is attempting initial entry to the network:

**SS MAC Address**

The following parameters shall be included in the RNG-REQ message when transmitted during SS initial entry to the network. The parameter shall be sent on the SS’s basic connection or for OFDMA on the following initial ranging connection:

**MAC Version** (11.1.3)

The following parameters may be included in the RNG-REQ message after the SS has received a RNG-RSP addressed to the SS:

**Requested Downlink Burst Profile**

**Ranging Anomalies**

The following parameter may be included in the RNG-REQ message:

**AAS broadcast capability**

The following parameter may be included in the RNG-REQ message when the MS is attempting to perform reentry, association, or HO:

**Requested Downlink Burst Profile**

The following parameter shall be included in the RNG-REQ message when the MS is attempting to perform reentry, association, or HO:

**Serving BSID**

The BSID of the BS to which the MS is currently connected (has completed the registration cycle and is in normal operation). The serving BSID shall not be included if the aging timer is timed-out (serving BSID AGINGTIMER; see Table 10-1). Inclusion of serving BSID in the RNG-REQ message signals to the target BS that the MS is currently connected to the network through the serving BS and is performing association or is in the process of HO network reentry.

The following TLV parameter shall be included in the RNG-REQ message when the MS is attempting to perform reentry, HO, location update, or abnormal power down reporting:

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**Ranging Purpose Indication**

The presence of this item in the message indicates the following MS action:

If Bit 0 is set to 1, in combination with a serving BSID, it indicates that the MS is currently attempting to HO or reentry; or, in combination with a Paging Controller ID, indicates that the MS is attempting network reentry from idle mode to the BS.

If Bit 1 is set to 1, it indicates that the MS is initiating the idle mode location update process.

Bit 2: Seamless HO indication. When this bit is set to 1 in combination with other included information elements, it indicates the MS is initiating ranging as part of seamless HO procedure.

Bit 3: Ranging Request for Emergency Call Setup. When this bit is set to 1, it indicates MS action of Emergency Call Process

Bit 4: MBS update. When this bit is set to 1, the MS is currently attempting to perform location update due to a need to update service flow management encodings for MBS flows.

Bit 5: Network Reentry from idle mode of MS which has entered idle mode in AAI-only ABS.

Bit 6: Ranging Request for HR Network. When this bit is set to 1, it indicates the HR-MS is currently attempting to perform ranging as a part of HR-Network operation.

Bit 7: *Reserved*

Bit 7: Power down reporting indication. When these bits are set to 001 by an M2M device, it indicates that an abnormal or involuntary power down has occurred.The following TLV parameter shall be included in the RNG-REQ message when the MS is attempting to perform reentry or location update:

**Paging Controller ID** (see 11.1.8.2)

The Paging Controller ID is a logical network identifier for the serving BS or other network entity retaining MS service and operational information and/or administering paging activity for the MS while in idle mode.This parameter shall not be included when a RNG-REQ is trans-mitted by an M2M device in Localized Idle Mode.

The following TLV parameter shall be included in the RNG-REQ message when the MS in Idle Mode is attempting to change Paging Cycle during Location Update:

**Paging Cycle Change** (see 11.5)

PAGING\_CYCLE requested by the MS

The following TLV parameter may be included in RNG-REQ message when an MS is performing initial ranging to the selected target BS:

**HO\_ID**

Optional ID assigned for use in initial ranging to the target BS during HO once the BS is selected as the target BS (see 6.3.20.2.7).

The following parameter may be included in the RNG-REQ message when the MS is attempting to perform reentry, association, or HO:

**MS MAC Address**

MS MAC Address shall be included if HO\_ID is omitted.

The following TLV parameter may be included in the RNG-REQ message when MS is attempting to perform location update:

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**MAC Hash Skip Threshold** (see 11.1.8.1)

Maximum number of successive MOB\_PAG-ADV messages that may be sent from a BS without individual notification for an MS, including MAC address hash of an MS for which the action code is 00 (No Action Required).

The following TLV parameter shall be included in the RNG-REQ message when the MS is attempting to perform location update due to power down:

**Power Down Indicator**

Indicates the MS is currently attempting to perform location update due to power down.

The following parameters may be included in RNG-REQ message when the MS is attempting to perform HO and needs to inform target BS of its preference to define Power Saving Class during HO to target BS.

**Power\_Saving\_Class\_Parameters**

Compound TLV to specify power saving class operation.

The following TLV shall be included whenever the CMAC tuple is included in the RNG-REQ message during reentry, secure Location Update or handover.

**CMAC\_KEY\_COUNT**

This field contains the MSs current value of the CMAC\_KEY\_COUNT, which is used to generate the CMAC\_KEY\_U used to generate the CMAC Tuple included in this message. See 7.2.2.2.9.

The following parameter shall be included in the RNG-REQ message when Bit 5 in Ranging Purpose Indication is set to 1.

**Paging Controller ID from AAI-only ABS** (see 11.5)

**Deregistration ID** (see 11.5)

**Paging Cycle from AAI-only ABS** (see 11.5)

**PGID from AAI-only ABS** (see 11.5)

**Paging Offset from AAI-only ABS** (see 11.5)

The following parameter shall be included in the RNG-REQ message when the MS is attempting to perform Network Reentry from idle mode, Keep-Alive check in sleep mode, Secure Location Update, or HO and the MS has a hashed message authentication code (HMAC)/cipher-based message authentication code (CMAC) tuple necessary to expedite security authentication.

**HMAC/CMAC Tuple** (see 11.1.2)

The HMAC/CMAC Tuple shall be the last attribute in the message. The MIMO Feedback information TLV parameter may be included in a RNG-REQ message when the Matrix A or Matrix B is supported by a fixed M2M device:

**MIMO Feedback information**

This TLV includes the 1-bit Matrix indicator indicating the preferred STC/MIMO matrix and 4-bit DL Effective CINR as defined in Table 8-332.

The following parameter may be included in a RNG-REQ message when an M2M device performs ranging:

**Ranging Retries**

The number of ranging retries in the current ranging attempt.

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The following TLV parameter may be included in a RNG-REQ message when an M2M device transmits the RNG-REQ message in response to an MOB\_PAG-ADV message that contains M2MCID Reassignment for M2M TLV.

**M2MCID Update Acknowledgement Indicator**

This TLV is used to acknowledge the receipt of an M2MCID update.

The following TLV parameter shall be included in a RNG-REQ message when an M2M device does not have the information of new M2M Group Zone.

**M2MCID update request**

This TLV is used to request M2MCIDs update.

The following parameter shall be included in the RNG-REQ message when the MS is attempting to perform ranging as a part of operation in HR-Network:

**Extended Ranging Purpose Indication for HR-Network (see 11.5)**

Indicates the ranging purpose of the MS during operating for HR-Network.

The following parameter shall be included in the RNG-REQ message when the MS is attempting to perform ranging request for HR multicast (HR multicast service flow update or location update due to crossing HR Multicast Group zone or multicast security key update):

**Action Code for HR Multicast (see 11.5)**

Indicates the ranging purpose of the MS during receiving multicast service in HR-Net-work.

The following TLV parameter shall be included in the RNG-REQ message when the MS is attempting to perform Network reentry for FBIS operation:

**FBIS\_Configuration\_Parameters (see 11.5)**

Compound TLV that provides parameters for FBIS initiation and operation.

The following TLV is included in the RNG-REQ message when the MS attempts to perform either initial network entry or network reentry, with an SBS of either CSG-Closed or CSG-Open subscription type.

**CSGID**

CSGID is an identifier used to identify the CSG associated with a group of SBSs (see 17.1.3).

**6.3.2.3.6 RNG-RSP (ranging response) message**

A RNG-RSP shall be transmitted by the BS in response to a received RNG-REQ. In addition, it may also be transmitted asynchronously to send corrections based on measurements that have been made on other received data or MAC messages. As a result, the SS shall be prepared to receive a RNG-RSP at any time, not just following a RNG-REQ transmission. The format of the RNG-REQ message is shown in Table 6-57.

To provide for flexibility, the message parameters following the Uplink Channel ID shall be encoded in a TLV form.

All other parameters are coded as TLV tuples, as defined in 11.6.

The following parameters shall be included in the RNG-RSP message:

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**Table 6-57—RNG-RSP message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| RNG-RSP\_Message\_Format() { | — | — |
|  |  |  |
| **Management Message Type = 5** | 8 | — |
|  |  |  |
| *Reserved* | 7 | Shall be set to zero. |
|  |  |  |
| **H-FDD Group Indicator** | 1 | 0: Group 1 |
|  |  | 1: Group 2 |
|  |  |  |
| **TLV Encoded Information** | *variable* | TLV-specific |
|  |  |  |
| } | — | — |
|  |  |  |

**Ranging Status**

The following parameters may be included in the RNG-RSP message:

**Timing Adjust Information**

If this field is not included, no adjustment shall be made

**Power Adjust Information**

If this field is not included, no adjustment shall be made

**Downlink Frequency Override**

**Uplink Channel ID Override Downlink Operational Burst Profile Basic CID**

A required parameter if the RNG-RSP message is being sent on the Initial Ranging CID in response to a RNG-REQ message that was sent on the Initial Ranging CID.

**Primary Management CID**

A required parameter if the RNG-RSP message is being sent on the Initial Ranging CID in response to a RNG-REQ message that was sent on the Initial Ranging CID.

**SS MAC Address (48-bit)**

A required parameter when the CID in the MAC header is the Initial Ranging CID.

**Frequency Adjust Information AAS Broadcast Permission Preamble Index Override**

Preamble Indices of new target BS(s) and RS(s) where the MS or RS should redo ranging. If the TLV includes two or more Preamble Indices, the first one in the list is the most preferable and the second is the next preferable. When the TLV is used with Downlink frequency override TLV, the MS or RS should redo ranging on the new DL channel identified by the Preamble Indices.

**Ranging Abort Timer**

Timer defined by a BS to prohibit the MS from attempting network entry at this BS, for a specific time duration. The MS may perform ranging at a different BS before the Ranging Abort Timer expires.

The following WirelessMAN-OFDM PHY-specific parameters may also be included in the RNG-RSP message:

**Frame Number**

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Frame number in which the corresponding RNG-REQ message or subchannelized initial ranging indication (for OFDM) was received. When Frame Number is included, SS MAC Address shall not appear in the same message.

**Initial Ranging Opportunity Number**

Initial ranging opportunity within the frame in which the corresponding RNG-REQ message or subchannelized initial ranging indication (for OFDM) was received. If not provided, and Frame Number is included in the message, initial ranging opportunity is assumed to be one.

The following WirelessMAN-OFDM PHY-specific parameter may also be included in the RNG-RSP message:

**Ranging Subchannel**

The OFDM ranging subchannel index that was used to transmit the initial ranging message.

The following WirelessMAN-OFDMA PHY-specific parameters shall be included in the RNG-RSP message when an initial or periodic ranging message based on code division multiple access (CDMA) is received, in which case the RNG-RSP shall use the Initial Ranging CID.

**Ranging code attributes**

Indicates the OFDMA time symbols reference, subchannel reference, and frame number used to transmit the ranging code, and the ranging code index that was sent by the SS.

The RNG-RSP is directed to the SS if it is sent on the Basic CID of the SS or if the RNG-RSP contains the MAC address of the SS, or, in the case of OFDMA, if the RNG-RSP contains CDMA-code parameters specifying the code sent by the SS.

When a BS sends a RNG-RSP message in response to a RNG-REQ message containing serving BSID, the BS may include the TLV parameter Service Level Prediction in the RNG-RSP message.

The service level prediction value indicates the level of service the MS can expect from this BS. The following encodings apply:

0 = No service possible for this MS.

1 = Some service is available for one or several service flows authorized for the MS.

2 = For each authorized service flow, a MAC connection can be established with QoS specified by the AuthorizedQoSParamSet.

3 = No service level prediction available.

A Service Level Prediction may be accompanied by a number of service flow encodings as specified in 11.13 sufficient to uniquely identify the AuthorizedQoSParamSet associated with the Service Level Prediction. If service flow encodings are included, then the Service Level Prediction response is specific to the presented AuthorizedQoSParamSet defined by the associated encodings. Included service flow encodings are restricted to the following parameters only:

— Global service class name.

— Service flow QoS parameter set encodings as defined in 11.13 so that the combination of global service class name and any service flow modifying parameters fully defines an AuthorizedQoSParamSet profile being assessed.

— Service flow identifier (SFID).

If individual AuthorizedQoSParamSet profiles are provided for multiple Service Level Predictions, then each Service Level Prediction is specific to its associated AuthorizedQoSParamSet profile and shall include only response options 0 or 2.

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When a BS sends a RNG-RSP message in response to a RNG-REQ message containing Paging Controller ID with Ranging Purpose indication Bit 1 set to ‘1’ or a Power Down Indicator, the BS shall include the following TLV parameter in the RNG-RSP message:

**Location Update Response**

Response to idle mode location update request (refer to Table 11-28)

The following TLV shall be included only if the Location Update Response is set to 0x00 (Success of Idle Mode Location Update) and the Paging Information has changed.

**Paging Information** (see 11.1.8.3)

New Paging Information assigned to MS.

The following TLV shall be included only if the Location Update Response = 0x00 (Success of Idle Mode Location Update) and if Paging Controller ID has changed.

**Paging Controller ID** (see 11.1.8.2)

Paging Controller ID is a logical network identifier for the serving BS or other network entity retaining MS service and operational information and/or administering paging activity for the MS while in idle mode.

The following TLV parameter shall be included in the RNG-RSP message when the MS is attempting to perform network reentry or HO and the target BS wishes to identify reentry process management messages that may be omitted during the current HO attempt:

**HO Process Optimization**

Identifies reentry process management messages that may be omitted during the current HO attempt due to the availability of MS service and operational context information obtained by means that are beyond the scope of this standard, and the MS service and operational status post-HO completion. The target BS may elect to use MS service and operational information obtained over the backbone network to build and send unsolicited SBC-RSP and/or REG-RSP management messages to update MS operational information. The MS shall not enter normal operation with target BS until completing receiving all network reentry, MAC management message responses as indicated in HO process optimization.

The following parameter may be included in RNG-RSP message transmitted in response to RNG-REQ message containing MAC Hash Skip Threshold:

**MAC Hash Skip Threshold**

Maximum number of successive MOB\_PAG-ADV messages that may be sent from a BS without individual notification for an MS, including MAC address hash of an MS for which the action code for the MS is 00 (No Action Required).

The following TLV parameter shall be included in the RNG-RSP message when the periodic ranging in sleep operation completes and the serving BS decides to assign a new SLPID for the MS:

**SLPID\_Update** (see 11.1.7.2)

The SLPID\_Update is a compound TLV value that provides a shorthand method for changing the SLPID used by the MS during sleep mode operation. The SLPID\_Update TLV specifies new SLPID replacing old SLPID.

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The following parameter may be included in RNG-RSP message by the BS to define and/or activate/ deactivate power saving class of type I, type II and type III. In case of HO, those TLVs are used only to define the Power Saving Class.

**Power\_Saving\_Class\_Parameters** (see Table 11-27)

Unified TLV encoding for Power Saving Class Parameters (see Table 11-28).

The following TLV parameter may be included in RNG-RSP message transmitted the BS permits an activation of power saving class. This TLV indicates the enabled action that MS performs upon reaching trigger condition in sleep mode.

**Enabled-Action-Triggered**

Indicates possible action upon reaching trigger condition

The following TLV parameter shall be included in the RNG-RSP message when a BS sends RNG-RSP message as a reply to the RNG-REQ message from an MS which is performing initial ranging during HO and for which the BS has a current HO ID value:

**HO\_ID**

Optional ID assigned for use in initial ranging to the target BS once this BS is selected as the target BS (see 11.5).

The following TLV parameter shall be included for the BS to notify the MS of known future next periodic ranging for the MS with its serving BS:

**Next Periodic Ranging**

Indicates the Frame Offset for the next periodic ranging opportunity. This value shall be set to zero to indicate that there has been DL traffic addressed to the MS.

The following parameter, necessary to expedite security authentication, shall be included in the RNG-RSP message when the BS notifies the MS through the HO Process Optimization TLV that the PKM-REQ/RSP sequence may be omitted for the current HO reentry attempt, or when the BS wishes to acknowledge a valid HMAC/CMAC Tuple in the acknowledged RNG-REQ management message:

**HMAC/CMAC Tuple** (see 11.1.2)

The HMAC/CMAC Tuple shall be the last attribute in the message.

The following TLV parameters may be included in an unsolicited RNG-RSP message:

**Rendezvous time**

This is the offset, measured in units of frame duration, when the BS is expected to provide a non-contention-based ranging opportunity for the MS. The offset is calculated from the frame where RNG-RSP message is transmitted. The BS is expected to provide the non-contention-based ranging opportunity at the frame specified by the rendezvous time parameter.

**CDMA code**

A unique code assigned to the MS, to be used for dedicated ranging. The code is from the initial ranging codeset.

**Transmission Opportunity Offset**

A unique transmission opportunity assigned to the MS, to be used for dedicated ranging, in units of symbol duration.

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The following parameter may be included in the RNG-RSP message for the purpose of assigning CDMA ranging codes to an RS:

**RS CDMA Codes TLV** (see 11.6)

The MR-BS may include the following TLV parameter to identify reentry process management messages that may be omitted during an RS handover:

**RS Network Entry Optimization** (see 11.6)

Identifies entry or reentry process management messages that may be omitted during the current entry or reentry attempt.

During network reentry, the RS shall not enter Normal Operation with Target MR-BS until completing receiving all network reentry, MAC management message responses as indicated in this TLV.

The following parameter may be included in the RNG-RSP message when the MRS is attempting to perform network reentry or handover:

**CID List TLV** (see 11.6.1)

The RNG-RSP message transmitted to an RS may contain the following TLVs:

**Path Addition** (see 11.1.13.2)

Specification of the path addition operations

**Path CID Binding Update** (see 11.1.13.3)

Specification of the path/CID binding operations including adding the binding between CIDs to the specific path.

The following parameter may be included in the RNG-RSP message that an RS sends to its serving MR-BS when an MS is attempting to perform association at the RS:

**Association Info TLV** (see 11.6)

Specification of the MS’s uplink quality that may be used by the MS’s serving MR-BS as a factor to determine whether to recommend the RS as the MS’s HO target station.

The following TLV parameter may be included in a RNG-RSP message to update M2MCID in an M2M device.

**M2MCID Update**

The following parameters shall be included only if these conditions are true: (1) Bit 6 of the ranging purpose indication is set to 1; (2) the Extended Ranging Purpose Indication for HR-Network is 0x00; (3) Bit 0 of the Action Code for HR Multicast in the RNG-REQ message is set to 1.

**HR multicast service flow update mapping info (see 11.1.18)**

HR multicast service flow update mapping info is used by the BSs in one HR multicast zone to provide consistency of HR Multicast Group ID mapping used in other HR multicast zone as determined by the serving HR multicast zone.

The following TLV is included in the RNG-RSP message when an SBS of CSG-Closed or CSG-Open sub-scription type transmits the RNG-RSP message in order to reject the request for access by the non-member MS to the SBS.

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**CSGID**

CSGID is an identifier used to identify the CSG associated with a group of SBSs (see 17.1.3).

**6.3.2.3.7 REG-REQ (registration request) message**

An REG-REQ shall be transmitted by an SS at initialization. An SS shall generate REG-REQs in the form shown in Table 6-58.

**Table 6-58—REG-REQ message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| REG-REQ\_Message\_Format() { | — | — |
|  |  |  |
| **Management Message Type = 6** | 8 | — |
|  |  |  |
| **TLV Encoded Information** | *variable* | TLV-specific |
|  |  |  |
| } | — | — |
|  |  |  |

An SS shall generate REG-REQs including the following parameters if authentication is supported:

**Primary Management CID** *(in the generic MAC header)*

The connection identifier in the generic MAC header is the Primary Management CID for this SS, as assigned in the RNG-RSP message.

All other parameters are coded as TLV tuples.

The REG-REQ shall contain the following TLVs:

**Hashed Message Authentication Code (HMAC)/CMAC Tuple**

Shall be the final attribute in the message’s TLV attribute list (11.1.2.1).

For PMP operation, the REG-REQ shall contain the following TLVs:

**CID Support** (11.7.6)

For PMP operation with OFDMA the REG-REQ may contain the following TLVs:

**SS management support** (11.7.2)

**IP management mode** (11.7.3)

For PMP operation with OFDM the REG-REQ shall contain the following TLVs:

**SS management support** (11.7.2)

**IP management mode** (11.7.3)

The REG-REQ may contain the following TLVs:

**IP version** (11.7.4)

**SS capabilities encodings** (11.7.8)

**Vendor ID encoding** (11.1.5)

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**Vendor-specific information** (11.1.6) **Convergence Sublayer capabilities** (11.7.7) **ARQ Parameters** (11.7.1)

ARQ and fragmentation parameters desired by the SS for establishing the secondary management connection. When the TLV is not supplied, the SS is indicating its desire to not support ARQ on the connection. For purposes of the parameter negotiation dialog, the parameters supplied in this message are equivalent to those supplied in the DSA-REQ message.

For an MS supporting HO, the REG-REQ (on initial network entry) shall contain the following TLVs:

**Handover supported field** (11.7.12.5)

**Mobility parameters support** (11.7.13)

For an MS supporting HO, the REG-REQ (on initial network entry) shall contain the following TLV:

**HO Process Optimization MS Timer** (11.7.12.2)

The REG-REQ may contain the following TLV:

**MAC header and extended subheader support** (11.7.21)

**BS switching timer** (11.7.12.7)

**Extended capability** (11.7.8.11)

The following TLV may be added if the MS supports H-FDD:

**H-FDD sleep capabilities** (11.7.8.10)

When an RS enters the network, the REG-REQ shall contain the following TLVs:

**MR-BS and RS MAC feature support** (see 11.7.25)

**RS MAC feature support** (see 11.7.25.1)

**6.3.2.3.8 REG-RSP (registration response) message**

A REG-RSP shall be transmitted by the BS in response to received REG-REQ.

To provide for flexibility, the message parameters following the response field shall be encoded in a TLV format.

**Table 6-59—REG-RSP message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| REG-RSP\_Message\_Format() { | — | — |
|  |  |  |
| **Management Message Type = 7** | 8 | — |
|  |  |  |
| **Response** | 8 | — |
|  |  |  |
| **TLV Encoded Information** | *variable* | TLV-specific |
|  |  |  |
| } | — | — |
|  |  |  |

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A BS shall generate REG-RSPs in the form shown in Table 6-59, including both of the following parameters:

**CID** *(in the generic MAC header)*

The connection identifier in the generic MAC header is the Primary Management CID for this SS.

**Response**

A 1 byte quantity with one of the two values: 0 = OK

1 = Message authentication failure

For the OFDM PHY, the REG-RSP shall contain the following TLVs:

**SS management support** (11.7.2)

Response to REG-REQ indicating the mode of SS management operation.

**Secondary Management CID** (11.7.5)

Present only if the SS has indicated in the REG-REQ that it is a managed SS.

When the Secondary Management CID is present, the following UL QoS parameters may be also included in the message:

Traffic Priority (11.13.5)

Maximum Sustained Traffic Rate (11.13.6)

Minimum Reserved Traffic Rate (11.13.8) Maximum Latency (11.13.13)

**IP management mode** (11.7.3)

Response to REG-REQ indication of whether the requester wishes to accept IP-based traffic on the secondary management connection, once the initialization process has completed.

The REG-RSP shall contain the following TLV if authentication is supported:

**HMAC/CMAC Tuple** (11.1.2.1)

The HMAC/CMAC Tuple attribute shall be the final attribute in the message’s TLV attribute list.

The REG-RSP may contain the following TLVs:

**SS capabilities encodings** (11.7.8)

Response to the capabilities of the requester provided in the REG-REQ. Included in the response if the request included capabilities information. The response indicates whether the capabilities may be used. If a capability is not recognized, the response indicates that this capability shall not be used by the requester. Capabilities returned in the REG-RSP shall not be set to require greater capability of the requester than is indicated in the REG-REQ.

**IP Version** (11.7.4)

**Vendor ID Encoding** (of the responder; 11.1.5)

**Vendor-specific information** (11.1.6)

Included if the RNG-REQ contained the Vendor ID Encoding of the requestor.

**Convergence Sublayer capabilities** (11.7.7)

Response to the capabilities of the requester provided in the REG-REQ. Included in the response if the request included Convergence Sublayer Capabilities information. The response indicates whether the capabilities may be used. If a capability is not recognized, the response indicates that this capability shall not be used by the requester. Capabilities returned in the REG-RSP shall not be set to require greater capability of the requester than is indicated in the REG-REQ.

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**ARQ Parameters** (11.7.1)

ARQ and fragmentation parameters specified by the BS to complete ARQ parameter negotiation for the secondary management connection. This information is only included in the message if ARQ parameters where supplied by the SS in the original REG-REQ message. For purposes of the parameter negotiation dialog, the parameters supplied in this message are equivalent to those supplied in the DSA-RSP message.

For mobile stations, when the information is available to create the CID update TLV, the target BS shall include the CID\_update and SAID\_update TLVs in the REG-RSP for an MS recognized by the target BS as performing HO, network reentry from idle mode or location update for MBS update. The BS may include the Compressed CID Update TLV instead of the CID\_update TLV in REG-RSP message if the CID update procedure is required. The target BS recognizes an MS performing location update for MBS update by the presence of a Paging Controller ID and Ranging Purpose Indication with Bit 4 set to 1 in the RNG-REQ message.

**CID\_update**

The CID\_update is a compound TLV value that provides a shorthand method for replacing the active connections used by the MS in its previous serving BS. Each CID\_update TLV specifies a CID in the target BS that shall replace a CID used in the previous serving BS. Multiple instances of CID\_update may occur in the REG-RSP to facilitate recreating and reassigning admitted or active service flows for the MS from its previous serving BS. If any of the service flow parameters change, then those service flow parameter encoding TLVs that have changed will be added. If the BS cannot reestablish a particular service flow, it shall not include an instance of CID\_update for that service flow.

These TLVs enable the target BS to renew connections used in the previous serving BS, but with different service flow management encodings settings.

**Compressed CID\_update**

The Compressed CID\_update TLV also provides a method for replacing the active connections used by the MS in its previous serving BS as CID update TLV. It can diminish the length of REG-RSP message.

**SAID\_update**

The SAID\_update is a compound TLV value that provides a shorthand method for renewing active SAs used by the MS in its previous serving BS. The TLVs specify SAID in the target BS that shall replace active SAID used in the previous serving BS. Multiple iterations of these TLVs may occur in the REG-RSP suitable to recreating and reassigning all active Security Associations for the MS from its previous serving BS including Primary, Dynamic and Static SAIDs. If any of the Security Associations parameters change, then those Security Associations parameters encoding TLVs that have changed will be added.

When a BS has Provisioned service flows to transmit to an MS, the BS shall include the following:

**Total number of provisioned service flow TLV** (11.7.18)

The REG-RSP may contain the following TLV:

**MAC header and extended subheader support** (11.7.21)

**Handover Indication Readiness Timer** (11.7.12.6)

**Extended capability** (11.7.8.11)

For an MS supporting HO, the REG-RSP (on initial network entry) shall contain the following TLVs:

**Handover supported field** (11.7.12.5)

**System Resource\_Retain\_Time** (11.7.12.1)

**Mobility parameters support** (11.7.13)

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For an MS supporting HO, the REG-RSP on initial network entry shall contain the following TLVs:

**HO Process Optimization MS Timer** (11.7.12.2)

**MS Handover Retransmission Timer** (11.7.12.3)

**Handover Indication Readiness Timer** (11.7.12.6)

The following TLV may be added if the MS supports H-FDD:

**H-FDD sleep capabilities** (11.7.8.10)

In response to a REG-REQ from an RS, the REG-RSP shall contain the following TLV:

**MR-BS and RS MAC feature support** (see 11.7.25)

**6.3.2.3.9 Privacy key management (PKM) messages (PKM-REQ/PKM-RSP)**

PKM employs two MAC message types: PKM-REQ (PKM request) and PKM-RSP (PKM response), as described in Table 6-60.

**Table 6-60—PKM MAC messages**

|  |  |  |
| --- | --- | --- |
| **Type value** | **Message name** | **Message description** |
|  |  |  |
| 9 | PKM-REQ | Privacy key management request [SS -> BS] |
|  |  |  |
| 10 | PKM-RSP | Privacy key management response [BS -> SS] |
|  |  |  |

These MAC management message types distinguish between PKM requests (SS-to-BS) and PKM responses (BS-to-SS). Each message encapsulates one PKM message in the management message payload.

PKM protocol messages transmitted from the SS to the BS shall use the form shown in Table 6-61. They are transmitted on the SSs primary management connection.

**Table 6-61—PKM-REQ message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| PKM-REQ\_Message\_Format() { | — | — |
|  |  |  |
| **Management Message Type = 9** | 8 | — |
|  |  |  |
| **Code** | 8 | — |
|  |  |  |
| **PKM Identifier** | 8 | — |
|  |  |  |
| **TLV Encoded Attributes** | *variable* | TLV-specific |
|  |  |  |
| } | — | — |
|  |  |  |

PKM protocol messages transmitted from the BS to the SS shall use the form shown in Table 6-62. They are transmitted on the SS’s primary management connection. However, the PKMv2 Group-Key-Update-Command message for the GTEK update mode shall be carried on the Broadcast connection.

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**Table 6-62—PKM-RSP message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| PKM-RSP\_Message\_Format() { | — | — |
|  |  |  |
| **Management Message Type = 10** | 8 | — |
|  |  |  |
| **Code** | 8 | — |
|  |  |  |
| **PKM Identifier** | 8 | — |
|  |  |  |
| **TLV Encoded Attributes** | *variable* | TLV-specific |
|  |  |  |
| } | — | — |
|  |  |  |

The parameters shall be as follows:

**Code**

The Code field is one byte and identifies the type of PKM packet. When a packet is received with an invalid code, it shall be silently discarded. The code values are defined in Table 6-63.

**PKM Identifier**

The Identifier field is one byte. An SS uses the ID to match a BS response to the SS requests. In the case of a 3-way SA-TEK procedure, however, a BS uses it to match an SS response to the BS challenges.

The SS shall increment (modulo 256) the Identifier field whenever it issues a new PKM message. In PKMv1, a “new” message is an Authorization Request or Key Request that is not a retransmission being sent in response to a Timeout event. In PKMv2, a PKMv2 RSA-Request, PKMv2 SA-TEK-Challenge, or PKMv2 Key-Request message is a “new” message. For retransmissions, the Identifier field shall remain unchanged.

The Identifier field in PKMv2 EAP-Transfer messages and Authentication Information messages, which is redundant and does not affect any response messaging, shall be set to zero. The Identifier field in a BS’s PKM-RSP message shall match the Identifier field of the PKM-REQ message the BS is responding to. The Identifier field in TEK Invalid messages and PKMv2 TEK Invalid messages, which are not sent in response to PKM-REQs, shall be set to zero. The Identifier field in unsolicited Authorization Invalid messages shall be set to zero. The Identifier field in PKMv2 Group-Key-Update-Command messages, which are used to distribute the updated group traffic encryption key (GTEK) and traffic keying material, shall be set to zero.

On reception of a PKM-RSP message, the SS associates the message with a particular state machine (the Authorization state machine in the case of Authorization Replies, Authorization Rejects, and Authorization Invalids for the PKMv1, PKMv2 RSA Reply, PKMv2 RSA Reject, PKMv2 EAP Transfer, PKMv2 SA-TEK-Challenge, PKMv2 SA-TEK-Response for the PKMv2; a particular TEK state machine in the case of Key Replies, Key Rejects, and TEK Invalids the PKMv1, PKMv2-Key-Reply, PKMv2-Key-Reject, PKMv2 TEK-Invalids, and PKMv2 Group-Key-Update-Command messages for the PKMv2).

In PKMv1, an SS shall keep track of its latest ID.

An SS shall keep track of the ID of its latest, pending Authorization Request. The SS shall discard Authorization Reply and Authorization Reject messages with Identifier fields not matching that of the pending Authorization Request.

An SS shall keep track of the IDs of its latest, pending Key Request for each SA. The SS shall discard Key Reply and Key Reject messages with Identifier fields not matching those of the pending Key Request messages.

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In PKMv2, both an SS and a BS shall keep track of their latest ID.

An SS shall keep track of the ID of its latest, pending PKMv2 RSA-Request. The SS shall discard PKMv2 RSA-Reply and PKMv2 RSA-Reject messages with Identifier fields not matching that of the pending PKMv2 RSA-Request. Moreover, a BS shall keep it, pending PKMv2 RSA-Reply. The BS shall discard PKMv2 RSA-Acknowledgment messages with Identifier fields not matching that of the pending PKMv2 RSA-Reply.

A BS shall keep track of the ID of its latest, pending PKMv2 SA-TEK-Challenge. The BS shall discard PKMv2 SA-TEK-Request messages with Identifier fields not matching that of the pending PKMv2 SA-TEK-Challenge. In addition, an SS shall keep it, pending PKMv2 SA-TEK-Request. The SS shall discard PKMv2 SA-TEK-Reply messages with Identifier fields not matching that of the pending PKMv2 SA-TEK-Request.

An SS shall keep track of the ID of its latest, pending PKMv2 Key-Request. The SS shall discard PKMv2 Key-Reply and PKMv2 Key-Reject messages with Identifier fields not matching that of the pending PKMv2 Key-Request.

**Attributes**

PKM attributes carry the specific authentication, authorization, and key management data exchanged between client and server. Each PKM packet type has its own set of required and optional attributes. Unless explicitly stated, there are no requirements on the ordering of attributes within a PKM message. The end of the list of attributes is indicated by the LEN field of the MAC PDU header.

**Table 6-63—PKM message codes**

|  |  |  |
| --- | --- | --- |
| **Code** | **PKM message type** | **MAC management** |
| **message name** |
|  |  |
|  |  |  |
| 0–2 | *Reserved* | — |
|  |  |  |
| 3 | SA Add | PKM-RSP |
|  |  |  |
| 4 | Auth Request | PKM-REQ |
|  |  |  |
| 5 | Auth Reply | PKM-RSP |
|  |  |  |
| 6 | Auth Reject | PKM-RSP |
|  |  |  |
| 7 | Key Request | PKM-REQ |
|  |  |  |
| 8 | Key Reply | PKM-RSP |
|  |  |  |
| 9 | Key Reject | PKM-RSP |
|  |  |  |
| 10 | Auth Invalid | PKM-RSP |
|  |  |  |
| 11 | TEK Invalid | PKM-RSP |
|  |  |  |
| 12 | Auth Info | PKM-REQ |
|  |  |  |
| 13 | PKMv2 RSA-Request | PKM-REQ |
|  |  |  |
| 14 | PKMv2 RSA-Reply | PKM-RSP |
|  |  |  |
| 15 | PKMv2 RSA-Reject | PKM-RSP |
|  |  |  |
| 16 | PKMv2 RSA-Acknowledgment | PKM-REQ |
|  |  |  |
| 17 | PKMv2 EAP-Start | PKM-REQ |
|  |  |  |
| 18 | PKMv2 EAP-Transfer | PKM-REQ/PKM-RSP |
|  |  |  |

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**Table 6-63—PKM message codes *(CONTINUED)***

|  |  |  |
| --- | --- | --- |
| **Code** | **PKM message type** | **MAC management** |
| **message name** |
|  |  |
|  |  |  |
| 19 | *Reserved* | — |
|  |  |  |
| 20 | PKMv2 SA-TEK-Challenge | PKM-RSP |
|  |  |  |
| 21 | PKMv2 SA-TEK-Request | PKM-REQ |
|  |  |  |
| 22 | PKMv2 SA-TEK-Response | PKM-RSP |
|  |  |  |
| 23 | PKMv2 Key-Request | PKM-REQ |
|  |  |  |
| 24 | PKMv2 Key-Reply | PKM-RSP |
|  |  |  |
| 25 | PKMv2 Key-Reject | PKM-RSP |
|  |  |  |
| 26 | PKMv2 SA-Addition | PKM-RSP |
|  |  |  |
| 27 | PKMv2 TEK-Invalid | PKM-RSP |
|  |  |  |
| 28 | PKMv2 Group-Key-Update-Command | PKM-RSP |
|  |  |  |
| 29 | *Reserved* | PKM-RSP |
|  |  |  |
| 30 | *Reserved* | — |
|  |  |  |
| 31 | MIH Initial Request | PKM-REQ |
|  |  |  |
| 32 | MIH Acknowledge | PKM-RSP |
|  |  |  |
| 33 | MIH Comeback Response | PKM-RSP |
|  |  |  |
| 34 | PKMv2 AK Transfer | PKM-RSP |
|  |  |  |
| 35 | PKMv2 AK Transfer Ack | PKM-REQ |
|  |  |  |
| 36 | DirectComms\_KeyAgreement\_MSG #1 | PKM-RSP |
|  |  |  |
| 37 | DirectComms\_KeyAgreement\_MSG #2 | PKM-REQ |
|  |  |  |
| 38 | DirectComms\_KeyAgreement\_MSG #3 | PKM-RSP |
|  |  |  |
| 39 | PKIDirectComms\_KeyAgree- | PKM-RSP |
|  | ment\_MSG #1 |  |
|  |  |  |
| 40 | PKIDirectComms\_KeyAgree- | PKM-REQ |
|  | ment\_MSG #2 |  |
|  |  |  |
| 41 | PKIDirectComms\_KeyAgree- | PKM-RSP |
|  | ment\_MSG #3 |  |
|  |  |  |
| 42–255 | *Reserved* | — |
|  |  |  |

Auth Invalid and Auth Info messages may be used in PKMv1 and PKMv2.

Formats for each of the PKM messages are described in the following subclauses. The descriptions list the PKM attributes contained within each PKM message type. The attributes themselves are described in 11.9. Unknown attributes shall be ignored on receipt and skipped over while scanning for recognized attributes.

The BS shall silently discard all requests that do not contain ALL required attributes. The SS shall silently discard all responses that do not contain ALL required attributes.

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**6.3.2.3.9.1 SA Add message**

The SA Add message is sent by the BS to the SS to establish one or more additional SAs.

Code: 3

Attributes are shown in Table 6-64.

|  |  |  |
| --- | --- | --- |
|  | **Table 6-64—SA Add message attributes** | |
|  |  |  |
| **Attribute** |  | **Contents** |
|  |  |  |
| Key-Sequence-Number |  | Authorization key (AK) sequence number. |
|  |  |  |
| (one or more) SA- |  | Each compound SA-Descriptor attribute specifies an SA identifier (SAID) |
| Descriptor(s) |  | and additional properties of the SA. |
|  |  |  |
| HMAC Digest |  | Keyed secure hash algorithm (SHA) message. |
|  |  |  |

The HMAC Digest attribute shall be the final attribute in the message’s attribute list.

**6.3.2.3.9.2 Auth Request (authorization request) message**

Code: 4

Attributes are shown in Table 6-65.

**Table 6-65—Auth Request message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| SS-Certificate | Contains the SS’s X.509 user certificate. |
|  |  |
| Security-Capabilities | Describes requesting SS’s security capabilities. |
|  |  |
| SAID | SS’s Primary SAID equal to the Basic CID. |
|  |  |

The SS-Certificate attribute contains an X.509 SS certificate (see 7.6) issued by the SS’s manufacturer. The SS’s X.509 certificate is a public-key certificate that binds the SS’s identifying information to its RSA public key in a verifiable manner. The X.509 certificate is digitally signed by the SS’s manufacturer, and that signature can be verified by a BS that knows the manufacturer’s public key. The manufacturer’s public key is placed in an X.509 certification authority (CA) certificate, which in turn is signed by a higher level CA.

The Security-Capabilities attribute is a compound attribute describing the requesting SS’s security capabilities. This includes the data encryption and data authentication algorithms the SS supports.

An SAID attribute contains a Primary SAID. In this case, the provided SAID is the SS’s Basic CID, which is equal to the Basic CID assigned to the SS during initial ranging.

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**6.3.2.3.9.3 Auth Reply (authorization reply) message**

Sent by the BS to a client SS in response to an Auth Request message, the Auth Reply message contains an AK, the key’s lifetime, the key’s sequence number, and a list of SA-Descriptors identifying the Primary and Static SAs that the requesting SS is authorized to access and their particular properties (e.g., type, cryptographic suite). The AK shall be encrypted with the SS’s public key. The SA-Descriptor list shall include a descriptor for the Basic CID reported to the BS in the corresponding Auth Request message. The SA-Descriptor list may include descriptors of Static SAIDs that the SS is authorized to access.

The Auth Reply message may also contain PKM configuration settings that override the default timer values.

**6.3.2.3.9.31 M2M Key Request message**

The M2M device sends this message to the BS to request the currently used multicast security parameters.

Code: 36

Attributes are shown in Table 6-93a.

**Table 6-93a—M2M Key Request attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| M2MCID | The identifier of the M2M device group of which the M2M |
|  | device is a member. |
|  |  |
| HMAC/CMAC Digest | Message digest calculated using AK. |
|  |  |

The HMAC/CMAC Digest attribute shall be the final attribute in the message’s attribute list. Inclusion of the HMAC/CMAC Digest attribute allows the M2M device and BS to authenticate the PKMv2 Key-Request message. The HMAC/CMAC Digest attribute’s authentication key is derived from the AK.

Code: 5

Attributes are shown in Table 6-94.

|  |  |
| --- | --- |
|  | **Table 6-94—Auth Reply message attributes** |
|  |  |
| **Attribute** | **Contents** |
|  |  |
| AUTH-Key | AK, encrypted with the target client SS’s public key. |
|  |  |
| Key-Lifetime | AK’s active lifetime. |
|  |  |
| Key-Sequence-Number | AK sequence number. |
|  |  |
| (one or more) SA- | Each compound SA-Descriptor attribute specifies a SAID and additional properties of |
| Descriptor(s) | the SA. |
|  |  |
| PKM Configuration | PKM timer values. |
| settings (optional) |  |
|  |  |

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**6.3.2.3.9.32 Auth Reject (authorization reject) message**

The BS responds to an SS’s authorization request with an Auth Reject message if the BS rejects the SS’s authorization request.

Code: 6

Attributes are shown in Table 6-95.

**Table 6-95—Auth Reject message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| Error-Code | Error code identifying reason for rejection of authorization request. |
|  |  |
| Display-String (optional) | Display String providing reason for rejection of authorization request. |
|  |  |

The Error-Code and Display-String attributes describe to the requesting SS the reason for the authorization failure.

**6.3.2.3.9.33 M2M Key Reply message**

The BS sends this message to the M2M device to provide security information that the M2M device uses to derive the currently used multicast security key, M2MGTEK.

Code: 37

Attributes are shown in Table 6-93b.

**Table 6-93b—M2M Key Reply attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| M2MCID | The identifier of the M2M device group of which |
|  | the M2M device is a member. |
|  |  |
| MGSS | Randomly generated seed value for generating |
|  | M2MGTEK. |
|  |  |
| M2MGTEK\_COUNT | The current M2MGTEK\_COUNT value that the |
|  | M2M device uses to derive the M2MGTEK. |
|  |  |
| HMAC/CMAC Digest | Message digest calculated using AK. |
|  |  |

The HMAC/CMAC Digest attribute shall be the final attribute in the message’s attribute list. Inclusion of the HMAC/CMAC Digest attribute allows the M2M device and BS to authenticate the PKMv2 Key-Request message. The HMAC/CMAC Digest attribute’s authentication key is derived from the AK.

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**6.3.2.3.9.34 Key Request message**

Code: 7

For PMP operations, attributes are shown in Table 6-94.

**Table 6-94—Key Request message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| Key-Sequence-Number | AK sequence number. |
|  |  |
| SAID | Security association identifier. |
|  |  |
| HMAC Digest | Keyed SHA message digest. |
|  |  |

The HMAC Digest attribute shall be the final attribute in the message’s attribute list.

Inclusion of the keyed digest allows the BS to authenticate the Key Request message. The HMAC Digest’s authentication key is derived from the AK or operator shared secret.

**6.3.2.3.9.35 Key Reply message**

Code: 8

Attributes are shown in Table 6-95.

|  |  |  |
| --- | --- | --- |
|  | **Table 6-95—Key Reply message attributes** | |
|  |  |  |
| **Attribute** |  | **Contents** |
|  |  |  |
| Key-Sequence-Number |  | AK sequence number. |
|  |  |  |
| SAID |  | Security Association ID. |
|  |  |  |
| TEK-Parameters |  | “Older” generation of key parameters relevant to SAID. |
|  |  |  |
| TEK-Parameters |  | “Newer” generation of key parameters relevant to SAID. |
|  |  |  |
| HMAC Digest |  | Keyed SHA message digest. |
|  |  |  |

The TEK-Parameters attribute is a compound attribute containing all of the keying material corresponding to a particular generation of a SAID’s TEK. This would include the TEK, the TEK’s remaining key lifetime, its key sequence number, and the cipher block chaining (CBC) IV. The TEK is encrypted. See 11.9.8 for details.

At all times, the BS maintains two sets of active generations of keying material per SAID. (A set of keying material includes a TEK and its corresponding CBC IV.) One set corresponds to the “older” generation of keying material; the second set corresponds to the “newer” generation of keying material. The newer generation has a key sequence number one greater than (modulo 4) that of the older generation. Subclause 7.4.1 specifies BS requirements for maintaining and using a SAID’s two active generations of keying material.

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The BS distributes to a client SS both generations of active keying material. Thus, the Key Reply message contains two TEK-Parameters attributes, each containing the keying material for one of the SAID’s two active sets of keying material.

The HMAC Digest attribute shall be the final attribute in the message’s attribute list.

Inclusion of the keyed digest allows the receiving client to authenticate the Key Reply message and ensure SS and BS have synchronized AKs. The HMAC Digest attribute’s authentication key is derived from the AK. See 7.5 for details.

**6.3.2.3.9.36 Key Reject message**

Receipt of a Key Reject message indicates the receiving client SS is no longer authorized for a particular SAID.

Code: 9

Attributes are shown in Table 6-96.

**Table 6-96—Key Reject message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| Key-Sequence-Number | AK sequence number. |
|  |  |
| SAID | Security association identifier. |
|  |  |
| Error-Code | Error code identifying reason for rejection of Key Request message. |
|  |  |
| Display-String (optional) | Display string containing reason for Key Reject message. |
|  |  |
| HMAC Digest | Keyed SHA message digest. |
|  |  |

The HMAC Digest attribute shall be the final attribute in the message’s attribute list.

Inclusion of the keyed digest allows the receiving client to authenticate the Key Reject message and ensure SS and BS have synchronized AKs. The HMAC Digest attribute’s authentication key is derived from the AK. See 7.5 for details.

**6.3.2.3.9.37 Authorization Invalid message**

The BS may send an Authorization Invalid message to a client SS as

1. An unsolicited indication, or
2. A response to a message received from that SS.

In either case, the Authorization Invalid message instructs the receiving SS to reauthorize with its BS.

The BS sends an Authorization Invalid message in response to a Key Request message if

— The BS does not recognize the SS as being authorized (i.e., no valid AK associated with the requesting SS), or

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— Verification of the Key Request message’s keyed message digest (in the HMAC Digest attribute) failed, indicating a loss of AK synchronization between SS and BS.

Code: 10

Attributes are shown in Table 6-97.

**Table 6-97—Authorization Invalid message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| Error-Code | Error code identifying reason for invalid authorization. |
|  |  |
| Display-String (optional) | Display string describing failure condition. |
|  |  |

**6.3.2.3.9.38 TEK Invalid message**

The BS sends a TEK Invalid message to a client SS if the BS determines that the SS encrypted an UL PDU with a TEK (i.e., a SAID’s TEK key sequence number), contained within the received packet’s MAC header, that is out of the BS’s range of known, valid sequence numbers for that SAID.

Code: 11

Attributes are shown in Table 6-98.

|  |  |
| --- | --- |
|  | **Table 6-98—TEK Invalid message attributes** |
|  |  |
| **Attribute** | **Contents** |
|  |  |
| Key-Sequence-Number | AK sequence number. |
|  |  |
| SAID | Security Association ID. |
|  |  |
| Error-Code | Error code identifying reason for TEK Invalid message. |
|  |  |
| Display-String (optional) | Display string containing vendor-defined information. |
|  |  |
| HMAC Digest | Keyed SHA message digest. |
|  |  |

The HMAC Digest attribute shall be the final attribute in the message’s attribute list.

Inclusion of the keyed digest allows the receiving client to authenticate the TEK Invalid message and ensure SS and BS have synchronized AKs. The HMAC Digest attribute’s authentication key is derived from the AK. See 7.5 for details.

**6.3.2.3.9.39 Auth Info (authentication information) message**

The Auth Info message contains a single CA-Certificate attribute, containing an X.509 CA certificate for the manufacturer of the SS. The SS’s X.509 user certificate shall have been issued by the CA identified by the X.509 CA certificate.

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Auth Info messages are strictly informative; while the SS shall transmit Auth Info messages as indicated by the Authentication state model (7.2.1.5), the BS may ignore them.

Code: 12

Attributes are shown in Table 6-99.

|  |  |
| --- | --- |
|  | **Table 6-99—Auth Info message attributes** |
|  |  |
| **Attribute** | **Contents** |
|  |  |
| CA-Certificate | Certificate of manufacturer CA that issued SS certificate. |
|  |  |

The CA-Certificate attribute contains an X.509 CA certificate for the CA that issued the SS’s X.509 user certificate. The external CA issues these CA certificates to SS manufacturers.

**6.3.2.3.9.40 PKMv2 RSA-Request message**

A client MS sends a PKMv2 RSA-Request message to the BS in order to request mutual authentication in the RSA-based authorization.

Code: 13

Attributes are shown in Table 6-100.

**Table 6-100— PKMv2 RSA-Request message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| MS\_Random | A 64-bit random number generated in the MS |
|  |  |
| MS\_Certificate | Contains the MS’s X.509 user certificate |
|  |  |
| SAID | MS’s Primary SAID equal to the Basic CID |
|  |  |
| SigSS | An RSA signature over all the other attributes in the message |
|  |  |

The MS-certificate attribute contains an X.509 MS certificate (see 7.6) issued by the MS’s manufacturer. The MS’s X.509 certificate is as defined in 6.3.2.3.9.2.

The SigSS attribute indicates a RSA signature over all the other attributes in this message, and the MS’s private key is used to make a RSA signature.

**6.3.2.3.9.41 PKMv2 RSA-Reply message**

Sent by the BS to a client MS in response to a PKMv2 RSA-Request message, the PKMv2 RSA-Reply message contains an encrypted pre-primary authorization key (pre-PAK), the key’s lifetime, and the key’s sequence number. The pre-PAK shall be encrypted with the MS’s public key. The MS\_Random number is returned from the PKMv2 RSA-Request message, along with a random number supplied by the BS, thus enabling assurance of key liveness.

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Code: 14

Attributes are shown in Table 6-101.

**Table 6-101— PKMv2 RSA-Reply message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| MS\_Random | A 64-bit random number generated in the MS |
|  |  |
| BS\_Random | A 64-bit random number generated in the BS |
|  |  |
| Encrypted pre-PAK | RSA-OAEP-Encrypt(PubKey(MS), pre-PAK | MS MAC Address) |
|  |  |
| Key Lifetime | PAK aging timer |
|  |  |
| Key Sequence Number | PAK sequence number |
|  |  |
| BS\_Certificate | Contains the BS’s X.509 certificate |
|  |  |
| SigBS | An RSA signature over all the other attributes in the message |
|  |  |

The SigBS attribute indicates a RSA signature over all the other attributes in this message, and the BS’s private key is used to make a RSA signature.

**6.3.2.3.9.42 PKMv2 RSA-Reject message**

The BS responds to an SS’s authorization request with a PKMv2 RSA-Reject message if the BS rejects the SS’s authorization request. When an MS receives this message, an MS may retransmit the PKMv2 RSA-Request message or quit RSA-based mutual authentication.

Code: 15

Attributes are shown in Table 6-102.

|  |  |
| --- | --- |
| **Table 6-102—PKMv2 RSA-Reject message attributes** | |
|  |  |
| **Attribute** | **Contents** |
|  |  |
| MS\_Random | A 64-bit random number generated in the MS |
|  |  |
| BS\_Random | A 64-bit random number generated in the BS |
|  |  |
| Error-Code | Error code identifying reason for rejection of authorization request |
|  |  |
| BS\_Certificate | Contains the BS’s X.509 certificate |
|  |  |
| Display-String (optional) | Display string providing reason for rejection of authorization request |
|  |  |
| SigBS | An RSA signature over all the other attributes in the message |
|  |  |

The Error-Code and Display-String attributes describe to the requesting MS the reason for the RSA-based authorization failure.

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The SigBS attribute indicates a RSA signature over all the other attributes in this message, and the BS’s private key is used to make a RSA signature.

**6.3.2.3.9.43 PKMv2 RSA-Acknowledgment message**

The MS sends the PKMv2 RSA-Acknowledgment message to BS in response to a PKMv2 RSA-Reply message. Only if the value of the Auth Result Code attribute is failure, then the Error-Code and Display-String attributes can be included in this message.

Code: 16

Attributes are shown in Table 6-103.

**Table 6-103—PKMv2 RSA-Acknowledgment message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| BS\_Random | A 64-bit random number generated in the BS |
|  |  |
| Auth Result Code | Indicates result (success or failure) of authorization procedure |
|  |  |
| Error-Code | Error code identifying reason for rejection of authorization request |
|  |  |
| Display-String (optional) | Display string providing reason for rejection of authorization request |
|  |  |
| SigSS | An RSA signature over all the other attributes in the message |
|  |  |

The SigSS attribute indicates a RSA signature over all the other attributes in this message, and the SS’s private key is used to make a RSA signature.

**6.3.2.3.9.44 PKMv2 EAP-Start message**

EAP Start may be used to initiate an EAP session.

In the case of EAP reauthentication, the HMAC/CMAC Digest and Key Sequence Number attributes shall be included. At initial EAP authentication, these attributes are omitted.

The use of EAP Start to initiate an EAP session during initial network entry is optional. The BS shall not rely on its arrival in order to initiate an EAP session.

Code: 17

Attributes are shown in Table 6-104.

**Table 6-104—PKMv2 EAP-Start message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| Key Sequence Number | AK sequence number |
|  |  |
| HMAC/CMAC Digest | Message digest calculated using AK |
|  |  |

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**6.3.2.3.9.45 PKMv2 EAP-Transfer message**

When an MS has an EAP payload received from an EAP method for transmission to the BS or when a BS has an EAP payload received from an EAP method for transmission to the MS, it encapsulates it in a PKMv2 EAP-Transfer message. In the case of reauthentication, the HMAC/CMAC Digest and Key Sequence Number attributes shall be included.

Code: 18

Attributes are shown in Table 6-105.

**Table 6-105—PKMv2 EAP-Transfer message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| EAP Payload | Contains the EAP authentication data, not interpreted in the MAC |
|  |  |
| Key Sequence Number | AK sequence number |
|  |  |
| HMAC/CMAC Digest | Message digest calculated using AK |
|  |  |

The EAP Payload field carries data in the format described in section 4 of IETF RFC 3748.

**6.3.2.3.9.46 PKMv2 SA-TEK-Challenge message**

The BS transmits the PKMv2 SA-TEK-Challenge message as a first step in the 3-way SA-TEK handshake at initial network entry and at reauthorization. The BS shall send this message to the MS after finishing authorization procedure(s) selected by the negotiated Authorization Policy Support included in the SBC-REQ/RSP messages. It identifies an AK to be used, and includes a random number challenge to be returned by the MS in the PKMv2 SA-TEK-Request message.

Code: 20

Attributes are shown in Table 6-106.

**Table 6-106—PKMv2 SA-TEK-Challenge message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| BS\_Random | A freshly generated random number of 64 bits. |
|  |  |
| Key Sequence Number | AK sequence number. |
|  |  |
| AKID | Identifies the authorization key (this is the AKID of the *new* AK in |
|  | the case of reauthentication). |
|  |  |
| Key lifetime | PMK lifetime, this attribute shall include only follows EAP-based |
|  | authorization or EAP-based reauthorization procedures. |
|  |  |
| HMAC/CMAC Digest | Message authentication digest for this message. |
|  |  |

The generation of the AK sequence number and the authorization key identifier (AKID) is defined in 7.2.2.4.1.

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The HMAC/CMAC Digest attribute shall be the final attribute in the message’s attribute list.

Inclusion of the HMAC/CMAC Digest attribute allows the MS and BS to authenticate a PKMv2 SA-TEK-Challenge message. The HMAC/CMAC Digest attribute’s authentication keys are derived from the AK.

**6.3.2.3.9.47 PKMv2 SA-TEK-Request message**

The MS transmits the PKMv2 SA-TEK-Request message after receipt and successful HMAC Digest or CMAC value verification of an SA-Challenge tuple or PKMv2 SA-TEK-Challenge message from the BS. The PKMv2 SA-TEK-Request proves liveliness of the MS and its possession of the AK to the BS. If this message is being generated during initial network entry, then it constitutes a request for SA-Descriptors identifying the primary and static SAs and GSAs the requesting MS is authorized to access and their particular properties (e.g., type, cryptographic suite).

If this message is being generated following HO, then it constitutes a request for establishment (in the target BS) of TEKs, GTEKs, and group key encryption keys (GKEKs) for the MS and renewal of active primary, static and dynamic SAs and associated SAIDs used by the MS in its previous serving BS.

Code: 21

Attributes are shown in Table 6-107.

**Table 6-107—PKMv2 SA-TEK-Request message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| MS\_Random | A 64-bit number chosen by the MS freshly for every new handshakea |
| BS\_Random | The 64-bit random number used in the PKMv2 SA-TEK-Challenge |
|  | message |
|  |  |
| Key Sequence Number | AK sequence number |
|  |  |
| AKID | Identifies the authorization key that was used for protecting this message |
|  |  |
| Security-Capabilities | The requesting MS’s supported cryptographic suites (11.9.13) |
|  |  |
| Security Negotiation Parameters | The requesting MS’s security capabilities (see 11.8.4) |
|  |  |
| HMAC/CMAC Digest | Message authentication digest for this message |
|  |  |

aReceipt of a new BS random value in SA-TEK-Challenge indicates the beginning of a new handshake.

**6.3.2.3.9.48 PKMv2 SA-TEK-Response message**

The BS transmits the PKMv2 SA-TEK-Response message as a final step in the 3-way SA-TEK handshake. Code: 22

Attributes are shown in Table 6-108.

In MR systems, a PKMv2 SA-TEK-Response message sent to an RS shall include the following TLV:

**SA\_SZK\_Update** (see 11.1.14)

TLV that specifies a security zone SAID and corresponding SZK, and SZKEK parameters.

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**Table 6-108—PKMv2 SA-TEK-Response message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| MS\_Random | The number received from the MS. |
|  |  |
| BS\_Random | The random number included in the PKMv2 SA-TEK-Challenge message. |
|  |  |
| Key Sequence Number | AK sequence number. |
|  |  |
| AKID | Identifies the authorization key to the MS that was used for protecting this |
|  | message. |
|  |  |
| SA\_TEK\_Update | A compound TLV list each of which specifies a SAID and additional |
|  | properties of the SA that the MS is authorized to access. This compound |
|  | field may be present at the reentry only. For each active SA in previous |
|  | serving BS, corresponding TEK, GTEK, and GKEK parameters are |
|  | included. |
|  |  |
| Frame Number | An absolute frame number in which the old PMK and all its associate AKs |
|  | should be discarded. |
|  |  |
| (one or more) SA-Descriptor(s) | Each compound SA-Descriptor attribute specifies a SAID and additional |
|  | properties of the SA. This attribute is present at the initial network entry or |
|  | reentry after receipt of a RNG-RSP message with HO Process Optimization |
|  | bits (Bit 1, Bit 2)=(0,0). |
|  |  |
| Security Negotiation Parameters | The responding BS’s security capabilities (see 11.8.4). |
|  |  |
| HMAC/CMAC Digest | Message authentication digest for this message. |
|  |  |
| PKM configuration settings | PKM configuration defined in 11.9.18 |
|  |  |

**6.3.2.3.9.49 PKMv2 Key-Request message**

An MS sends a PKMv2 Key-Request message to the BS to request new TEK and TEK-related parameters (GTEK and GTEK-related parameters for MBS) or GKEK and GKEK-related parameters for MBS.

Code: 23

Attributes are shown in Table 6-109.

**Table 6-109—PKMv2 Key-Request message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| Key Sequence Number | AK sequence number |
|  |  |
| SAID | Security association identifier |
|  | —GSAID for MBS |
|  |  |
| Nonce | A random number generated in an MS |
|  |  |
| HMAC/CMAC Digest | Message digest calculated using AK |
|  |  |

The HMAC/CMAC Digest attribute shall be the final attribute in the message’s attribute list.

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Inclusion of the HMAC/CMAC Digest attribute allows the MS and BS to authenticate the PKMv2 Key-Request message. The HMAC/CMAC Digest attribute’s authentication key is derived from the AK.

**6.3.2.3.9.50 PKMv2 Key-Reply message**

The BS responds to an MS’s PKMv2 Key-Request message with a PKMv2 Key-Reply message.

Code: 24

Attributes are shown in Table 6-110.

**Table 6-110—PKMv2 Key-Reply message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| Key Sequence Number | AK sequence number. |
|  |  |
| SAID | Security association identifier |
|  | —GSAID for MBS. |
|  |  |
| TEK-Parameters | “Older” generation of key parameters relevant to SAID |
|  | —GTEK-Parameters for the MBS. |
|  |  |
| TEK-Parameters | “Newer” generation of key parameters relevant to SAID. |
|  | — GTEK-Parameters for the multicast or broadcast service. |
|  |  |
| GKEK-Parameters | “Older” generation of GKEK-related parameters for MBS. |
|  |  |
| GKEK-Parameters | “Newer” generation of GKEK-related parameters for MBS. |
|  |  |
| Nonce | A same random number included in the PKMv2 Key-Request message. |
|  |  |
| HMAC/CMAC Digest | Message digest calculated using AK. |
|  |  |

The TEK-Parameters and SAID attributes are as defined in 6.3.2.3.9.34.

The GKEK-Parameters attribute is a compound attribute containing all of the GKEK-related parameters corresponding to a GSAID. This would include the GKEK, the GKEK’s remaining key lifetime, and the GKEK’s key sequence number. The older generation of the GKEK-Parameters attribute is valid within the current lifetime, and the newer generation of the GKEK-Parameters attribute is valid within the next lifetime.

The BS shall always supply fresh (see 7.2.2.2.6) key material in the newer generation of Key Parameters in the PKMv2 Key-Reply message.

The HMAC/CMAC Digest attribute shall be the final attribute in the message’s attribute list.

Inclusion of the HMAC/CMAC Digest attribute allows the MS and BS to authenticate the PKMv2 Key-Reply message. The HMAC/CMAC Digest attribute’s authentication key is derived from the AK.

**6.3.2.3.9.51 PKMv2 Key-Reject message**

The BS responds to an MS’s PKMv2 Key-Request message with a PKMv2 Authorization-Reject message if the BS rejects the MS’s traffic keying material request.

Code: 25

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Attributes are shown in Table 6-111.

**Table 6-111—PKMv2 Key-Reject message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| Key Sequence Number | AK sequence number. |
|  |  |
| SAID | Security association identifier. |
|  |  |
| Error-Code | Error code identifying reason for rejection of the PKMv2 Key-Request |
|  | message. |
|  |  |
| Display-String (optional) | Display string containing reason for the PKMv2 Key-Request message. |
|  |  |
| Nonce | A same random number included in the PKMv2 Key Request message. |
|  |  |
| HMAC/CMAC Digest | Message digest calculated using AK. |
|  |  |

The HMAC/CMAC Digest attribute shall be the final attribute in the message’s attribute list.

Inclusion of the HMAC/CMAC Digest attribute allows the MS and BS to authenticate the PKMv2 Key-Reject message. The HMAC/CMAC Digest attribute’s authentication key is derived from the AK.

**6.3.2.3.9.52 PKMv2 SA-Addition message**

This message is sent by the BS to the SS to establish one or more additional SAs.

Code: 26

Attributes are shown in Table 6-112.

**Table 6-112—PKMv2 SA-Addition message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| Key Sequence Number | AK sequence number. |
|  |  |
| (one or more) SA-Descriptor(s) | Each compound SA-Descriptor attribute specifies a SAID and additional |
|  | properties of the SA. |
|  |  |
| HMAC/CMAC Digest | Message digest calculated using AK. |
|  |  |

The HMAC/CMAC Digest attribute shall be the final attribute in the message’s attribute list.

Inclusion of the HMAC/CMAC Digest attribute allows the MS and BS to authenticate the PKMv2 SA-Addition message. The HMAC/CMAC Digest attribute’s authentication key is derived from the AK.

**6.3.2.3.9.53 PKMv2 TEK-Invalid message**

The BS sends a PKMv2 TEK-Invalid message to a client MS if the BS determines that the MS encrypted an UL PDU with a TEK (i.e., a SAID’s TEK key sequence number), contained within the received packet’s MAC header, that is out of the BS’s range of known, valid sequence numbers for that SAID.

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Code: 27

Attributes are shown in Table 6-113.

**Table 6-113—PKMv2 TEK-Invalid message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| Key Sequence Number | AK sequence number. |
|  |  |
| SAID | Security association identifier. |
|  |  |
| Error-Code | Error code identifying reason for PKMv2 TEK-Invalid message. |
|  |  |
| Display-String (optional) | Display string containing reason for the PKMv2 TEK-Invalid message. |
|  |  |
| HMAC/CMAC Digest | Message digest calculated using AK. |
|  |  |

The HMAC/CMAC Digest attribute shall be the final attribute in the message’s attribute list.

Inclusion of the HMAC/CMAC Digest attribute allows the MS and BS to authenticate the PKMv2 SA-Addition message. The HMAC/CMAC Digest attribute’s authentication key is derived from the AK.

**6.3.2.3.9.54 PKMv2 Group-Key-Update-Command message**

This message is sent by BS to refresh and push the GKEK-related parameters (for GKEK update mode) or the GTEK-related parameters (for GTEK update mode) to MSs served with the specific multicast service, broadcast service, or MBS.

Code: 28

Attributes are shown in Table 6-114.

**Table 6-114—PKMv2 Group-Key-Update-Command message attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| Key Sequence Number | AK sequence number for GKEK update mode, |
|  | GKEK sequence number for GTEK update mode. |
|  |  |
| GSAID | Security association identifier. |
|  |  |
| Key Push Modes | Usage code of PKMv2 Group-Key-Update-Command message. |
|  | In MR systems, GTEK update mode corresponds to SZK update mode, and |
|  | GKEK update mode corresponds to SZKEK update mode. |
|  |  |
| Key Push Counter | Counter one greater than that of older generation. |
|  |  |
| GTEK/SZK-Parameters | “Newer” generation of GTEK-related parameters relevant to GSAID. The |
|  | GTEK-Parameters is the TEK-Parameters for multicast, broadcast service, or |
|  | MBS. |
|  | In MR systems, SZK-related parameters relevant to security zone SAID. |
|  |  |

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**Table 6-114—PKMv2 Group-Key-Update-Command message attributes *(CONTINUED)***

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| GKEK/SZKEK- | “Newer” generation of GKEK-related parameters for multicast, broadcast |
| Parameters | service, or MBS. |
|  | In MR systems, SZKEK-related parameters relevant to SAID for encrypting |
|  | SZK. |
|  |  |
| HMAC/CMAC Digest | Message integrity code of this message. |
|  |  |

Key Sequence Number attribute is the sequence number of the shared AK between an MS and a BS in this message for GKEK update mode. Key Sequence number is the GKEK sequence number in this message for GTEK update mode.

GSAID is SAID for the multicast group or the broadcast group. The type and length of the GSAID is equal to ones of the SAID.

There are two types in a PKMv2 Group-Key-Update-Command message, GKEK update mode and GTEK update mode. The former is used to update GKEK, and the latter is used to update GTEK for the multicast service, the broadcast service, or MBS. The Key Push Modes attribute indicates the usage code of a PKMv2 Group-Key-Update-Command message. The PKMv2 Group-Key-Update-Command message for the GKEK update mode is carried on the primary management connection, but, for the GTEK update mode, it is carried on the broadcast connection. A few of the attributes in a PKMv2 Group-Key-Update-Command message shall not be used according to this Key Push Modes attribute’s value. See 11.9.27 for details.

The Key Push Counter attribute is used to protect against replay attacks. This value is one greater than that of older generation. If the CMAC Digest is included in this message, then the Key Push Counter may not be included.

A PKMv2-Group-Key-Update-Command message contains only the newer generation of key parameters, because this message informs an MS of key material to be used for the next lifetime. The GTEK-Parameters attribute is a compound attribute containing all of the keying material corresponding to a newer generation of a GSAID’s GTEK. This would include the GTEK, the GTEK’s remaining key lifetime, the GTEK’s key sequence number, the associated GKEK sequence number, and the cipher block chaining (CBC) initialization vector. The GTEK is TEK for the multicast group or the broadcast group. The type and length of the GTEK is equal to ones of the TEK. The GKEK (Group Key Encryption Key) can be randomly generated from a BS or a network entity (i.e., an ASA server or an MBS server). The GKEK should be identically shared within the same multicast group, broadcast service group or MBS group. The GTEK is encrypted with GKEK for the multicast service, broadcast service or MBS. GKEK parameters contain the GKEK encrypted by the KEK, GKEK sequence number, and GKEK lifetime. See 7.5.4.5 for details.

The HMAC/CMAC Digest attribute shall be the final attribute in the message’s attribute list. Inclusion of the keyed digest allows the receiving client to authenticate the PKMv2 Group-Key-Update-Command message. The HMAC/CMAC Digest attribute’s authentication key is derived from the AK for the GKEK update mode and GKEK for the GTEK update mode. See 7.2.2.2.9 for details.

**6.3.2.3.9.55 MIH Initial Request message**

The MS sends this message to the BS to deliver an MIH query encapsulated in an MIHF frame.

Code: 31

Attributes are shown in Table 6-115.

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**Table 6-115—MIH Initial Request attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| MIHF frame type | Indicates the type of MIHF frame (11.1.11.2) |
|  |  |
| Delivery Method and Status Code | Indicates the delivery method of query response (11.9.39) |
|  |  |
| MIHF frame | The encapsulated MIHF query (11.1.11.1) |
|  |  |

**6.3.2.3.9.56 MIH Acknowledge**

This message is sent by the BS to the MS to acknowledge a received MIH query encapsulated in an MIHF frame. The response to the query is sent in a later MIH Comeback Response message, and the MS uses a Query ID, received in this MIH Acknowledge message and associated with the MS Initial Request by virtue of the stateful nature of the MIH Acknowledge, to correlate the MIH Initial Request message query with the later response.

Code: 32

Attributes are shown in Table 6-116.

**Table 6-116—MIH Acknowledge attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| Cycle | Indicates the delivery method of query response (11.9.38) |
|  |  |
| Query ID | Used to map query and query response (11.1.11.3) |
|  |  |
| Delivery Method and Status Code | Indicates the delivery method and status code (11.9.39) |
|  |  |

**6.3.2.3.9.57 MIH Comeback Response**

The BS sends this message to the MS to deliver a query response encapsulated in an MIHF frame.

Code: 33

Attributes are shown in Table 6-117.

**Table 6-117—MIH Comeback Response attributes**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| MIHF frame type | Indicates the type of the included MIHF frame. Only included when |
|  | an MIHF frame is present. |
|  |  |
| Query ID | Used to map query and query response (11.1.11.3). |
|  |  |
| Delivery Method and Status Code | Indicates the delivery method and status code (11.9.39). |
|  |  |
| MIHF frame | The encapsulated MIH response (11.1.11.1). |
|  |  |

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**6.3.2.3.9.58 PKMv2 AK transfer message**

In an MR system with an RS operating in distributed security mode, the MR-BS shall send an SS’s AK in the PKMv2 AK Transfer message to the access RS operating in distributed security mode.

Code: 34

Attributes are shown in Table 6-118.

**Table 6-118—PKMv2 AK Transfer message**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| Key Sequence Number | RS AK sequence number |
|  |  |
| SAID | MS/subordinate RS’s primary SAID |
|  |  |
| SAID | RS primary SAID |
|  |  |
| AK-Parameters | AK related parameters defined in 11.9.40 |
|  |  |
| Frame Number | An absolute frame number in which the old PMK and |
|  | all its associate AKs should be discarded |
|  |  |
| (one or more) SA-Descriptor(s) | Each compound SA-Descriptor attribute specifies |
|  | SAID additional properties of the SA |
|  |  |
| Nonce | A random number generated in an MR-BS |
|  |  |
| HMAC/CMAC Digest | Message authentication digest |
|  |  |

**6.3.2.3.9.59 PKMv2 AK transfer ACK**

An RS operating in distributed security mode shall send a PKMv2 AK Transfer Ack message to the MR-BS in reply to PKMv2 AK Transfer message in order to securely acknowledge key reception.

Code: 35

Attributes are shown in Table 6-117.

**Table 6-119—PKMv2 AK Transfer ACK**

|  |  |
| --- | --- |
| **Attribute** | **Contents** |
|  |  |
| Key Sequence Number | RS AK sequence number |
|  |  |
| SAID | Access RS primary SAID |
|  |  |
| Key Sequence Number | MS/subordinate RS’s AK sequence number |
|  |  |
| SAID | MS/subordinate RS’s primary SAID |
|  |  |
| Nonce | A same random number included in the PKMv2 AK |
|  | Transfer message |
|  |  |
| HMAC/CMAC Digest | Message authentication digest |
|  |  |

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**6.3.2.3.10 DSA-REQ message**

A DSA-REQ message is sent by an SS or BS to create a new service flow.

**Table 6-120—DSA-REQ message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| DSA-REQ\_Message\_Format() { | — | — |
|  |  |  |
| **Management Message Type = 11** | 8 | — |
|  |  |  |
| **Transaction ID** | 16 | — |
|  |  |  |
| **TLV Encoded Information** | *variable* | TLV-specific |
|  |  |  |
| } | — | — |
|  |  |  |

An SS or BS shall generate DSA-REQ messages in the form shown in Table 6-120, including the following parameters:

**CID** *(in the generic MAC header)*

SS’s primary management connection identifier.

**Transaction ID**

Unique identifier for this transaction assigned by the sender.

All other parameters are coded as TLV tuples.

A DSA-REQ message shall not contain parameters for more than one service flow unless the Group parameter Create/Change TLV (11.13.39) is used.

The DSA-REQ message shall contain the following:

**Service Flow Parameters** (see 11.13)

Specification of the service flow’s traffic characteristics and scheduling requirements.

**Convergence Sublayer Parameter Encodings** (see 11.13.18)Specification of the service flow’s CS-specific parameters.

The DSA-REQ message shall contain the following parameter encoded as a TLV tuple if authentication is supported:

**HMAC/CMAC Tuple** (see 11.1.2)

The HMAC/CMAC Tuple attribute contains a keyed message digest (to authenticate the sender). The HMAC Tuple attribute shall be the final attribute in the DSx message’s attribute list.

In multihop relay systems with scheduling RSs, DSA-REQ is used for two other purposes—one for admission control and one for path management. Such DSA-REQ is only sent over relay links from an MR-BS or an RS to its subordinate RS.

In multihop relay systems with scheduling RSs, MR-BS may send a DSA-REQ to all the RSs on the path to request an admission control decision. This DSA-REQ is processed by each RS on the path and forwarded to its subordinate RS. The CID of the associated service flow is included in the CID TLV field of the Service

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Flow Parameters TLV and is either the transport CID for the service flow or the tunnel CID of the tunnel into which the service flow is mapped. The DSA-REQ pertaining to a tunnel shall not contain the SFID TLV field of the Service Flow Parameters TLV. The MR-BS and RS shall generate DSA-REQ in the form shown in Table 6-120, except that the CID used in the MAC header is the primary management CID of MR-BS/ RS’s subordinate RS.

This DSA-REQ sent over relay link for the purpose of admission control may contain the following TLV, if explicit path management is used:

**Path ID** (see 11.1.13.1)

Specification of the ID of the path that shall be traversed by the service flow

This DSA-REQ sent over relay link for the purpose of admission control may contain the following TLV, if embedded path management is used and the systematic CID is not assigned locally by the RS:

**Path Info** (see 11.1.13.4)

Specification of the ordered primary management CID list of the RSs on the path that shall be traversed by the service flow

In multihop relay systems, a DSA-REQ may also be sent by the MR-BS to populate the path information to every RS on the path and/or distribute the binding information between connections and a selected path. The MR-BS shall generate DSA-REQs in the form shown in Table 6-120. When an RS that is not the access RS for the path receives a DSA-REQ, that RS shall also generate a DSA-REQ in the form shown in Table 6-120 and send this DSA-REQ to the subordinate RS on the path.

The DSA-REQ message sent over relay link for the purpose of path management may contain the following TLVs:

**Path Addition** (see 11.1.13.2)

Specification of the path addition operations

**Path CID Binding Update** (see 11.1.13.3)

Specification of the path/CID binding operations including adding the binding between CIDs to the specific path.

This DSA-REQ sent over relay link for the purpose of path management shall not contain the following TLVs:

**Service Flow Parameters** (see 11.13)

Specification of the service flow’s traffic characteristics and scheduling requirements

The DSA-REQ message sent over relay link shall not contain the following TLV:

**Convergence Sublayer Parameter Encodings** (see 11.13.18)

Specification of the service flow’s CS specific parameters

**6.3.2.3.10.1 SS-Initiated DSA**

The SFID shall not be present in the DSA message; at the BS, the service flow within the DSA-REQ message shall be assigned a unique SFID, which shall be sent back in the DSA-RSP message. SS-initiated DSA-REQ messages may use the service class name in place of some, or all, of the QoS parameters.

**6.3.2.3.10.2 BS-Initiated DSA**

BS-initiated DSA-REQ messages may also include a CID. CIDs are unique within the MAC domain.

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BS-initiated DSA-REQ messages for named service classes shall include the QoS parameter set associated with that service class. BS-initiated DSA-REQ messages shall also include the Target SAID for the service flow.

When the DSA-REQ message is sent to an M2M device, the following TLV may be included:

**M2MCID (see 11.13.46)**

M2MCID associated with the SF.

**Minimal Access Window Size (see 11.13.47)**

The minimal size of a window within which the M2M device shall select the start time for the network entry procedure.

When the DSA-REQ message is sent to an M2M device to establish a DL multicast service flow, the follow-ing TLV may be included:

**M2M Multicast Traffic Reception timer (see 11.13.48)**

The maximum time interval that M2M devices in idle mode shall wait to receive the M2M mul-ticast data, in unit of frames (0~255), as defined in 6.3.34.1.

When an MS commences multicast service in HR-Network, the following parameters shall be included in the DSA-REQ message:

**HR Multicast Group Zone ID (see 11.13.51)**

Indicates multicast group zone IDs for the connection that is associated with the service flow in DSA-REQ in HR-Network.

**HR Multicast Group ID (see 11.13.52)**

Indicates the multicast group for the connection that is associated with the service flow in DSA-REQ.

**HR Multicast Indication cycle (see 11.13.53)**

Indicates the multicast indication cycle for the multicast in HR-Network.

**6.3.2.3.11 DSA-RSP message**

A DSA-RSP message shall be generated in response to a received DSA-REQ message. The format of a DSA-RSP message shall be as shown in Table 6-121.

**Table 6-121—DSA-RSP message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| **(bit)** |
|  |  |
|  |  |  |
| DSA-RSP\_Message\_Format() { | — | — |
|  |  |  |
| **Management Message Type = 12** | 8 | — |
|  |  |  |
| **Transaction ID** | 16 | — |
|  |  |  |
| **Confirmation Code** | 8 | — |
|  |  |  |
| **TLV Encoded Information** | *variable* | TLV-specific |
|  |  |  |
| } | — | — |
|  |  |  |

Parameters shall be as follows:

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The presence of an ARQ Feedback Payload in a MAC PDU is indicated by the value of the ARQ Feedback Payload bit in the Type field (see Table 6-4) in the generic MAC header. When present, the first packed payload shall be the ARQ Feedback Payload. The PSH preceding the ARQ Feedback Payload indicates the total length of the payload including the PSH and all ARQ Feedback IEs within the payload. The FSN/BSN field of the PSH shall be ignored for the ARQ Feedback Payload and the FC bits shall be set to 00.

**6.3.3.5 CRC calculation**

A service flow may require that a CRC be added to each MAC PDU carrying data for that service flow (11.13.11). In this case, for each MAC PDU with HT = 0, a CRC32 (as defined in 6.3.3.5.1 for SC and OFDM mode and 6.3.3.5.2 for OFDMA mode), shall be appended to the payload of the MAC PDU; i.e., request MAC PDUs are unprotected. The CRC shall cover the generic MAC header and the payload of the MAC PDU. The CRC shall be calculated after encryption; i.e., the CRC protects the generic header and the ciphered payload.

**6.3.3.5.1 CRC32 calculation for SC and OFDM mode**

The data (input) bytes shall be flipped (for each byte exchange bit0 ↔ bit7, bit1 ↔ bit6, bit2 ↔ bit5, and bit3 ↔ bit4).

The CRC32 shall be calculated using the following standard generator polynomial of degree 32:

*G*  *X*= *X*32+ *X*26+ *X*23+ *X*22+ *X*16+ *X*12+ *X*11+ *X*10+ *X*8+ *X*7+ *X*5+ *X*4+ *X*2+ *X* + 1

(where, the hexadecimal representation of truncated *G*(*X*) is “0x04c11db7”)

The CRC32 is the ones complement of the sum (modulo 2) of the following:

a) The remainder of *XK* (*X*31 + *X*30 + *X*29 + …+ *X*2 + *X* + 1) divided (modulo 2) by *G*(*X*), where *K* is the number of bits in the input data, and

1. The remainder after multiplication of the bit-flipped input data (treated as a polynomial) by *X*32 and then division by *G*(*X*).

The CRC32 field shall then be transmitted bit-flipped commencing with the most significant byte. (The first transmitted byte will have in its bit 7 the coefficient of *X*24 and in bit 0 the coefficient of *X*31. The fourth byte will have the coefficient of *X*0 in bit 7 and the coefficient of *X*7 in bit 0).

As a typical implementation, at the transmitter, the initial remainder of the division is preset to all 1s and is then modified by division of the bit-flipped data by the generator polynomial *G*(*X*). The ones complement of this remainder is then bit flipped byte after byte when transmitted, with the most significant byte first.

At the receiver, the initial remainder is preset to all 1s and the input bytes shall be flipped first and then treated as coefficient of a polynomial. When divided by *G*(*X*), this polynomial shall results in the absence of transmission errors, in a unique nonzero remainder value. The unique remainder value is the polynomial:

*X*31+ *X*30+ *X*26+ *X*25+ *X*24+ *X*18+ *X*15+ *X*14+ *X*12+ *X*11+ *X*10+ *X*8+ *X*6+ *X*5+ *X*4+ *X*3+ *X* + 1

(or as its hexadecimal representation 0xC704DD7B)

**6.3.3.5.1.1 CRC32 test vectors for SC and OFDM mode**

The followings an example of CRC calculation in SC and OFDM mode:

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Generic MAC header (Hex) = 40 40 1A 06 C4 5A

Payload (Hex) = BC F6 57 21 E7 55 36 C8 27 A8 D7 1B 43 2C A5 48

CRC32 for SC and OFDM mode (Hex) = CB B6 5F 48

**6.3.3.5.2 CRC32 calculation for OFDMA mode except for DL MAP and UL MAP Messages for channel bandwidth below 1.25 MHz.**

The data (input) bytes shall not be flipped as in OFDM mode.

The CRC32 shall be calculated using the following standard generator polynomial of degree 32:

*G*  *X*= *X*32+ *X*26+ *X*23+ *X*22+ *X*16+ *X*12+ *X*11+ *X*10+ *X*8+ *X*7+ *X*5+ *X*4+ *X*2+ *X* + 1

(where, the hexadecimal representation of truncated *G(X)* is “0x04c11db7”)

At the transmitter, the following procedure is applied:

1. First 32 bits are complemented, which is equivalent to setting the initial value of the CRC register as 0xFFFFFFFF.
2. The first bit of the first field (MSB of the first byte of the MAC header) corresponds to the *XN*–1 term and the last bit of the last field corresponds to the *X*0 term, where *N* is the number of bits in the input data sequence.
3. The resulting polynomial multiplied by *X*32 is divided by *G*(*X*).
4. The remainder bit sequence is complemented.
5. The 32 bits of the CRC value are placed in the CRC field so that the *X*31 term is the left-most bit of the first byte, and the *X*0 term is the right most bit of the last byte.
6. The resulting CRC field is sent MSB first (6.3.3.1).

At the receiver, the initial remainder is preset to all 1s and the input bytes shall be fed into the CRC engine MSB first. When divided by *G*(*X*), this polynomial shall result in the absence of transmission errors, in a unique nonzero remainder value. The unique remainder value is the polynomial:

*X*31+ *X*30+ *X*26+ *X*25+ *X*24+ *X*18+ *X*15+ *X*14+ *X*12+ *X*11+ *X*10+ *X*8+ *X*6+ *X*5+ *X*4+ *X*3+ *X* + 1

(or as its hexadecimal representation 0xC704DD7B)

**6.3.3.5.2.1 CRC32 test vectors for OFDMA mode**

The following is an example of CRC calculation in OFDMA mode:

Generic MAC header (Hex) = 40 40 1A 06 C4 5A

Payload (Hex) = BC F6 57 21 E7 55 36 C8 27 A8 D7 1B 43 2C A5 48

CRC32 for OFDMA mode (Hex) = 1B D1 BA 21

**6.3.3.5.3 CRC8 calculation for OFDMA mode for DL MAP and UL MAP messages for channel bandwidth below 1.25 MHz.**

The data (input) bytes shall not be flipped as in OFDM mode.

The CRC8 shall be calculated using the following standard generator polynomial of degree 8:

*G*  *X*= *X*8+ *X*2+ *X* + 1

(where, the hexadecimal representation of truncated *G(X)* is “0x07)

At the transmitter, the following procedure is applied:

1. Initial value of the CRC register as 0.
2. The first bit of the first field (MSB of the first byte of the MAC header) corresponds to the *XN*–1 term and the last bit of the last field corresponds to the *X*0 term, where *N* is the number of bits in the input data sequence.
3. The resulting polynomial multiplied by *X*8 is divided by *G*(*X*).
4. The remainder bit sequence is complemented.
5. The 8 bits of the CRC value are placed in the CRC field
6. At the receiver, the initial remainder is preset to all 0s and the input bytes shall be fed into the CRC engine MSB first. When divided by *G*(*X*), this polynomial shall result in the absence of transmission errors in a zero reminder value:

**6.3.3.6 Encryption of** MAC PDU**s**

When transmitting a MAC PDU on a connection that is mapped to an SA, the sender shall perform encryption and data authentication of the MAC PDU payload as specified by that SA. When receiving a MAC PDU on a connection mapped to an SA, the receiver shall perform decryption and data authentication of the MAC PDU payload, as specified by that SA.

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The generic MAC header shall not be encrypted. The header contains all the encryption information [EC field, EKS (encryption key sequence) field, and CID] needed to decrypt a payload at the receiving station. This is illustrated in Figure 6-38.



|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |
| Generic MAC header |  | Payload (optional) | | | | | |  | CRC |
|  |  | (Optional) |
|  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |



Encrypted portion of the MAC PDU

**Figure 6-38—MAC PDU encryption**

Two bits of a MAC header contain a key sequence number. Note that the keying material associated with an SA has a limited lifetime, and the BS periodically refreshes an SA’s keying material. The BS manages a 2-bit key sequence number independently for each SA and distributes this key sequence number along with the SA’s keying material to the client SS. The BS increments the key sequence number with each new generation of keying material. The MAC header includes this sequence number to identify the specific generation of that SA keying material being used to encrypt the attached payload. Being a 2-bit quantity, the sequence number wraps around to 0 when it reaches 3.

Comparing a received MAC PDU’s key sequence number with what it believes to be the “current” key sequence number, the SS or the BS can easily recognize a loss of key synchronization with its peer. An SS shall maintain the two most recent generations of keying material for each SA. Keeping on hand the two most recent key generations is necessary for maintaining uninterrupted service during an SA’s key transition.

Encryption of the payload is indicated by the EC bit field. A value of 1 indicates the payload is present and encrypted and the EKS field contains meaningful data. A value of 0 indicates the payload is not encrypted or not present. Any MAC PDU containing an unencrypted payload received on a connection mapped to an SA requiring encryption shall be discarded.

**6.3.3.7 Padding**

Within a data burst, the unused portion shall be initialized to a known state. This may be accomplished by setting each unused byte to the stuff byte value (0xFF). If the size of the unused region is at least the size of a MAC header, the region may also be initialized by formatting the unused space as a MAC PDU. When doing so, the MAC header CID field shall be set to the value of the Padding CID (see Table 10-5); the CI, EC, HT, and Type fields shall be set to zero; the length field shall be set to the number of unused bytes (including the size of the MAC header created for the padding MAC PDU) in the data burst; and the HCS shall be computed in the normal way.

**6.3.3.8 MR construction and transmission of MAC PDUs**

Two modes for forwarding MAC PDUs belonging to a connection are specified within the standard. The tunnel mode is described in 6.3.3.8.1, and the CID based forwarding mode in 6.3.3.8.2.

The mode of RS operation (transparent or non-transparent), the type of scheduling (centralized or distributed) and the number of hops from the MR-BS to the MS/SS, determine which forwarding modes may be used.

In the case of a transparent RS in a two-hop topology, CID based forwarding shall be used.

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