MAC-PDU

The MAC Protocol Data Unit (MPDU) is composed of a fixed length header, a variable length payload, and an optional CRC (Cyclic Redundancy Check). The MAC-PDU can have a maximum length of 2048 bytes. A generic wireless MAC-PDU is represented in Figure 1. The top part of the figure shows the header in detail and indicates the length (in bits) of each component. The bottom part shows the complete PDU and the length (in bytes) of each component.

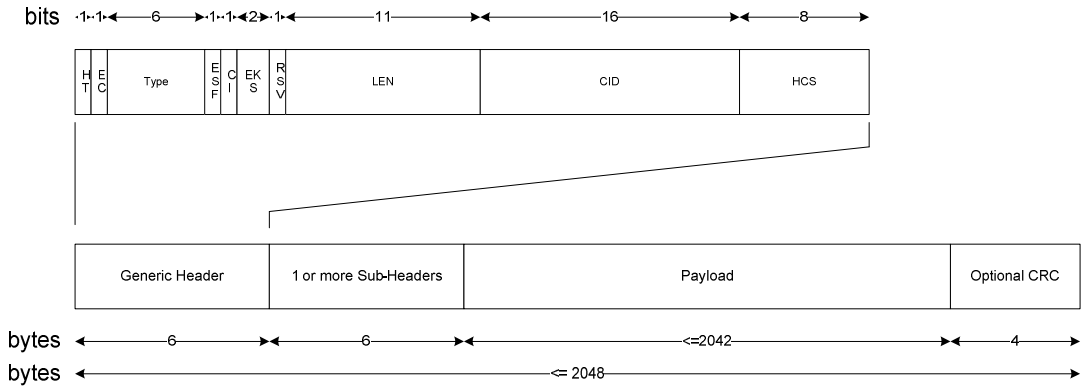

Figure 1 Generic Wireless MAC-PDU

In the figure, HT indicates the Header Type, which is used to indicate whether a payload follows (type 0) or not (type 1). The payload is not present on signaling MAC-PDUs (e.g. a bandwidth request, as in Figure 2). For 802.16e systems, the HT is always set to 0 in the downlink, because payload is always present.

EC (Encryption Control) indicates if the content is encrypted (1) or not (0); the header itself is never encrypted. When this field is set to 1, the Encryption Key Sequence (EKS) becomes relevant and provides the index of the Traffic Encryption Key (TEK) and Initialization Vector (IV) used for encryption of the payload. If EC is set to 0 (payload not encrypted), the two EKS bits are reserved for other purposes.

The 6 bits reserved for Type describe any subheaders and special payload types contained in the payload (e.g. fragmented PDUs).

ESF stands for Extended Subheader Field and indicates whether subheaders are present after the generic header (1). If they are absent, this value is set to 0. The CI (CRC Indicator) follows the same principle: 1 if CRC is present, 0 if it is absent.

One reserved bit (RSV) is also present in the header. Reserved bits are usually set to 0 for transmission and ignored in the reception. These bits are usually saved for supporting new functions.

The length field (LEN) indicates, in bytes, the total length of the MPDU, including the header, subheader, payload, and CRC.

CID stands for Connection Identifier. In traditional wireless technologies, users are assigned channels that are kept allocated during the span of a connection. In WiMAX, users are instead assigned a set of CIDs, which are a 16-bit long parameter that uniquely identify the connection between the BS and SS and are linked to the messages sent. CIDs eliminate the need for channels and free resources to be allocated dynamically. CIDs can be used for both downlink and uplink or only in one direction. CIDs are classified in different categories, such as basic connection, primary management, user data transport, and broadcast and are kept during the whole session.

Basic Connection CIDs are mandatory and used for MAC control messages, e.g. Downlink Burst Profile Change Request and Response messages (DBPC-REQ/RSP).

Primary Management CIDs are also mandatory and used to send MAC control messages that are not sent through basic connection CIDs, such as dynamic service flow messages (e.g. Dynamic Service Flow Addition Request DSA-REQ).

When CIDs are related to user data transport connections, they identify the service flow to which the PDU belongs. A service flow is a flow of packets that matches a given Quality of Service (QoS) and exist for both downlink and uplink. The flows may exist even when not actually carrying traffic and are identified by a 32-bit long parameter called the Service Flow Identifier (SFID). An independent CID is needed for each active service flow (i.e. different QoS requirements).

The existence of SFIDs allows the dynamic management of service flows with messages that can add, change, or delete existing flows in the system without affecting all network users.

Broadcast CIDs carry broadcast data messages such as channel descriptors (UCD/DCD) and mapping (DL-MAP and UL-MAP).

The 8 bits of Header Check Sum (HCS) are mandatory and used to detect transmission errors in the header of the MPDU.

The generic header of a MPDU has a fixed length, the payload however has a variable length because it may contain a single SDU, a fraction of an SDU or multiple SDUs. In the second case, a fragmentation header (FH) to describe the SDU. On the other hand, when multiple SDUs are present, one or more packing subheaders (PS) are inserted after the generic header, or immediately before each SDU. The indication of presence and location of these subheaders is given by the Type in the generic header.

The variable payload size, the fact that one or more subheaders may be present after the generic header, and the optional use of CRC (Cyclic Redundancy Check) makes for a variable-length MPDU, which provides more efficient data transmission, e.g. multiple MPDUs can be transmitted in a single burst to save PHY overhead.

Signaling messages do not use payloads, and do not require any subheaders, thus they have a slightly different format. Figure 2 shows, as an example, the MAC-PDU used in a bandwidth request. This type of message is sent only after the SS already has a transport connection setup. The BR field indicates the Bandwidth Request Message, i.e. the amount of uplink resources (given in bytes) being requested by the SS. The Type field determines if the requested bandwidth is incremental (000) or aggregate (001), in which case the message should be combined with previous requests. The CID in this message specifies the connection for which the request is being made.

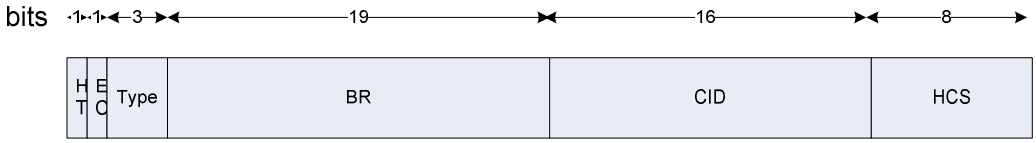

Figure 2 Bandwidth Request MAC-PDU

The MAC-PDU is an overhead to the transmitted user data and has to be considered in network dimensioning because it diminishes data throughput. This overhead varies with the message size, thus an average number should be estimated based on the size of the packets being transmitted. Additionally, protocol control messages also add to the overhead and must be considered in throughput calculations. For a mix of services, a 5% overhead can be considered as an average.