IEEE P802.22  
Wireless RANs

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| [802.22b General Frame] | | | | |
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Abstract

This document is a revision of initialization and network association (7.14) for 802.22b systems and provies definitions related with the revision.

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**7. MAC Common Part sublayer**

**7.3 General superframe structure**

The IEEE 802.22 WRAN system includes two operational modes: a normal mode and a self-coexistence mode. In normal mode, one WRAN cell occupies one channel and operates on all the frames in a superframe; while in self-coexistence mode, multiple WRAN cells share the same channel and each coexisting WRAN cell operates on one or several different frames exclusively.

The IEEE 802.22 WRAN system includes two operational modes: a normal mode and a self-coexistence mode. In normal mode, one WRAN cell occupies one channel and operates on all the frames in a superframe; while in self-coexistence mode, multiple WRAN cells share the same channel and each coexisting WRAN cell operates on one or several different frames exclusively.

The IEEE 802.22b WRAN system includes two operational modes: a normal mode and a self-coexistence mode. In normal mode, one WRAN cell occupies one or more channels if multiple operating channels are available; while in self-coexistence mode, multiple WRAN cells share the same channel and each coexisting WRAN cell operates on one or several different frames exclusively.

When operating in normal mode, a WRAN cell shall transmit the Superframe Control header (SCH) at the beginning of the first frame of a superframe on the operating channel; when operating in self-coexistence mode, a WRAN cell shall transmit its SCH at the beginning of the first frame allocated to it in the superframe. The structure of the SCH for both normal mode and self-coexistence mode can be found in 7.5.1. A WRAN runs in normal mode by default and transits to self-coexistence mode when the WRAN can detect and decode an SCH or a CBP from an adjacent WRAN cell on its operating channel.

When operating in normal mode, an IEEE 802.22 WRAN cell shall transmit the Superframe Control header (SCH) at the beginning of the first frame of a superframe on the operating channel; when operating in self-coexistence mode, an IEEE 802.22 WRAN cell shall transmit its SCH at the beginning of the first frame allocated to it in the superframe. The structure of the SCH for both normal mode and self-coexistence mode can be found in 7.5.1. An IEEE 802.22 WRAN runs in normal mode by default and transits to self-coexistence mode when the WRAN can detect and decode an SCH or a CBP from an adjacent WRAN cell on its operating channel.

An IEEE 802.22b WRAN shall transmit the Frame Control Header (FCH) at the beginning of the first frame on the operating channel in both normal mode and self-coexistencce mode. An IEEE 802.22b WRAN runs in normal mode by default and transits to self-coexistence mode when the WRAN can detect and decode an FCH or a CBP from an adjacent WRAN cell on its operating channel.

**7.3.1 802.22 WRAN general superframe structure for normal mode**

**7.3.1.x 802.22b WRAN general frame structure for normal mode**

The frame structure depicted in Figure xx shall be constituted of the following:

\_ A PHY frame preamble, see Clause 9

\_ A Frame Control Header (FCH), see xxx

\_ The rest of the first frame including its frame header and data payload

At the beginning of every frame, the MR-BS shall transmit the frame preamble and the FCH on the operating channel using the modulation/coding specified in x.x.x and Table xxx respectively. In order to associate with an MR-BS, a CPE must receive the FCH to establish communication with the MR-BS. During each MAC frame, the MR-BS shall manage the upstream and downstream operations, which may include ordinary data communication, measurement activities, coexistence procedures, and so on.



**7.3.2 802.22 WRAN general superframe structure for self-coexistence mode**

**7.3.2.x 802.22b WRAN general frame structure for self-coexistence mode**

The 802.22b WRAN frame structure in self-coexistence mode is shown in Figure xx. The self-coexistence mode is for the scenario when multiple MR-BSs with overlapping coverage have to share the same channel. The frequency reuse factor cannot be maintained as one due to their mutual interference. In this case, these MR-BSs shall share the channel on a per frame basis. The negotiation process of frame allocation can be found in x.x.x.

In self-coexistence mode, the MR-BS and CPEs in a WRAN cell shall only transmit during the active frames allocated to that WRAN cell. They can only transmit during other frames when a self-coexistence window (SCW) has been scheduled. During the frames not allocated to the present cell, the MR-BS and CPEs may monitor the channel for any transmission from neighboring WRAN cells to improve self-coexistence.

**7.4 IEEE 802.22 general frame structure**

**7.4.x IEEE 802.22b general frame structure**

The top-down time division duplex (TDD) frame structure employed in the MAC is illustrated in Figure xx.

As illustrated in Figure xx, a frame is comprised of two parts: a downstream (DS) subframe and an upstream (US) subframe. A portion of the US subframe may be allocated as a window to facilitate self- coexistence. This SCW may be scheduled by the base station at the end of the US subframe when necessary to allow transmission of opportunistic coexistence beacon protocol bursts. The SCW includes the necessary time buffers to absorb the difference in propagation delay between close-by and distant base stations and CPEs operating on the same channel. The boundary between the DS and US subframes shall be adaptive to adjust to the downstream and upstream relative capacity.

An IEEE 802.22b general frame structure has two different modes for relaying: centralized scheduling mode and distributed scheduling mode.

**7.4.x.x IEEE 802.22b general frame structure on centralized scheduling mode**



Each of the downstream and upstream subframes for a centralized scheduling mode may be separated of two parts: downstream and relay downstream subframes, and upstream and relay upstream subframes. Downstream and upstream subframes are used for transmission between MR-BS and CPEs (R-CPEs and S-CPEs), while relay downstream and upstream subframes are used for transmission between R-CPE and S-CPEs.

For a centralized scheduling mode, the downstream and upstream subframes and the relay downstream and upstream subframes are managed by an MR-BS.



At the beginning of every frame, the MR-BS shall transmit the frame preamble and the FCH on the operating channel using the modulation/coding specified in x.x.x and Table xxx respectively. In order to associate with an MR-BS, a CPE must receive the FCH to establish communication with the MR-BS. During each MAC frame, the MR-BS shall manage the upstream and downstream operations as well as the relay upstream and downstream operations, which may include ordinary data communication, measurement activities, coexistence procedures, and so on. During the relay downstream subframe, the R-CPE transmits the MAC frames, which are transferred from the MR-BS during the downstream subframe, to the S-CPE on the scheduled slots determined by the MR-BS.

The upstream subframe may contain scheduled upstream PHY PDUs, each transmitted from different CPEs for their upstream traffic. It may also include contention intervals scheduled for the following:

CPE association (initial ranging)

CPE link synchronization, power control and geolocation (periodic ranging)

Bandwidth request

Urgent coexistence situation (UCS) notification

Quiet period resource adjustment

The relay upstream subframe may contain scheduled upstream PHY PDUs, each transmitted from different CPEs for their upstream traffic from being relayed by the R-CPE. It may also include contention intervals scheduled for the following:

CPE association (relay initial ranging x.x.x)

CPE power control and geolocation (relay periodic ranging x.x.x)

Relay bandwidth request (x.x.x)

Relay urgent coexistence situation (UCS) notification

Quiet period resource adjustment

The PHY PDUs depicted in Figure 12 may be transmitted across several subchannels as shown in Figure 13, which depicts how a frame may be transmitted (in time and frequency) by the PHY layer.

Figure 13 shows an example of the two-dimensional (time/frequency) structure of the MAC frame that shall consist of an integer number of fixed size OFDM slots. Each slot shall consist of one OFDM symbol by one subchannel (i.e., 1 OFDM slot = 1 symbol × 1 subchannel). To help understand Figure 13, the MAC packets are assumed to be structured in a linear TDM manner (see Figure 12) while the PHY packets are arranged in a two-dimensional time/frequency domain (symbol in the horizontal direction, logical subchannels in the vertical direction). For the FCH, the DS/US-MAP, Relay DS/US MAP if appeared, the DCD, the UCD, the Realy DCD/UCD if appeared as well as for the downstream payload and the relay downstream payload if appeared, the MAC information is first laid vertically by subchannels then stepped horizontally in the time direction. This vertical layering allows early scheduling of DS bursts assigned to distant CPEs to compensate for propagation delays and to avoid potential interference at the CPE in the case of overlapping WRAN cells with different DS/US capacity split.

The MAC data elements from Figure 12, starting from the FCH and including the first broadcast burst, shall be entered into the second OFDM symbol, as shown in Figure 13, in the increasing order of logical subchannels until all logical subchannels are occupied. Then, the subsequent data elements, if they have not all been mapped, shall be placed in the same order on the following OFDM symbols. The balance of the last OFDM symbols shall be padded with zeros. The modulation and coding schemes for the padding zeros are defined by the DIUC for the last DS burst in the DS-MAP. Note that the DS-MAP indicates the length of the contiguous DS MAC elements, not their absolute position in the DS subframe.

If the relay downstream subframe is appeared in the downstream subframe, the relay downstream subframe shall be appeared followed by the downstream subframe in the MAC frame. The MAC data bursts in the relay downstream subframe may be entered into the first subchannel in the increasing order of logical subchannels until all logical subchannels are occupied. Then, the subsequent data elements if they have not all been mapped, shall be placed in the same order on the following OFDM symbols. The balance of the last OFDM symbols shall be padded with zeroz. The modulation and coding schemes for the padding zeros are defined by the DIUC for the last DS burst in the Relay DS-MAP. Relay DS-MAP indicates the length of the contiguous Relay DS MAC elements in the relay downstream subframe.

The MAC data elements that are contained in upstream bursts shall be mapped to the US subframe in a different order as shown in Figure 13. They are first mapped horizontally, OFDM symbol by OFDM symbol, in the same logical subchannel. Once a logical subchannel has been filled to the end of the upstream subframe, the balance of the MAC data elements shall be mapped to the next logical subchannel, in an increasing subchannel order. This process continues until all of the subchannels and symbols allocated to the burst are filled. If the quantity of MAC data elements is insufficient to fill an upstream burst so that an integer number of OFDMA slots is occupied once encoded, zero padding shall be inserted at the end.

Alternatively, the horizontal laying of the MAC data elements may fill one subchannel with at least 7 OFDM symbols at a time and continue on the following subchannels. However, when all logical subchannels have been filled, the next MAC data elements shall be placed in the first available logical subchannel in the following burst. The width of the last vertical burst will be between 7 and 13 symbols depending on the total number of symbols in the upstream subframe.

The long upstream packet structure, where a logical subchannel is completely filled before moving to the next subchannel, is used to maximize the allowed power per subcarrier for a given CPE EIRP limit, i.e., this horizontal laying reduces the EIRP required by the CPE for its upstream burst by minimizing the number of subchannels needed. In the upstream, the shorter burst alternative shown in Figure 13 is used to reduce latency by allowing advance of the US burst in the US subframe to give the base station time to react before the start of the next frame, at the cost of reduced transmit power and efficiency (e.g., video game near real-time versus transmission efficiency).

If the relay upstream subframe is appeared in the upstream subframe, the relay upstream subframe may be appeared followed by the upstream subframe in the MAC frame. The MAC data elements that are contained in relay upstream bursts shall be mapped to the relay US subframe in the same order of US subframe mapping.

The format of the FCH MAC burst is described in 7.5.2. The FCH is modulated using the data mode selected (e.g., Mode 4 or 5, see Table 202). Binary convolutional coding (BCC, 9.7.2.1) shall also be applied to the FCH burst. The FCH specifies the burst profile and the length of either the DS-MAP, the Relay DS-MAP, if transmitted, the US-MAP, or the Relay US-MAP. If neither, the DS-MAP, the Relay DS-MAP, the US-MAP, nor the Relay US-MAP is transmitted, the value shall be set to zero. The DS-MAP message, if transmitted, shall be the first MAC PDU in the burst following the FCH. A US-MAP message, if transmitted, shall immediately follow either the DS-MAP message, if transmitted, or the FCH. The Relay DS-MAP message, if transmitted, shall be immediately follow either the DS-MAP message or the FCH. The Relay US-MAP message, if transmitted shall be immediately follow either the Relay DS-MAP message, if transmitted, or the Relay US-MAP message. The Relay DS-MAP shall not be appeared without the being DS-MAP and the Relay US-MAP shall not be appeared without being the US-MAP. If DCD UCD, Realy DCD and Relay UCD messages are transmitted in the frame, they shall immediately follow the DS-MAP, US-MAP, Relay DS-MAP and Relay US-MAP messages. The symbols containing these broadcast MAC control messages shall be modulated using data mode 5 as described in Table 202 with the mandatory BCC mode (see 9.7.2.1).

In the upstream direction, if a CPE does not have any data to transmit in its US allocation, it shall transmit an US PHY burst containing a generic MAC header (see 7.6.1.1) with its basic FID, together with a Bandwidth Request subheader (see 7.6.1.2.1). This would allow the BS to reclaim this CPE’s allocation in the following frames and use the resource for some other purpose.

In the upstream direction, if a CPE does not have any data to transmit in its relay US allocation, it shall transmit an US PHY burst containing a generic MAC header (see 7.6.1.1) with its basic FID, together with a Bandwidth Request subheader (see 7.6.1.2.1). This would allow the MR-BS to reclaim this CPE’s allocation in the following frames and use the resource for some other purpose.

The MR-BS may schedule up to eight types of contention windows (see 7.13): the Initial Ranging window is used for initializing the association; the periodic ranging window is used for regularly adjusting the timing and power at the CPE; the BW request window is for CPEs to request upstream bandwidth allocation from the BS; the UCS notification window is used by CPEs to report an urgent coexistence situation with incumbents; the relay initial ranging window is used for initializing the association by relaying; the relay periodic ranging window is used for regularly adjusting the timing and power at the CPE for relaying; the relay BW request window is for CPEs to request relay upstream bandwidth allocation from the MR-BS; the UCS notification window is used for CPEs to report an urgent coexistence situation with incumbents; while the SCW is employed by CBP packets for signaling information to adjacent and overlapping WRAN cells for the purpose of self-coexistence, signal the device identification for resolving interference situations with incumbents when requested by local regulation, and for carrying out terrestrial geolocation between CPEs of the same WRAN cell. However, CBP burst transmissions for terrestrial geolocation purpose shall have lower priority than any other coexistence transmission on the CBP burst

**.4.x.x IEEE 802.22b general frame structure on distributed scheduling mode**



Each of the downstream and upstream subframes for a distributed scheduling mode may be separated of two parts: downstream and local downstream subframes and upstream and local upstream subframes. Downstream and upstream subframes are used for transmission between MR-BS and CPEs, while relay downstream and upstream subframes are used for transmission between R-CPE and S-CPEs.

For a distributed scheduling mode, the local downstream and upstream subframes are controlled by an R-CPE, which is capable of configurating and maintaining a local cell within an 802.22b WRAN cell.



At the beginning of every frame, the MR-BS shall transmit the frame preamble and the FCH on the operating channel using the modulation/coding specified in 9.4.1.2 and Table 202 respectively. In order to associate with an MR-BS, a CPE must receive the FCH to establish communication with the MR-BS. During each MAC frame, the MR-BS shall manage the upstream and downstream operations, which may include ordinary data communication, measurement activities, coexistence procedures, and so on.

For local cell operations within an 802.22b WRAN, the MR-BS may provide a local downstream subframe for an R-CPE, which is capable of managing a local cell. During a local downsteam subframe, the R-CPE (distributed scheduling R-CPE) shall transmit the local frame preamble and the local FCH (L-FCH) on the operating channel using the modulation/coding specified in 9.4.1.2 and Table 202 respectively. In order to associated with the distributed scheduling R-CPE, a CPE must receive the L-FCH to establish communication with the distributed scheduling R-CPE. During the local downstream and upstream subframes, the distributed scheduling R-CPE shall manage the upstream and downstream operations within its cell, which may include ordinary data communication, measurement activities, coexistence procedures, and so on.

The upstream subframe may contain scheduled upstream PHY PDUs, each transmitted from different CPEs for their upstream traffic to the MR-BS. It may also include contention intervals scheduled for the following:

CPE association (initial ranging)

CPE link synchronization, power control and geolocation (periodic ranging)

Bandwidth request

Urgent coexistence situation (UCS) notification

Quiet period resource adjustment

The local upstream subframe may contain scheduled upstream PHY PDUs, each transmitted from different CPEs for their upstream traffic to the R-CPE. It may also include contention intervals scheduled for the following:

CPE local association (local initial ranging)

CPE local link synchronization, power control and geolocation (local periodic ranging)

Local bandwidth request

Local urgent coexistence situation (UCS) notification

Quiet period resource adjustment

The PHY PDUs depicted in Figure 12 may be transmitted across several subchannels as shown in Figure 13, which depicts how a frame may be transmitted (in time and frequency) by the PHY layer.

Figure 13 shows an example of the two-dimensional (time/frequency) structure of the MAC frame that shall consist of an integer number of fixed size OFDM slots. Each slot shall consist of one OFDM symbol by one subchannel (i.e., 1 OFDM slot = 1 symbol × 1 subchannel). To help understand Figure 13, the MAC packets are assumed to be structured in a linear TDM manner (see Figure 12) while the PHY packets are arranged in a two-dimensional time/frequency domain (symbol in the horizontal direction, logical subchannels in the vertical direction). For the FCH, the DS/US-MAP, the DCD, and UCD, as well as for the downstream payload, the MAC information is first laid vertically by subchannels then stepped horizontally in the time direction. For the L-FCH, the L-MAP, the L-DCD /UCD on the distributed scheduling mode, the MAC information is first laid vertically by subchannels then stepped horizontally in the time direction. This vertical layering allows early scheduling of DS bursts assigned to distant CPEs to compensate for propagation delays and to avoid potential interference at the CPE in the case of overlapping WRAN cells with different DS/US capacity split.

The MAC data elements from Figure 12, starting from the FCH and including the first broadcast burst, shall be entered into the second OFDM symbol, as shown in Figure 13, in the increasing order of logical subchannels until all logical subchannels are occupied. Then, the subsequent data elements, if they have not all been mapped, shall be placed in the same order on the following OFDM symbols. The balance of the last OFDM symbols shall be padded with zeros. The modulation and coding schemes for the padding zeros are defined by the DIUC for the last DS burst in the DS-MAP. Note that the DS-MAP indicates the length of the contiguous DS MAC elements, not their absolute position in the DS subframe.

If the local downstream subframe is appeared in the downstream subframe, the local downstream subframe shall be appeared followed by the downstream subframe in the MAC frame. The MAC data bursts in the local downstream subframe shall be entered into the first subchannel in the increasing order of logical subchannels until all logical subchannels are occupied. Then, the subsequent data elements if they have not all been mapped, shall be placed in the same order on the following OFDM symbols. The balance of the last OFDM symbols shall be padded with zeroz. The modulation and coding schemes for the padding zeros are defined by the DIUC for the last DS burst in the Local DS-MAP. Local DS-MAP indicates the length of the contiguous DS MAC elements in the local downstream subframe.

The MAC data elements that are contained in upstream bursts shall be mapped to the US subframe in a different order as shown in Figure 13. They are first mapped horizontally, OFDM symbol by OFDM symbol, in the same logical subchannel. Once a logical subchannel has been filled to the end of the upstream subframe, the balance of the MAC data elements shall be mapped to the next logical subchannel, in an increasing subchannel order. This process continues until all of the subchannels and symbols allocated to the burst are filled. If the quantity of MAC data elements is insufficient to fill an upstream burst so that an integer number of OFDMA slots is occupied once encoded, zero padding shall be inserted at the end.

Alternatively, the horizontal laying of the MAC data elements may fill one subchannel with at least 7 OFDM symbols at a time and continue on the following subchannels. However, when all logical subchannels have been filled, the next MAC data elements shall be placed in the first available logical subchannel in the following burst. The width of the last vertical burst will be between 7 and 13 symbols depending on the total number of symbols in the upstream subframe.

The long upstream packet structure, where a logical subchannel is completely filled before moving to the next subchannel, is used to maximize the allowed power per subcarrier for a given CPE EIRP limit, i.e., this horizontal laying reduces the EIRP required by the CPE for its upstream burst by minimizing the number of subchannels needed. In the upstream, the shorter burst alternative shown in Figure 13 is used to reduce latency by allowing advance of the US burst in the US subframe to give the base station time to react before the start of the next frame, at the cost of reduced transmit power and efficiency (e.g., video game near real-time versus transmission efficiency).

If the local upstream subframe is appeared in the upstream subframe, the local upstream subframe shall be appeared followed by the upstream subframe in the MAC frame. The MAC data elements that are contained in local upstream bursts shall be mapped to the local US subframe in the same order of US subframe mapping.

Alternatively, the horizontal laying of the MAC data elements may fill one subchannel with at least 7 OFDM symbols at a time and continue on the following subchannels. However, when all logical subchannels have been filled, the next MAC data elements shall be placed in the first available logical subchannel in the following burst. The width of the last vertical burst will be between 7 and 13 symbols depending on the total number of symbols in the local upstream subframe.

The long upstream packet structure, where a logical subchannel is completely filled before moving to the next subchannel, is used to maximize the allowed power per subcarrier for a given CPE EIRP limit, i.e., this horizontal laying reduces the EIRP required by the CPE for its upstream burst by minimizing the number of subchannels needed. In the upstream, the shorter burst alternative shown in Figure 13 is used to reduce latency by allowing advance of the US burst in the US subframe to give the R-CPE time to react before the start of the next frame, at the cost of reduced transmit power and efficiency (e.g., video game near real-time versus transmission efficiency).

The format of the L-FCH MAC burst is described in 7.5.2. The L-FCH is modulated using the data mode selected (e.g., Mode 4 or 5, see Table 202). Binary convolutional coding (BCC, 9.7.2.1) shall also be applied to the L-FCH burst. The L-FCH specifies the burst profile and the length of either the L-DS-MAP, if transmitted, or the L-US-MAP. If neither, the L-DS-MAP nor the L-US-MAP is transmitted, the value shall be set to zero. The L-DS-MAP message, if transmitted, shall be the first MAC PDU in the burst following the L-FCH. A L-US-MAP message, if transmitted, shall immediately follow either the L-DS-MAP message, if transmitted, or the L-FCH. If L-DCD and L-UCD messages are transmitted in the frame, they shall immediately follow the L-DS-MAP and L-US-MAP messages. The symbols containing these broadcast MAC control messages shall be modulated using data mode 5 as described in Table 202 with the mandatory BCC mode (see 9.7.2.1).

In the upstream direction, if a CPE does not have any data to transmit in its local US allocation, it shall transmit an US PHY burst containing a generic MAC header (see 7.6.1.1) with its basic FID, together with a Bandwidth Request subheader (see 7.6.1.2.1). This would allow the MR-BS to reclaim this CPE’s allocation in the following frames and use the resource for some other purpose. (Centralized Scheduling Mode)

In the upstream direction, if a CPE does not have any data to transmit in its local US allocation, it shall transmit an US PHY burst containing a generic MAC header (see 7.6.1.1) with its basic FID, together with a Local Bandwidth Request subheader (see 7.6.1.2.1). This would allow the R-CPE to reclaim this CPE’s allocation in the following frames and use the resource for some other purpose. (Distributed Scheduling Mode)

The distributed scheduling R-CPE may schedule up to four types of contention windows (see 7.13): the local Initial Ranging window is used for initializing the association; the local periodic ranging window is used for regularly adjusting the timing and power at the CPE; the local BW request window is for CPEs to request local upstream bandwidth allocation from the dirstibuted scheduling R-CPE; the UCS notification window is used by CPEs to report an urgent coexistence situation with incumbents.



**7.5.2 Frame Control header**

**Table 2 — Frame control header format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| Frame\_Control\_Header\_Format() { |  |  |
| Length of FCH | X bits | Indicates the length of FCH |
| Length of the frame | 6 bits | Indicates the length of the frame in number  of OFDM symbols from the start of the frame including all preambles. |
| Length of the MAP message | 10 bits | This field specifies the length of the MAP  information element following the FCH in  OFDM slots. A length of 0 (zero) indicates the absence of any burst in the frame. |
| DL subframe configuration | variable |  |
| UL subframe configuration | variable |  |
| HCS | 8 bits | Header Check Sequence  See Table 3. |
| } |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Syntax** | **Type** | **Length** | **Value** | **Scope** |
| DL subframe configuration |  | 17 bits | Number of zones (4bits)  for(j=0; j < Number of zones; j++)  {  Zone mode (1bit)  OFDMA Symbol Offset (7bits)  Zone Duration (5 bits)  } |  |
| UL subframe configuration |  | 17 bits | Number of zones (4bits)  for(j=0; j < Number of zones; j++)  {  Zone mode (1bit)  OFDMA Symbol Offset (7bits)  Zone Duration (5 bits)  } |  |

|  |  |  |
| --- | --- | --- |
| **Value** | **Size** | **Note** |
| Number of zones | 4 bits | First zone refers always to access zone for DL / UL subframe configuration |
| Zone mode | 1 bit | 0 : access zone 1: relay zone |
| OFDMA symbol offset | 7 bits | The zone starts at the OFDMA symbol offset, counted after the preamble of the frame |
| Zone duration | 5 bits | The zone ends after the duration starting frame the OFDMA sysmbol offest. The unit of duration is an OFDMA symbol |

Example of subframe configuration

**7.7 Management messages**

As can be seen in Table 19, the MAC defines a collection of management messages to support and implement its basic functions. All these messages are carried in the payload of a MAC PDU, and share the same message structure as depicted in Figure 15. Management messages begin with a Type field that uniquely identifies the message in question, while its payload varies according to the message type. As for transmission, management messages can only be transmitted in Initial Ranging, Basic, Primary, Multicast Management, or Broadcast type of FIDs (see Table 279, Table 280, and Table 281). No other types of FIDs shall carry management messages.

Type (8-bit) Payload (variable)

**Figure 15 — General management message structure**

Each of the management messages shown in Table 19 are described in the following subclauses.

**Table 19 — Management messages**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Type** | **Message** | **Description** | **Reference** | **Class of connection** |
| 0 | DCD | Downstream Channel Descriptor | 7.7.1 | Broadcast |
| 1 | DS-MAP | Downstream Access Definition | 7.7.2 | Broadcast |
| 2 | UCD | Upstream Channel Descriptor | 7.7.3 | Broadcast |
| 3 | US-MAP | Upstream Access Definition | 7.7.4 | Broadcast |
| 4 | RNG-REQ | Ranging Request | 7.7.5 | Initial Ranging or Basic |
| 5 | RNG-CMD | Ranging Command | 7.7.6 | Initial Ranging or Basic |
| 6 | REG-REQ | Registration Request | 7.7.7.1 | Primary Management |
| 7 | REG-RSP | Registration Response | 7.7.7.2 | Primary Management |
| 8 | DSA-REQ | Dynamic Service Addition Request | 7.7.8.1 | Primary Management |
| 9 | DSA-RSP | Dynamic Service Addition Response | 7.7.8.2 | Primary Management |
| 10 | DSA-ACK | Dynamic Service Addition  Acknowledge | 7.7.8.3 | Primary Management |
| 11 | DSC-REQ | Dynamic Service Change Request | 7.7.8.4 | Primary Management |
| 12 | DSC-RSP | Dynamic Service Change Response | 7.7.8.5 | Primary Management |
| 13 | DSC-ACK | Dynamic Service Change  Acknowledge | 7.7.8.6 | Primary Management |
| 14 | DSD-REQ | Dynamic Service Deletion Request | 7.7.8.7 | Primary Management |
| 15 | DSD-RSP | Dynamic Service Deletion Response | 7.7.8.8 | Primary Management |
| 16 | DSX-RVD | Dynamic Service Request  acknowledgement before authentication | 7.7.8.10 | Primary Management |
| 17 | MCA-REQ | Multicast Assignment Request | 7.7.9 | Primary Management |
| 18 | MCA-RSP | Multicast Assignment Response | 7.7.10 | Primary Management |
| 19 | CBC-REQ | CPE Basic Capability Request | 7.7.11.1 | Basic |
| 20 | CBC-RSP | CPE Basic Capability Response | 7.7.11.2 | Basic |
| 21 | DREG-CMD | De/Re-register Command | 7.7.12 | Basic  Primary Management |
| 22 | DREG-REQ | CPE De-registration Request | 7.7.13 | Primary Management |
| 23 | ARQ-  Feedback | Standalone ARQ Feedback | 7.7.14 | Primary Management |
| 24 | ARQ-Discard | ARQ Discard | 7.7.15 | Primary Management |
| 25 | ARQ-Reset | ARQ Reset | 7.7.16 | Primary Management |
| 26 | CHS-REQ | Channel Switch Request | 7.7.17.1 | Primary Management or  Broadcast |
| 27 | CHS-RSP | Channel Switch Response | 7.7.17.2 | Primary Management |
| 28 | CHQ-REQ | Channel Quiet Request | 7.7.17.3 | Primary Management,  Multicast Management or  Broadcast |
| 29 | CHQ-RSP | Channel Quiet Response | 7.7.17.4 | Primary Management,  Multicast Management or  Broadcast |
| 30 | IPC-UPD | Incumbent Prohibited Channels  Update | 7.7.17.4 | Primary Management,  Multicast Management or  Broadcast |
| 31 | BLM-REQ | Bulk Measurement Request | 7.7.18.1 | Primary Management,  Multicast Management or  Broadcast |
| 32 | BLM-RSP | Bulk Measurement Response | 7.7.18.2 | Primary Management |
| 33 | BLM-REP | Bulk Measurement Report | 0 | Primary Management |
| 34 | BLM-ACK | Bulk Measurement Acknowledgement | 7.7.18.4 | Primary Management |
| 35 | TFTP-CPLT | Config File TFTP Complete | 0 | Primary Management |
| 36 | TFTP-RSP | Config File TFTP Complete Response | 0 | Primary Management |
| 37 | SCM-REQ | Security Control Management Request | 0 | Primary Management |
| 38 | SCM-RSP | Security Control Management  Response | 0 | Primary Management |
| 39 | FRM\_UPD | The first active frame allocation  update in self-coexistence mode | 7.7.22 | Basic |
| 40 | CBP -RLY | CBP Relay | 7.7.23 | Primary Management,  Multicast Management |

**7.7.1 Downstream Channel Descriptor (DCD)**

The format of a DCD message is shown in Table 20. This message shall be transmitted by the BS at a periodic interval (Table 273) to define the characteristics of a downstream physical channel.

**Table 20 — DCD message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| DCD\_Message\_Format() { |  |  |
| Management Message Type = 0 | 8 bits |  |
| Configuration Change Count | 8 bits | Incremented by one (modulo 256) by the BS whenever any  of the values of this channel descriptor change. If the value of this count in a subsequent DCD remains the same, the CPE can quickly decide that the remaining fields have not changed and may be able to disregard the remainder of the message. This value is also referenced from the DS-MAP messages (see Table 25). |
| DCD Channel Information Elements  (IEs) | Variable  in integer number  of bytes | Table 21 |
| Begin PHY Specific Section { |  |  |
| Number of downstream burst profiles:  n | 6 bits | Number of burst profiles described in the current DCD  message. Its maximum size corresponds to the maximum number of DIUC burst profiles contained in Table 27. |
| *Reserved* | 2 bits | All bits shall be set to zero. |
| for (*i* = 1; *i*  n; *i*++) { |  | “n” is defined as the “Number of downstream burst profiles”  to be described in the current DCD message. |
| Downstream\_Burst\_Profile | Variable | PHY specific (Table 23). |
| } |  |  |
| } |  |  |
| } |  |  |

**7.7.1.1 DCD Channel information elements**

The elements in Table 21 are the allowed information elements that can be included in the DCD message.

**Table 21 — DCD channel information elements**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Element**  **ID**  **(1 byte)** | **Length** | **Description** |
| Downstream\_Burst\_Pr  ofile | 1 | Variable | Value reserved for the burst profile (see Table 23) |
| EIRPBS | 2 | 8 | Signed in units of dBm in 0.5 dB steps with a range from –64  dBm (encoded 0x00) to +63.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme. |
| TTG | 3 | 8 | 0x00–0xFF: range of TTG in 2.75 μs increments. Default set  to 0x4D to allow for 210 μs for 30 km propagation. |
| RSSIR\_BS\_nom | 4 | 8 | Initial ranging nominal signal strength per subcarrier to be  received at the BS by a 0 dBi antenna gain, i.e., corrected for the gain of the BS receive antenna in the direction of the CPE  and for 0 coupling and cable loss (see 7.14.2.8.1). Signed in  units of dBm in 0.5 dB steps ranging from –104 dBm (encoded  0x00) to +23.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme. |
| Channel Action | 5 | 3 | Action to be taken by all CPEs in a cell.  000: None  001: Switch  010–111: *Reserved* |
| Action Mode | 6 | 1 | This is valid only for channel switch (Action = 001).  Indicates a restriction on transmission until the specified  Channel Action is performed. The BS shall set the Action Mode field to either 0 or 1 on transmission. A value of 1 means that the CPE to which the frame containing this element is addressed shall transmit no further frames until the scheduled Channel Action is performed. An Action Mode set to 0 does not impose any requirement on the receiving CPE. |
| Action Superframe  Number | 7 | 8 | The superframe number (modulo 256) at which Channel  Action shall be performed. |
| Action Frame Number | 8 | 4 | Integer value greater than or equal to zero that indicates the  starting frame number, within the Action Superframe Number, at which the Channel Action shall be performed by all CPEs. |
| Number of Backup  channels | 9 | 4 | Number of backup channels in the backup and candidate  channel list IE (see Table 22). |
| Backup and Candidate  channel list. | 10 | Variable | See Table 22 for specification. |
| MAC version | 11 | 8 | IEEE 802.22 MAC version to which the message originator  conforms.  0x01: IEEE Std 802.22  0x02–0xFF: *Reserved* |

**(bits)**

**Table 22 — Backup and Candidate channel list**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| Backup\_and\_candidate\_channel\_list\_IE\_Format() { |  |  |
| Element ID = 10 | 8 bits |  |
| Length | 8 bits |  |
| Number of Channels in the list | 8 bits |  |
| For (*i*=0; *i* < Number of Channels in the list; *i*++) { |  | List of backup channels in order of priority to be  used by CPEs in case of loss of communication with the BS due to incumbents. This list may also include candidate channels, in which case they will follow the backup channels in the list, and will also be included in order of priority. The number of backup channels in the list is |

|  |  |  |
| --- | --- | --- |
|  |  | indicated in DCD Element ID 9 (see Table 21).  The list shall be a disjoint set with the current operating channel. |
| Channel Number [i] | 8 bits |  |
| } |  |  |
| } |  |  |

**7.7.1.2 Downstream burst profile**

**Table 23 — Downstream burst profile format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| Downstream\_Burst\_Profile\_Format() { |  |  |
| Type = 1 | 8 bits |  |
| Length | 8 bits |  |
| DIUC | 6 bits | 7.7.2.1.1 |
| *Reserved* | 2 bits | All bits shall be set to zero |
| Information elements (IEs) | Variable | Table 24 |
| } |  |  |

**Table 24 — Downstream Burst Profile information elements**

**(bytes)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Element ID (1 byte)** | **Length** | **Description** |
| DIUC mandatory exit  threshold | 151 | 1 | –64 dB (encoded 0x00) to +63.5 dB (encoded 0xFF)  CINR at or below which this DIUC can no longer be used and where change to a more robust DIUC is required (in 0.5 dB units). |
| DIUC minimum entry  threshold | 152 | 1 | –64 dB (encoded 0x00) to +63.5 dB (encoded 0xFF)  The minimum CINR required to start using this DIUC when changing from a more robust DIUC is required (in 0.5 dB  units) |

**7.7.2 Downstream Map (DS-MAP)**

The format of a DS-MAP message is shown in Table 25. The DS-MAP message defines the access to the downstream information in access zone. The length of the DS-MAP shall be an integer number of bytes.

**Table 25 — DS-MAP message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| DS-MAP\_Message\_Format() { |  |  |
| Management Message Type = 1 | 8 bits |  |
| DCD Count | 8 bits | Matches the value of the configuration  change count of the DCD, which describes the downstream burst profiles  that apply to this map. |
| Begin PHY Specific Section { |  |  |
| Number of IEs: n | 12 bits | Number of IEs in the downstream map |
| for (*i* = 1; *i*  n; i++) { |  |  |
| DS-MAP\_IE() | Variable | PHY specific (7.7.2.1) |
| } |  |  |
| } |  |  |
| If(!byte\_boundary) |  |  |
| Padding bits | 0–7 bits | Padding to octet alignment—All bits  shall be set to 0. |
| } |  |  |



**7.7.2.1 DS-MAP IE**

The format of the DS-MAP IE is shown in Table 26.

**Table 26 — DS-MAP information elements**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Description** |
| DS-MAP\_IE() { |  |  |
| DIUC | 6 bits | 7.7.2.1.1 |
| If (DIUC == 62) |  |  |
| Extended DIUC Dependent IE | Variable | 7.7.2.1.2 |
| else { |  |  |
| SID | 9 bits | Station ID of CPE or multicast group. |
| } |  |  |
| Length | 12 bits | Number of OFDM slots linearly allocated to the DS  burst specified by this IE. |
| Boosting | 3 bits | 111: +9 dB  110: +6 dB  101: +3 dB  100: 0 dB, normal (not boosted)  011: –3 dB  010: –6 dB  001: –9 dB  000: –12 dB |
| } |  |  |
| } |  |  |

**7.7.2.1.1 DIUC allocations**

Table 27 illustrates the various DIUC values used in the MAC.

**Table 27 — DIUC values**

|  |  |  |  |
| --- | --- | --- | --- |
| **DIUC** | **Usage** | | |
| 0–12 | *Reserved* | | |
| 13 | Uncoded | NA | BPSK |
| 14 | Convolutional Code | FEC rate = 1/2 | QPSK |
| 15 | Convolutional Code | FEC rate = 2/3 | QPSK |
| 16 | Convolutional Code | FEC rate = 3/4 | QPSK |
| 17 | Convolutional Code | FEC rate = 5/6 | QPSK |
| 18 | Convolutional Code | FEC rate = 1/2 | 16-QAM |
| 19 | Convolutional Code | FEC rate = 2/3 | 16-QAM |
| 20 | Convolutional Code | FEC rate = 3/4 | 16-QAM |
| 21 | Convolutional Code | FEC rate = 5/6 | 16-QAM |
| 22 | Convolutional Code | FEC rate = 1/2 | 64-QAM |
| 23 | Convolutional Code | FEC rate = 2/3 | 64-QAM |
| 24 | Convolutional Code | FEC rate = 3/4 | 64-QAM |
| 25 | Convolutional Code | FEC rate = 5/6 | 64-QAM |
| 26 | CTC | FEC rate = 1/2 | QPSK |
| 27 | CTC | FEC rate = 2/3 | QPSK |
| 28 | CTC | FEC rate = 3/4 | QPSK |
| 29 | CTC | FEC rate = 5/6 | QPSK |
| 30 | CTC | FEC rate = 1/2 | 16-QAM |
| 31 | CTC | FEC rate = 2/3 | 16-QAM |
| 32 | CTC | FEC rate = 3/4 | 16-QAM |
| 33 | CTC | FEC rate = 5/6 | 16-QAM |
| 34 | CTC | FEC rate = 1/2 | 64-QAM |
| 35 | CTC | FEC rate = 2/3 | 64-QAM |

|  |  |  |  |
| --- | --- | --- | --- |
| **DIUC** | **Usage** | | |
| 36 | CTC | FEC rate = 3/4 | 64-QAM |
| 37 | CTC | FEC rate = 5/6 | 64-QAM |
| 38 | LDPC | FEC rate = 1/2 | QPSK |
| 39 | LDPC | FEC rate = 2/3 | QPSK |
| 40 | LDPC | FEC rate = 3/4 | QPSK |
| 41 | LDPC | FEC rate = 5/6 | QPSK |
| 42 | LDPC | FEC rate = 1/2 | 16-QAM |
| 43 | LDPC | FEC rate = 2/3 | 16-QAM |
| 44 | LDPC | FEC rate = 3/4 | 16-QAM |
| 45 | LDPC | FEC rate = 5/6 | 16-QAM |
| 46 | LDPC | FEC rate = 1/2 | 64-QAM |
| 47 | LDPC | FEC rate = 2/3 | 64-QAM |
| 48 | LDPC | FEC rate = 3/4 | 64-QAM |
| 49 | LDPC | FEC rate = 5/6 | 64-QAM |
| 50 | SBTC | FEC rate = 1/2 | QPSK |
| 51 | SBTC | FEC rate = 2/3 | QPSK |
| 52 | SBTC | FEC rate = 3/4 | QPSK |
| 53 | SBTC | FEC rate = 5/6 | QPSK |
| 54 | SBTC | FEC rate = 1/2 | 16-QAM |
| 55 | SBTC | FEC rate = 2/3 | 16-QAM |
| 56 | SBTC | FEC rate = 3/4 | 16-QAM |
| 57 | SBTC | FEC rate = 5/6 | 16-QAM |
| 58 | SBTC | FEC rate = 1/2 | 64-QAM |
| 59 | SBTC | FEC rate = 2/3 | 64-QAM |
| 60 | SBTC | FEC rate = 3/4 | 64-QAM |
| 61 | SBTC | FEC rate = 5/6 | 64-QAM |
| 62 | Extended DIUC | | |
| 63 | End of Map | | |

**7.7.2.1.2 DS-MAP Extended DIUC IE**

A DS-MAP IE entry with a DIUC value of 62 indicates that the IE carries special information and conforms to the structure shown in Table 28. A CPE shall ignore an extended IE entry with an extended DIUC value for which the CPE has no knowledge. In the case of a known extended DIUC value but with a length field longer than expected, the CPE shall process information up to the known length and ignore the remainder of the IE.

**Table 28 — DS-MAP Extended IE general format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| DS\_Extended\_IE() { |  |  |
| Extended DIUC | 6 bits |  |
| Length | 8 bits | Length of this IE in bits. |
| Unspecified Data | Variable |  |
| } |  |  |

**7.7.2.1.2.1 DS-MAP Dummy Extended IE**

A CPE shall be able to decode the DS-MAP Dummy Extended IE. A BS shall not transmit this IE (unless under test). A CPE may skip decoding downlink bursts scheduled after the start time of this IE within the current frame.

**Table 29 — DS-MAP Dummy Extended IE format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| Dummy\_IE() { |  |  |
| Extended DIUC | 6 bits | 0x00 |
| Length | 8 bits | Length of this IE in bits. |
| Unspecified Data | Variable |  |
| } |  |  |

**7.7.2 Relay Downstream Map (RDS-MAP)**

The format of a RDS-MAP message is shown in Table xx. The RDS-MAP message defines the access to the downstream information in relay zone. The length of the RDS-MAP shall be an integer number of bytes.

**Table xx — RDS-MAP message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| RDS-MAP\_Message\_Format() { |  |  |
| Management Message Type = x | 8 bits |  |
| DCD Count | 8 bits | Matches the value of the configuration  change count of the DCD, which describes the downstream burst profiles  that apply to this map. |
| Relay Zone Index | 4 bits | Indicates the index of relay zone |
| Begin PHY Specific Section { |  |  |
| Number of IEs: n | 12 bits | Number of IEs in the downstream map |
| for (*i* = 1; *i*  n; i++) { |  |  |
| RDS-MAP\_IE() | Variable | PHY specific (7.7.2.1) |
| Relay Zone Mode | 1 bits | 0: centralized relay mode  1: distributed relay mode |
| If(Relay Zone Mode ==1){ |  |  |
| Used segment bitmap | 4 bits | Bit0: No segment  Bit1: Segment 0  Bit2: Segment 1  Bit3: Segment 2 |
| } |  |  |
| } |  |  |
| } |  |  |
| If(!byte\_boundary) |  |  |
| Padding bits | 0–7 bits | Padding to octet alignment—All bits  shall be set to 0. |
| } |  |  |

**7.7.2.1 RDS-MAP IE**

The format of the RDS-MAP IE is shown in Table xx.

**Table 26 — RDS-MAP information elements**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Description** |
| RDS-MAP\_IE() { |  |  |
| DIUC | 6 bits | 7.7.2.1.1 |
| If (DIUC == 62) |  |  |
| Extended DIUC Dependent IE | Variable | 7.7.2.1.2 |
| else { |  |  |
| SID | 9 bits | Station ID of CPE, multicast group, local group. |
| } |  |  |
| Length | 12 bits | Number of OFDM slots linearly allocated to the DS  burst specified by this IE. |
| Boosting | 3 bits | 111: +9 dB  110: +6 dB  101: +3 dB  100: 0 dB, normal (not boosted)  011: –3 dB  010: –6 dB  001: –9 dB  000: –12 dB |
| } |  |  |
| } |  |  |



**7.7.3 Upstream Channel Descriptor (UCD)**

The format of a UCD message is shown in Table 30. This message shall be transmitted by the BS at a periodic interval (Table 272) to define the characteristics of an upstream physical channel.

**Table 30 — UCD message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| UCD\_Message\_Format() { |  |  |
| Management Message Type = 2 | 8 bits |  |
| Configuration Change Count | 8 bits | Incremented by one (modulo 256) by the BS whenever any of  the values of this channel descriptor change. If the value of this count in a subsequent UCD remains the same, the CPE  can quickly decide that the remaining fields have not changed  and may be able to disregard the remainder of the message. This value is also referenced from the US-MAP messages (see  Table 34). |
| BW Request Backoff Start | 4 bits | Initial backoff window size in units of BW Request  opportunity (see Table 31) used by CPEs to contend to send BW requests to the BS, expressed as a power of 2. Values of *n* range 0–15.  Refer in the note to 6.16 on Contention Resolution.  Include a subsection that will describe the size and the content of the BW Request US burst and refer to it in the note. |
| BW Request Backoff End | 4 bits | Final backoff window size in units of BW Request  opportunity (see Table 39) to contend to send BW requests to the BS, expressed as a power of 2. Values of *n* range 0–15. All  declared opportunities for BW request in subsequent frames  are concatenated in this potentially large number. |
| UCS Notification Backoff Start | 4 bits | Initial backoff window size in units of UCS notification  opportunity (see Table 31) used by CPEs to contend to send  UCS notifications to the BS. This is expressed as a power of  2. Values of *n* range 0–15. |
| UCS Notification Backoff End | 4 bits | Final backoff window size in units of UCS notification  opportunity (see Table 31) used by CPEs to contend to send  UCS notifications to the BS. This is expressed as a power of  2. Values of *n* range 0–15. All declared opportunities for UCS Notifications in subsequent frames are concatenated in this  potentially large number. |
| Information elements (IEs) for the  overall channel | Variable | See 7.7.3.1. |
| Begin PHY Specific Section { |  |  |
| Number of upstream burst profiles:  *n* | 6 bits | Number of upstream burst profiles described in the current  UCD message. Its maximum size corresponds to the maximum number of UIUC burst profiles contained in Table  36. |
| for (*i* = 1; *i*  n; *i*++) { |  | n = number of upstream burst profiles |
| Upstream\_Burst\_Profile | Variable | PHY specific (Table 32) |
| } |  |  |
| } |  |  |
| } |  |  |

**7.7.3.1 UCD Channel IEs**

Common channel encodings are provided in Table 31.

**Table 31 — UCD channel information elements**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Element ID (1 byte)** | **Length**  **(bytes)** | **Description** |
| Upstream\_Burst\_Profile | 1 | Variable | Value reserved for the burst profile (see Table 32) |
| Contention-based  reservation timeout | 2 | 1 | Number of US-MAPs to receive before contention-based  reservation is attempted again for the same connection |
| Bandwidth request  opportunity size | 3 | 1 | Size (in OFDM slots) of PHY bursts, mapped  horizontally in one subchannel at a time as in the case of normal upstream data, that a CPE may use to format and  transmit a bandwidth request message in a contention  request opportunity. The value includes all PHY overhead as well as allowance for the BW Request MAC subheader that the message will hold (see Table 5). |
| UCS Notification request  opportunity size | 4 | 1 | Size (in OFDM slots) of PHY bursts, mapped  horizontally in one subchannel at a time as in the case of normal upstream data, that a CPE may use to transmit a  UCS notification. The value includes all PHY overhead  for the GMH containing the UCS flag (see Table 3). |
| Initial ranging codes | 150 | 1 | Number of initial ranging CDMA codes. Possible values  are 0–255. |
| Periodic ranging codes | 151 | 1 | Number of periodic ranging CDMA codes. Possible  values are 0–255. |
| Bandwidth request codes | 152 | 1 | Number of bandwidth request CDMA codes. Possible  values are 0–255. |
| UCS notification codes | 153 | 1 | Number of UCS notification CDMA codes. Possible  values are 0–255. |
| Start of CDMA codes  group | 154 | 1 | Indicates the starting number, S, of the group of codes  used for this upstream. All the ranging codes used on this upstream will be between S and (S+N+M+L+I) mod  256). Where:  N is the number of initial-ranging codes  M is the number of periodic-ranging codes  L is the number of bandwidth-request codes I is the number of UCS notification codes The range of values is 0 ≤ S ≤ 255. |
| Relay inital ranging codes | 155 | 1 | Number of initial ranging CDMA codes. Possible values  are 0–255. |
| Relay periodic ranging codes | 156 | 1 | Number of initial ranging CDMA codes. Possible values  are 0–255. |

**7.7.3.2 Upstream burst profile**

The format of the upstream burst profile is shown in Table 32, and the information elements contained in the upstream burst profiles are defined in Table 33.

**Table 32 — Upstream burst profile format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| Upstream\_Burst\_Profile\_Format() { |  |  |
| Type = 1 | 8 bits |  |
| Length | 8 bits |  |
| UIUC | 6 bits | Table 36 |
| *Reserved* | 2 bits | All bits shall be set to zero. |
| Information elements (IEs) | Variable | Table 33 |
| } |  |  |

**Table 33 — Upstream burst profile information elements**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Element ID (1 byte)** | **Length**  **(bytes)** | **Description** |
| Ranging data ratio | 151 | 1 | Reduction factor, in units of 0.5 dB, between the EIRP per  subcarrier used for this burst and the EIRP per subcarrier that should be used for CDMA Ranging. |
| Normalized CNR  override | 152 | 7 | The first byte shall represent a signed integer which specifies, in  dB, the first normalized CNR value in Table 228 (i.e., normalized  CNR value corresponding to the CDMA code).  Bytes 2–7: represent a list of numbers, where each number is encoded by one nibble, and is interpreted as a signed integer. The  number encoded by each nibble represents the difference, in dB,  in normalized CNR relative to the previous line in Table 228. Thus the left most nibble of the second byte corresponds to the difference between the normalized CNR value for QPSK, rate:  1/2, and the normalized CNR value for the CDMA code. |

**7.7.4 Upstream Map (US-MAP)**

The format of a US-MAP message is shown in Table 34. The US-MAP message defines the access to the upstream channel using US-MAP IEs.

**Table 34 — US-MAP message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| US-MAP\_Message\_Format() { |  |  |
| Management Message Type = 3 | 8 bits |  |
| UCD Count | 8 bits | Matches the value of the Configuration Change Count  of the UCD, which describes the upstream burst profiles that apply to this map. |
| Allocation Start Time | 6 bits | Effective start time (in OFDM symbols from the start  of the frame including all preambles) of the upstream allocation defined by the US-MAP. |
| Duration | 5 bits | The zone ends after allocation start time. The unit of duration is an OFDMA symbol |
| Begin PHY Specific Section { |  |  |
| Number of IEs: n | 12 bits | Number of IEs in the upstream map |
| for (*i* = 1; *i*  n; *i*++) { |  |  |
| US-MAP\_IE() | Variable | PHY specific (7.7.4.1)  Define upstream bandwidth allocations. Each US-MAP message shall contain at least one IE that marks the end of the last allocated burst. (UIUC=63 as defined in Table 36). |
| } |  |  |
| } |  |  |
| If(!byte\_boundary) |  |  |
| Padding bits | 0–7 bits | Padding to octet alignment—All bits shall be set to 0. |
| } |  |  |



**7.7.4.1 US-MAP IE**

The SID field carried by the US-MAP IE is associated with a unicast address. When specifically addressed to allocate a bandwidth grant, the FID shall be the Basic FID of the CPE. A UIUC shall be used to define the type of upstream access and the upstream burst profile associated with that access. An Upstream\_Burst\_Profile shall be included in the UCD for each UIUC to be used in the US-MAP. The beginning of the upstream subframe is clearly defined by the allocation start time, which corresponds to the number of symbols from the first preamble symbol of the current frame (e.g., superframe preamble or frame preamble) plus the width of the TTG (see Figure 12). The end of the upstream subframe is define either by the SCH in the case of the scheduling of an intra-frame quiet period or by the US-MAP when a SCW is scheduled at the end of the frame by the presence of UIUC’s 0 or 1 in the US-MAP.

The US-MAP IE is shown in Table 35, and is used to define the upstream bandwidth allocations. The first US-MAP IE shall start at the lowest numbered subchannel on the first non-allocated symbol defined by the allocation start time field of the US-MAP message. These IEs shall represent the number of OFDM slots provided for the allocation. Each allocation IE shall start immediately following the previous allocation and shall advance in the time domain. If the end of the US subframe has been reached, the allocation shall continue on the next subchannel at the first symbol (defined by the allocation start time field). The US subframe can also be defined in terms of columns as described in 7.3.2. A Burst Descriptor shall be specified in the UCD for each UIUC to be used in the US-MAP.

The SID field in this message can also refer to a group of CPEs, e.g., a multicast group. In this case, only UIUC = 0 or 1 shall be allowed to enable configuration of that group of CPEs to use an SCW (see 7.17.3 and 7.20.1.2).

**Table 35 — US-MAP information elements**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Description** |
| US-MAP\_IE() { |  |  |
| SID | 9 bits | Station ID of the CPE. |
| UIUC | 6 bits | 7.7.4.1.1 (see Table 36). |
| If ((UIUC 0) && (UIUC  1)) { |  |  |
| CBP Frame Number | 4 bits | Frame number where the active or passive CBP action is to take  place. If the identified frame falls in the next superframe (e.g., current frame is 9 and the CBP Frame Number is 4), the CPE shall make sure that a SCW is still scheduled for this frame as indicated by the upcoming SCH. If not, the CBP action shall be cancelled. |
| If(UIUC==0) { |  | Active SCW mode (CPE to transmit a CBP burst as requested by  the BS). |
| Timing advance | 16 bits | Signed number in TU corresponding to the advance of the  transmission of the CBP burst at the CPE. As the CPE starts to transmit the CBP burst as its fourth symbol before the end of the frame, zero advance corresponds to this signal being received by the BS at the beginning of its fourth symbol before the end of the frame when the CPE is co-located with the BS (see Table 44). |
| EIRP Density Level | 8 bits | EIRP per transmitted subcarrier (see 9.9.4.2). Signed in units of 0.5  dB, ranging from –104 dBm (encoded 0x00) to +23.5 dBm  (encoded 0xFF). |
| } |  |  |
| If(UIUC==1) { |  | Passive SCW mode (CPE to receive and demodulate the CBP burst  and send content to the BS). |
| Channel Number | 8 bits | Channel number in which the CPE shall listen to the medium for a  coexistence beacon. |
| Synchronization mode | 1 bit | = 0 The CPE will capture the CBP burst using its current  synchronization (i.e., locked to its BS) for geolocation purposes.  = 1 The CPE will re-synchronize on the received CBP burst using the preamble symbol and optionally pilot carriers to decode the payload for self-coexistence purposes. |
| } else if (UIUC =>2) && (UIUC =<3) ) { |  |  |
| Number of Subchannels | 4 bits | Number of subchannels reserved for the BW Request/UCS  Notification opportunistic window. |
| } else if (UIUC =>4) && (UIUC=<6) ) { |  |  |
| Number of Subchannels | 4 bits | Number of subchannels reserved for the CDMA Ranging/BW  Request/UCS notification opportunistic window. Note that in case where UIUC=8 and any UIUC in the range 4 to 6 are allocated to a |

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Description** |
|  |  | frame, the largest number of subchannel specified shall prevail.  Note also that when the CDMA ranging burst is to be used for terrestrially-based geolocation (see 10.5.2), the number of  subchannels shall be at least 6. |
| Number of symbols | 5 bits | Number of symbols in the US ranging channel reserved for the  opportunistic windows carrying either CDMA Periodic Ranging/BW Request/UCS notification as specified by the respective UIUC. These shall be placed in the ranging channel following the initial ranging window if scheduled and consecutively (see Figure 157). |
| } else if (UIUC == 7) { |  |  |
| CDMA\_ Allocation\_IE () | 20 bits | See 7.7.4.1.2. |
| } else if (UIUC == 8) { |  | The first 5 symbols of the upstream subframe shall be reserved for  the opportunistic initial ranging burst. |
| Number of Subchannels | 4 bits | Number of subchannels reserved for the initial ranging burst. Note  that in case where UIUC=8 and any UIUC in the range 4 to 6 are allocated to a frame, the largest number of claimed subchannels specified shall prevail. |
| } else if (UIUC == 9) { |  | US-MAP EIRP Control IE |
| US-MAP EIRP Control IE | Variable | See 7.7.4.1.3. |
| } else if (UIUC == 62) { |  |  |
| US\_Extended\_IE() | Variable | See 7.7.4.1.4. |
| } else { |  |  |
| Burst\_Type | 1 bit | This value specifies the burst type for the burst specified by this  US-MAP IE.  0: Bursts are mapped in the time axis over the full width of the upstream subframe before incrementing in the frequency axis.  1: Bursts are mapped in the time axis over segments of 7 symbols before incrementing in the frequency axis and then re-tracing to the lowest unused subchannel in the next 7 symbol segment. The width  of the last segment is to be between 7 and 13 symbols depending on the width of the upstream subframe. |
| Duration | 12 bits | Number of OFDM slots linearly allocated to the US burst specified  by this IE. (Up to 60 by 30 slots can be allocated to a US burst.) |
| MDP | 1 bit | Measurement Data Preferred  Used by the BS to indicate to the CPE that this upstream allocation is to be preferably used by the CPE for the specific purpose of  reporting back any measurement data. The measurement data to be  reported is in connection to the specified Transaction ID.  In case the CPE does not have anything to report, it can use this allocation for any other data. This is useful, for example, after a  quiet period.  0: Measurement data not required (default)  1: Measurement data preferred |
| MRT | 1 bit | Measurement Report Type  In case MDP == 1, this field indicates which type of report the BS  wants the CPE to send back.  0: Detailed (see 7.7.18.3.1.1 through 7.7.18.3.1.8)  1: Consolidated (see 7.7.18.3.1.9) |
| CMRP | 1 bit | Channel Management Response Preferred  Used by the BS to indicate to the CPE that this upstream allocation is to be used for confirming or not the receipt of the channel  management command with the Transaction ID specified.  0: Channel management response not required (default)  1: Channel management response required |
| } |  |  |
| } |  |  |
| } |  |  |

**7.7.4.1.1 UIUC allocations**

Table 36 specifies the UIUC incorporated into the MAC. In particular, the self-coexistence UIUCs (in both modes) have the same applicability to their DIUC counterpart (see 7.7.2.1.1).

**Table 36 — UIUC values**

|  |  |  |  |
| --- | --- | --- | --- |
| **UIUC** | **Usage** | | |
| 0 | Self-Coexistence (Active Mode) | | |
| 1 | Self-Coexistence (Passive Mode) | | |
| 2 | UCS Notification | | |
| 3 | BW Request | | |
| 4 | CDMA UCS Notification | | |
| 5 | CDMA BW Request | | |
| 6 | CDMA Periodic Ranging | | |
| 7 | CDMA Allocation IE (see Table 37) | | |
| 8 | CDMA Initial Ranging | | |
| 9 | US-MAP EIRP Control IE | | |
| 10-12 | Reserved | | |
| 13 | Uncoded | N/A | BPSK |
| 14 | Convolutional Code | FEC rate = 1/2 | QPSK |
| 15 | Convolutional Code | FEC rate = 2/3 | QPSK |
| 16 | Convolutional Code | FEC rate = 3/4 | QPSK |
| 17 | Convolutional Code | FEC rate = 5/6 | QPSK |
| 18 | Convolutional Code | FEC rate = 1/2 | 16-QAM |
| 19 | Convolutional Code | FEC rate = 2/3 | 16-QAM |
| 20 | Convolutional Code | FEC rate = 3/4 | 16-QAM |
| 21 | Convolutional Code | FEC rate = 5/6 | 16-QAM |
| 22 | Convolutional Code | FEC rate = 1/2 | 64-QAM |
| 23 | Convolutional Code | FEC rate = 2/3 | 64-QAM |
| 24 | Convolutional Code | FEC rate = 3/4 | 64-QAM |
| 25 | Convolutional Code | FEC rate = 5/6 | 64-QAM |
| 26 | CTC | FEC rate = 1/2 | QPSK |
| 27 | CTC | FEC rate = 2/3 | QPSK |
| 28 | CTC | FEC rate = 3/4 | QPSK |
| 29 | CTC | FEC rate = 5/6 | QPSK |
| 30 | CTC | FEC rate = 1/2 | 16-QAM |
| 31 | CTC | FEC rate = 2/3 | 16-QAM |
| 32 | CTC | FEC rate = 3/4 | 16-QAM |
| 33 | CTC | FEC rate = 5/6 | 16-QAM |
| 34 | CTC | FEC rate = 1/2 | 64-QAM |
| 35 | CTC | FEC rate = 2/3 | 64-QAM |
| 36 | CTC | FEC rate = 3/4 | 64-QAM |
| 37 | CTC | FEC rate = 5/6 | 64-QAM |
| 38 | LDPC | FEC rate = 1/2 | QPSK |
| 39 | LDPC | FEC rate = 2/3 | QPSK |
| 40 | LDPC | FEC rate = 3/4 | QPSK |
| 41 | LDPC | FEC rate = 5/6 | QPSK |
| 42 | LDPC | FEC rate = 1/2 | 16-QAM |
| 43 | LDPC | FEC rate = 2/3 | 16-QAM |
| 44 | LDPC | FEC rate = 3/4 | 16-QAM |
| 45 | LDPC | FEC rate = 5/6 | 16-QAM |
| 46 | LDPC | FEC rate = 1/2 | 64-QAM |
| 47 | LDPC | FEC rate = 2/3 | 64-QAM |
| 48 | LDPC | FEC rate = 3/4 | 64-QAM |
| 49 | LDPC | FEC rate = 5/6 | 64-QAM |
| 50 | SBTC | FEC rate = 1/2 | QPSK |
| 51 | SBTC | FEC rate = 2/3 | QPSK |
| 52 | SBTC | FEC rate = 3/4 | QPSK |
| 53 | SBTC | FEC rate = 5/6 | QPSK |
| 54 | SBTC | FEC rate = 1/2 | 16-QAM |
| 55 | SBTC | FEC rate = 2/3 | 16-QAM |
| 56 | SBTC | FEC rate = 3/4 | 16-QAM |
| 57 | SBTC | FEC rate = 5/6 | 16-QAM |
| 58 | SBTC | FEC rate = 1/2 | 64-QAM |
| 59 | SBTC | FEC rate = 2/3 | 64-QAM |
| 60 | SBTC | FEC rate = 3/4 | 64-QAM |
| 61 | SBTC | FEC rate = 5/6 | 64-QAM |
| 62 | Extended UIUC |  |  |
| 63 | End of Map |  |  |

**7.7.x Relay Upstream Map (RUS-MAP)**

The format of a RUS-MAP message is shown in Table xx. The RUS-MAP message defines the access to the upstream channel using RUS-MAP IEs.

**Table xx — US-MAP message format**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Notes** |
| US-MAP\_Message\_Format() { |  |  |
| Management Message Type = x | 8 bits |  |
| UCD Count | 8 bits | Matches the value of the Configuration Change Count  of the UCD, which describes the upstream burst profiles that apply to this map. |
| Relay Zone Index | 4 bits | Indicates the index of relay zone |
| Allocation Start Time | 7 bits | The zone starts at the OFDMA symbol offset, counted after the preamble of the frame |
| Duration | 5 bits | The zone ends after allocation start time. The unit of duration is an OFDMA symbol |
| Begin PHY Specific Section { |  |  |
| Number of IEs: n | 12 bits | Number of IEs in the upstream map |
| for (*i* = 1; *i*  n; *i*++) { |  |  |
| RUS-MAP\_IE() | Variable | PHY specific (7.7.4.1)  Define upstream bandwidth allocations. Each US-MAP message shall contain at least one IE that marks the end of the last allocated burst. (UIUC=63 as defined in Table 36). |
| Relay Zone Mode | 1 bits | 0: centralized relay mode  1: distributed relay mode |
| If(Relay Zone Mode ==1){ |  |  |
| Used segment bitmap | 4 bits | Bit0: No segment  Bit1: Segment 0  Bit2: Segment 1  Bit3: Segment 2 |
| } |  |  |
| } |  |  |
| } |  |  |
| If(!byte\_boundary) |  |  |
| Padding bits | 0–7 bits | Padding to octet alignment—All bits shall be set to 0. |
| } |  |  |



**7.7.4.1 RUS-MAP IE**

**Table xx — RUS-MAP information elements**

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Description** |
| US-MAP\_IE() { |  |  |
| SID | 9 bits | Station ID of the CPE. |
| UIUC | 6 bits | 7.7.4.1.1 (see Table 36). |
| If ((UIUC=> 0) && (UIUC=<  1)) { |  |  |
| CBP Frame Number | 4 bits | Frame number where the active or passive CBP action is to take  place. If the identified frame falls in the next superframe (e.g., current frame is 9 and the CBP Frame Number is 4), the CPE shall make sure that a SCW is still scheduled for this frame as indicated by the upcoming SCH. If not, the CBP action shall be cancelled. |
| If(UIUC==0) { |  | Active SCW mode (CPE to transmit a CBP burst as requested by  the BS). |
| Timing advance | 16 bits | Signed number in TU corresponding to the advance of the  transmission of the CBP burst at the CPE. As the CPE starts to transmit the CBP burst as its fourth symbol before the end of the frame, zero advance corresponds to this signal being received by the BS at the beginning of its fourth symbol before the end of the frame when the CPE is co-located with the BS (see Table 44). |
| EIRP Density Level | 8 bits | EIRP per transmitted subcarrier (see 9.9.4.2). Signed in units of 0.5  dB, ranging from –104 dBm (encoded 0x00) to +23.5 dBm  (encoded 0xFF). |
| } |  |  |
| If(UIUC==1) { |  | Passive SCW mode (CPE to receive and demodulate the CBP burst  and send content to the BS). |
| Channel Number | 8 bits | Channel number in which the CPE shall listen to the medium for a  coexistence beacon. |
| Synchronization mode | 1 bit | = 0 The CPE will capture the CBP burst using its current  synchronization (i.e., locked to its BS) for geolocation purposes.  = 1 The CPE will re-synchronize on the received CBP burst using the preamble symbol and optionally pilot carriers to decode the payload for self-coexistence purposes. |
| } else if (UIUC =>2) && (UIUC =<3) ) { |  |  |
| Number of Subchannels | 4 bits | Number of subchannels reserved for the BW Request/UCS  Notification opportunistic window. |
| } else if (UIUC =>4) && (UIUC=<6) ) { |  |  |
| Number of Subchannels | 4 bits | Number of subchannels reserved for the CDMA Ranging/BW  Request/UCS notification opportunistic window. Note that in case where UIUC=8 and any UIUC in the range 4 to 6 are allocated to a |

|  |  |  |
| --- | --- | --- |
| **Syntax** | **Size** | **Description** |
|  |  | frame, the largest number of subchannel specified shall prevail.  Note also that when the CDMA ranging burst is to be used for terrestrially-based geolocation (see 10.5.2), the number of  subchannels shall be at least 6. |
| Number of symbols | 5 bits | Number of symbols in the US ranging channel reserved for the  opportunistic windows carrying either CDMA Periodic Ranging/BW Request/UCS notification as specified by the respective UIUC. These shall be placed in the ranging channel following the initial ranging window if scheduled and consecutively (see Figure 157). |
| } else if (UIUC == 7) { |  |  |
| CDMA\_ Allocation\_IE () | 20 bits | See 7.7.4.1.2. |
| } else if (UIUC == 8) { |  | The first 5 symbols of the upstream subframe shall be reserved for  the opportunistic initial ranging burst. |
| Number of Subchannels | 4 bits | Number of subchannels reserved for the initial ranging burst. Note  that in case where UIUC=8 and any UIUC in the range 4 to 6 are allocated to a frame, the largest number of claimed subchannels specified shall prevail. |
| } else if (UIUC == 9) { |  | US-MAP EIRP Control IE |
| US-MAP EIRP Control IE | Variable | See 7.7.4.1.3. |
| } else if (UIUC == 62) { |  |  |
| US\_Extended\_IE() | Variable | See 7.7.4.1.4. |
| } else { |  |  |
| Burst\_Type | 1 bit | This value specifies the burst type for the burst specified by this  US-MAP IE.  0: Bursts are mapped in the time axis over the full width of the upstream subframe before incrementing in the frequency axis.  1: Bursts are mapped in the time axis over segments of 7 symbols before incrementing in the frequency axis and then re-tracing to the lowest unused subchannel in the next 7 symbol segment. The width  of the last segment is to be between 7 and 13 symbols depending on the width of the upstream subframe. |
| Duration | 12 bits | Number of OFDM slots linearly allocated to the US burst specified  by this IE. (Up to 60 by 30 slots can be allocated to a US burst.) |
| MDP | 1 bit | Measurement Data Preferred  Used by the BS to indicate to the CPE that this upstream allocation is to be preferably used by the CPE for the specific purpose of  reporting back any measurement data. The measurement data to be  reported is in connection to the specified Transaction ID.  In case the CPE does not have anything to report, it can use this allocation for any other data. This is useful, for example, after a  quiet period.  0: Measurement data not required (default)  1: Measurement data preferred |
| MRT | 1 bit | Measurement Report Type  In case MDP == 1, this field indicates which type of report the BS  wants the CPE to send back.  0: Detailed (see 7.7.18.3.1.1 through 7.7.18.3.1.8)  1: Consolidated (see 7.7.18.3.1.9) |
| CMRP | 1 bit | Channel Management Response Preferred  Used by the BS to indicate to the CPE that this upstream allocation is to be used for confirming or not the receipt of the channel  management command with the Transaction ID specified.  0: Channel management response not required (default)  1: Channel management response required |
| } |  |  |
| } |  |  |
| } |  |  |