IEEE P802.22  
Wireless RANs

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| MAC Frame Modification | | | | |
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|  |  |  |  |  |

Abstract

MAC Frame Modifications are added in this document.

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1. 802.22b OFDMA Frame Forwarding in a Relay Network
   1. 802.22b Network



Example of a 802.22b Network

* 1. Possible Connections

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | A-BS | C-A-CPE 1 | C-A-CPE 2 | D-A-CPE 1 | D-A-CPE 2 | S-CPE 1 | S-CPE 2 | S-CPE 3 | S-CPE 4 | S-CPE 5 | S-CPE 6 | S-CPE 7 | S-CPE 8 | S-CPE 9 | S-CPE 10 |
| A-BS |  | AZ | AZ | AZ | AZ | AZ | AZ | AZ | AZ | AZ | AZ |  |  |  |  |
| C-A-CPE 1 |  |  |  |  |  |  |  | CRZ | CRZ |  |  |  |  |  |  |
| C-A-CPE 2 |  |  |  |  |  |  |  |  |  | CRZ | CRZ |  |  |  |  |
| D-A-CPE 1 |  |  |  |  |  |  |  |  |  |  |  | DRZ | DRZ |  |  |
| D-A-CPE 2 |  |  |  |  |  |  |  |  |  |  |  |  |  | DRZ | DRZ |

* 1. 802.22b Relay Downstream
     1. Downstream MAP Construction for downstream

DS-MAP

--- DS-MAP IE [0] :: DIUC (62) :: Extended DIUC Code (0x01)

--- Multi-Zone Configuration IE ()

---- Number of Zone (4)

---- Zone Index (0) :: Zone Mode (0) :: Access Zone :: OFDMA symbol offset :: zone duration

---- Zone Index (1) :: Zone Mode (1) :: Centralized Relay Zone :: OFDMA symbol offset :: zone duration

---- Zone Index (2) :: Zone Mode (2) :: Distributed Relay Zone :: OFDMA symbol offset :: zone duration

---- Zone Index (3) :: Zone Mode (2) :: Distributed Relay Zone :: OFDMA symbol offset :: zone duration

--- DS-MAP IE [1]:: DIUC (62):: Extended DIUC Code (0x02)

--- AZDS-MAP IE

--- Zone Index (0)

--- DIUC

--- SID (S-CPE 1)

--- Length (x slots)

--- Boosting

--- Relay Mode (Off)

--- Relay Node (Null)

* Relay mode (1bit) and Relay node (13bits) are newly added on AZDS-MAP IE. Relay mode is a indication whether the burst allocated in AZDS-MAP is relayed or not. Relay node is a centralized scheduling A-CPE’s SID when relay mode is set. When relay mode is set, the burst allocated in AZDS-MAP shall be transmitted to the centralized scheduling A-CPE, then shall be relayed to the target S-CPE.
* S-CPE 1 is directly connected to A-BS, then relay mode is off.

--- DS-MAP IE [2] :: DIUC (62):: Extended DIUC Code (0x02)

--- AZDS-MAP IE

--- Zone Index (0)

--- DIUC

--- SID (S-CPE 2)

--- Length (x slots)

--- Boosting

--- Relay Mode (Off)

--- Relay Node (Null)

* S-CPE 2 is directly connected to A-BS, then relay mode is off.

--- DS-MAP IE [3] :: DIUC (62):: Extended DIUC Code (0x02)

--- AZDS-MAP IE

--- Zone Index (0)

--- DIUC

--- SID (S-CPE 3)

--- Length (x slots)

--- Boosting

--- Relay Mode (Off)

--- Relay Node (Null)

* S-CPE 3 is connected to A-BS throught centralized scheduling A-CPE 1. There are two choices for downstream, which is a direct transmission from A-BS to S-CPE or is a relay transmission through the centralized scheduling A-CPE
* Relay mode is off, then downstream is transmitted to S-CPE directly.

--- DS-MAP IE [4] :: DIUC (62):: Extended DIUC Code (0x02)

--- AZDS-MAP IE

--- Zone Index (0)

--- DIUC

--- SID (S-CPE 4)

--- Length (x slots)

--- Boosting

--- Relay Mode (Off)

--- Relay Node (Null)

* S-CPE 4 is connected to A-BS throught centralized scheduling A-CPE 1. There are two choices for downstream, which is a direct transmission from A-BS to S-CPE or is a relay transmission through the centralized scheduling A-CPE
* Relay mode is off, then downstream is transmitted to S-CPE directly.

--- DS-MAP IE [5] :: DIUC (62):: Extended DIUC Code (0x02)

--- AZDS-MAP IE

--- Zone Index (0)

--- DIUC

--- SID (S-CPE 5)

--- Length (x slots)

--- Boosting

--- Relay Mode (On)

--- Relay Node (Centralized Scheduling A-CPE 2’s SID)

* S-CPE 5 is connected to A-BS throught centralized scheduling A-CPE 2. There are two choices for downstream, which is a direct transmission from A-BS to S-CPE or is a relay transmission through the centralized scheduling A-CPE
* Relay mode is set, then downstream is transmitted to S-CPE through the centralized scheduling A-CPE indicated in Relay node. If S-CPE receives downstream in AZ, it can ignore received downstream

--- DS-MAP IE [6] :: DIUC (62):: Extended DIUC Code (0x03)

--- CRZDS-MAP IE

--- Zone Index (1)

--- DIUC

--- SID (S-CPE 5)

--- CRZ Start Offset (y slots)

--- Length (x slots)

--- Boosting

* For relay burst transmission, the slot allocation in centralized relay zone (CRZ) is defined in CRZDS-MAP. Centralized scheduling A-CPE shall transmit the received burst in AZ to S-CPE through the allocated CRZ.

--- DS-MAP IE [7] :: DIUC (62):: Extended DIUC Code (0x02)

--- AZDS-MAP IE

--- Zone Index (0)

--- DIUC

--- SID (S-CPE 6)

--- Length (x slots)

--- Boosting

--- Relay Mode (On)

--- Relay Node (Centralized Scheduling A-CPE 2’s SID)

* S-CPE 6 is connected to A-BS throught centralized scheduling A-CPE 2. There are two choices for downstream, which is a direct transmission from A-BS to S-CPE or is a relay transmission through the centralized scheduling A-CPE
* Relay mode is set, then downstream is transmitted to S-CPE through the centralized scheduling A-CPE indicated in Relay node.

--- DS-MAP IE [8] :: DIUC (62):: Extended DIUC Code (0x03)

--- CRZDS-MAP IE

--- Zone Index (1)

--- DIUC

--- SID (S-CPE 6)

--- CRZ Start Offset (x+y slots)

--- Length (x slots)

--- Boosting

* For relay burst transmission, the slot allocation in centralized relay zone (CRZ) is defined in CRZDS-MAP. Centralized scheduling A-CPE shall transmit the received burst in AZ to S-CPE through the allocated CRZ.

--- DS-MAP IE [9] :: DIUC (62):: Extended DIUC Code (0x04)

--- AZDS-MAP IE

--- Zone Index (0)

--- DIUC

--- SID (Null or Distributed Scheduling A-CPE 1’s SID)

--- Length (x slots)

--- Boosting

--- Relay Mode (On/Off)

--- Relay Node (Distributed Scheduling A-CPE 1’s SID)

* S-CPE 7 is connected to A-BS throught distributed scheduling A-CPE 1. S-CPE7 is managed by the distbuted scheduling A-CPE, then all downstream bursts from A-BS shall be transmitted to the distributed scheduling A-CPE
* For relay burst transmission on distributes scheduling A-CPE, the distributed scheduling A-CPE shall transmit DS-MAP including the downstream slot allocation to S-CPE as same as A-BS.

--- DS-MAP IE [10] :: DIUC (62):: Extended DIUC Code (0x04)

--- AZDS-MAP IE

--- Zone Index (0)

--- DIUC

--- SID (Null or Distributed Scheduling A-CPE 1’s SID)

--- Length (x slots)

--- Boosting

--- Relay Mode (On/Off)

--- Relay Node (Distributed Scheduling A-CPE 1’s SID)

--- DS-MAP IE [11] :: DIUC (62):: Extended DIUC Code (0x04)

--- AZDS-MAP IE

--- Zone Index (0)

--- DIUC

--- SID (Null or Distributed Scheduling A-CPE 2’s SID)

--- Length (x slots)

--- Boosting

--- Relay Mode (On/Off)

--- Relay Node (Distributed Scheduling A-CPE 2’s SID)

--- DS-MAP IE [12] :: DIUC (62):: Extended DIUC Code (0x04)

--- AZDS-MAP IE

--- Zone Index (0)

--- DIUC

--- SID (Null or Distributed Scheduling A-CPE 2’s SID)

--- Length (x slots)

--- Boosting

--- Relay Mode (On/Off)

--- Relay Node (Distributed Scheduling A-CPE 2’s SID)



* 1. 802.22b Relay Upstream



* + 1. Initial Ranging
       1. Initial Ranging between CPEs and A-BS (No change from 802.22 Standard)
       2. Local Initial Ranging beween S-CPEs and a distributed scheduling A-CPE (Same procedure of Initial Ranging)
       3. Relay Initial Ranging between S-CPEs and a centralized scheduling A-CPE



**7.15.2.1cCDMA relay initial ranging and automatic adjustments (centralized scheduling A-CPE and S-CPE)**

A CPE enabling to acquire downlink synchronization and uplink transmission parameters from the A-BS in an AZ shall perform initial ranging with CDMA code to the A-BS. While, the initial ranging request from the CPE may not arrive to the A-BS due to the transmission power constraint of the CPE. In this case, a certain centralized scheduling A-CPE may perform relay initial ranging for the CPE.

a) The CPE, after acquiring downlink synchronization and uplink transmission parameters from the A-BS, may select one Ranging Slot in an upstream CRZ (US CRZ Ranging Slot) using the random backoff. The random backoff shall use a binary truncated exponent algorithm. After selecting the CRZ Ranging Slot, the CPE shall choose a CRZ Initial Ranging Code (from the CRZ initial Ranging domain) for the CRZ Ranging Slot using a uniform random process. The selected CRZ Ranging Code is sent to the centralized scheduling A-CPE in the selected CRZ Ranging Slot. In this stage, the CPE is not aware whether the centralized scheduling A-CPE exists within the transmission range of the CPE.

b) The centralized scheduling A-CPE may receive as many CRZ Ranging Codes in the CRZ Ranging Slot. The centralized scheduling A-CPE cannot tell which CPE sent the ranging request; therefore, upon successfully receiving a CRZ ranging code during the CRZ Ranging Slot, the centralized scheduling A-CPE sends a RNG-RPT message (Table xx) that contains initial ranging adjustment information such as the initial ranging status, the received CRZ ranging code as well as the received CRZ ranging slot (OFDMA symbol number, etc.) where the CRZ ranging code has been identified.

c) When an A-BS receives the RNG-RPT with the status being set to 0 (require initial ranging adjustment), the A-BS transmits RNG-CMD to the CPE, where the RNG-CMD message contains all the needed adjustments (e.g., time, EIRP, and possibly frequency corrections) and a status notification.

d) When the CPE may receive several RNG-CMD messages sent from theA-BS, the CPE will choose one RNG-CMD into the received RNG-CMDs for the further ranging. Upon receiving a RNG-CMD message with the “Continue” status, the CPE shall continue the ranging process as done on the first entry with CRZ ranging codes on the CRZ ranging slot to the centralized scheduling A-CPE.

e) When an A-BS receives the RNG-RPT with the status being set to 1 (initial ranging done), the A-BS allocates a CRZ upstream bandwidth by using CDMA\_Allocation\_IE in CRZUS-MAP IE for which the CPE transmits RNG-REQ to the centralized scheduling A-CPE. In this stage, a valid SID is not assigned for the CPE. The centralized scheduling A-CPE shall transmit the RNG-REQ received from the CPE to the A-BS.

f) When successfully receiving the RNG-REQ, the A-BS shall provide a valid SID for the CPE by sending RNG-CMD message. In addition, the centralized scheduling A-CPE shall maintain the SID of the CPE broadcasted by RNG-CMD. If this RNG-CMD message includes a “continue” indication, the ranging process should be continued using the ranging mechanism.

g) The timeout required for the CPE to wait for RNG-CMD is defined by the timer T3.

Table xx – RNG-RPT message format

|  |  |  |
| --- | --- | --- |
| Syntax | Size | Note |
| RNG-RPT\_Message\_Format() { |  |  |
| Management Message Type = xx | 8 bits |  |
| Information elements (IEs) | Variable | Table xx |
| If(!byte\_boundary) |  |  |
| Padding Bits | 0-7 bits |  |
| } |  |  |

Table xx – RNG-RPT information elements

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Element ID (1 byte) | Length (bits) | Description |
| Ranging Status | 1 | 2 | 00: require initial ranging adjustment  01: Initial Ranging done  10-11: Reserved |
| EIRP per subcarrier | 2 | 8 | See Table 44 |
| CDMA Code | 2 | 8 | A unique code assigned to the CPE, to be used for the CRZ initial ranging code set. |
| Transmission opportunity offset | 3 | 8 | A unique transmission opportunity assigned to the CPE, to be used for the CRZ initial ranging in units of symbol duration |

**7.14.3.8.3 CDMA initial ranging and automatic adjustments by relaying on centralized scheduling A-CPE (Relay initial ranging)**

Although a CPE successfully obtains downstream parameters from a A-BS, CDMA initial ranging to the ABS as described in 7.14.3.8.1 may be failed due to the CPE transmitting power constraint. However, a CPE is still able to have an uplink to A-BS by relaying on a centralized scheduling A-CPE. A CPE shall synchronize to the frame preamble in order to perform initial ranging to a A-BS. At this point, the CPE shall scan the US-MAP message to find an Initial Ranging Interval and CRZ Initial Ranging Interval if available. The ABS may allocate a CRZ Initial Ranging Interval consisting of one or more transmission opportunities within a CRZ of US subframe. The CPE shall extract the number of initial ranging codes and may extract the number of CRZ initial ranging codes (see Table 31, element ID 155) from the UCD MAC management message.

The CPE randomly selects the CDMA code as described in 7.15.2.1a and sends the initial ranging CDMA code to the A-BS on the Initial Ranging Interval, and sends the CRZ initial ranging CDMA code to the centralized scheduling A-CPE on the CRZ Initial Ranging Interval as well in US allocation dedicated for that purpose. The initial ranging between the CPE and the A-BS shall be following as described in 7.14.3.8.1. The following section describes the case that the CRZ initial ranging is performed between the CPE and the centralized scheduling A-CPE.

The centralized scheduling A-CPE may receive the CRZ Initial Ranging CDMA code within the CRZ Initial Ranging Interval in a CRZ of US subframe. As many CPEs may contend for ranging, the CDMA code received may be the sum of many CPE transmissions. The centralized scheduling A-CPE isolates each of these transmissions and computes the ranging adjustments based on the relative time of arrival of each CPE upstream burst, i.e., the timing offset, so that all these bursts arrive at the centralized scheduling A-CPE at the beginning of the symbol period within sufficient tolerance.

Ranging adjusts each CPE’s timing offset such that each CPE appears to be co-located with the centralized scheduling A-CPE. The CPE shall set its initial timing offset to “zero advance” as if it was physically collocated with the centralized scheduling A-CPE. When the CRZ Initial Ranging transmission opportunity occurs, the CPE may send a CRZ CDMA code. After reception and decoding of this CDMA code, the centralized scheduling A-CPE will send a RNG-RPT MAC message to the A-BS, where instead of the centralized scheduling A-CPE the A-BS will react by sending a RNG-CMD MAC message in a following frame with the same CDMA code and indicate the timing advance that the CPE should use for its upstream transmissions (see Table 44) so that the beginning of its bursts is aligned with the center of the cyclic prefix within the tolerance indicated in 9.9.1.

The CPE randomly selects the CDMA code as described in 7.15.2.1a and sends the CRZ initial ranging CDMA code to the centralized scheduling A-CPE on the CRZ Initial Ranging Interval. Thus, the CPE sends the message as if it were co-located with the centralized scheduling A-CPE.

The CPE shall calculate the transmit EIRP per subcarrier for initial ranging, EIRPIR\_CPE, from the following equation:

EIRPIR\_CPE = EIRPA-CPE + RSSIR\_A-CPE\_nom – (RSSIR\_CPE – GRX\_CPE) + 10×log(NIR\_sub/Nsub )

Where

RSSIR\_A-CPE\_nom and EIRPA-CPE are defined in a DCD IE (see Table 23)

GRX\_CPE is the antenna gain at the CPE

RSSIR\_CPE is the RSSL measured by the CPE, which is then corrected by the CPE antenna gain to represent the RSSL for an isotropic antenna

NIR\_sub is the number of subcarriers used by the CPE for initial ranging

Nsub is 1680 for PHY mode 1 or 840 for PHY mode 2

The CPE shall send a CDMA code with a power level resulting in the EIRPIR\_CPE per subcarrier. If the CPE does not receive a response after waiting at least one frame to allow processing at the centralized scheduling A-CPE, the CPE shall send a new CDMA code at the next appropriate Initial Ranging transmission opportunity with 1 dB higher power level. The CPE shall, however, stop increasing the power level at the following condition:

EIRPIR\_MAX +10×log(NIR\_sub) > EIRPCPE\_MAX

Where

EIRPCPE\_MAX is the upper bound in maximum transmitted EIRP for the CPE on the current operating channel as described in Table 108 of 7.7.11.3.2.1 or 4 Watt for the fixed CPE whichever is the smallest

EIRPIR\_CPE\_MAX is the upper bound for the increased EIRPIR\_CPE

If the CPE receives a RNG-CMD message containing the parameters of the code it has transmitted and the status “continue,” it shall consider the transmission attempt unsuccessful but implement the corrections specified in the RNG-CMD and issue another CDMA code after the appropriate backoff delay. If the CPE receives an CRZUS-MAP containing a CDMA allocation IE with the parameters of the code it has transmitted, it shall consider the RNG-CMD reception successful, and proceed to send a unicast RNG-REQ (on Initial Ranging FID, allocated to Cell SID) on the allocated BW. The centralized scheduling A-CPE shall transmit the RNG-REQ received from the CPE to the A-BS.

After correctly receiving RNG-REQ, the A-BS shall return a RNG-CMD message to the CPE. Within the RNG-CMD message shall be the Station ID (SID) assigned to this CPE. In addition, the centralized scheduling A-CPE shall maintain the SID of the CPE broadcasted by RNG-CMD.

Moreover, a CPE can successfully perform CDMA initial ranging to the several devices including a A-BS and centralized scheduling A-CPEs. In this case, the CPE shall select one of those.

* + 1. Bandwidth Allocation
       1. Bandwidth Request is performed at the following cases
          1. Contention-based CDMA Initial Ranging (UIUC == 8)

Bandwidth request from CPE to BS in order to transmit RNG-REQ from CPE to BS

* + - * 1. Contention-based Bandwidth Request

Contention-based Bandwidth Request (UIUC == 3)

If there is no upstream bandwidth, a CPE requests contention-based bandwidth request to BS

Contention-based CDMA Bandwidth Request (UIUC == 5)

If there is no upstream bandwidth, a CPE requests contention-based CDMA bandwidth request to BS. This is a similar to Contention-based CDMA Initial Ranging

* + - * 1. Bandwidth Request on allocated Upstream

If there is upstream bandwidth, a CPE request bandwidth by using Bandwidth request subheader to BS

* + - 1. A relay 802.22b network shall support the above Bandwidth Request applied in 802.22 Standard. Extended bandwidth request subheader in Draft 2.0 supports only Case 2.1 (Contention-based Bandwidth Request) and Case 3 (Bandwidth Request on allocated Upstream), but Draft 2.0 does not describe the contention-based CDMA bandwidth request, and Contention-based CDMA Initial Ranging in Draft 2.0 is not operated successfully in a relay network. To solve these, this document provides the details for resolutions.

**7.11.1a Bandwidth Request for a relay network**

**7.11.1a.1 Bandwidth Request by a distributed scheduling A-CPE**

A distributed scheduling A-CPE directly handles the bandwidth requests it receives from its S-CPEs.

A distributed scheduling A-CPE may receive bandwidth requests from its S-CPEs via the MAC signaling header, the grant management subheader or the CDMA bandwidth request code.

To forward upstream traffic to A-BS, a distributed scheduling A-CPE may request uplink bandwidth via a stand-alone bandwidth request header. A distributed scheduling A-CPE may combine with the bandwidth needs of queued packets into one bandwidth request header per QoS class.

The distributed scheduling A-CPE may transmit a BW request header soon after it receives a BW request header from one of its S-CPEs (timed to yield an uplink allocation sequential to the arrival of those packets) instead of waiting for the actual packets to arrive in order to reduce delay in relaying traffic (see Figure H1).

**7.11a.2 Bandwidth Request by a centralized scheduling A-CPE**

In centralized scheduling mode, the A-BS shall determine the bandwidth allocations (i.e., MAPs) for all links in its cell. As a result, centralized scheduling A-CPEs shall receive the MAPs from the A-BS for the links to/ from their CPEs before they can transmit them.

For the same reason, centralized scheduling A-CPEs shall forward all bandwidth request headers and bandwidth request CDMA bandwidth ranging code information they receive from CPEs to the A-BS.

If the centralized scheduling A-CPE has available uplink bandwidth, it shall simply forward the bandwidth request information by using an Extended BW subheader (Table xx) to the A-BS. Otherwise, the centralized scheduling A-CPEs shall request uplink bandwidth from the A-BS using CDMA bandwidth ranging codes or Contention-based bandwidth request.

When the centralized scheduling A-CPE receives a CRZ CDMA bandwidth ranging code from a S-CPE, the Extended BR subheader contains BW request type being set to 0 and the received CRZ bandwidth ranging code. Upon receiving an Extended BR subheader from a centralized scheduling A-CPE, the A-BS shall insert CDMA Allocation IEs in CRZUS-MAP IE for which the CPE performs bandwidth request to the centralized scheduling A-CPE.

When the centralized scheduling A-CPE receives a bandwidth request subheader from a S-CPE, the Extended BR subheader contains BW request type being set to 1, SID of the S-CPE, Type and BR. Upon receiving an Extended BR subheader from a centralized scheduling A-CPE, the A-BS shall insert the allocated bandwidth information in CRZUS-MAP IE for which the S-CPE performs upstream in US CRZ.

|  |  |  |
| --- | --- | --- |
| Table D1- Extended Bandwidth Request subheader format | | |
| Syntax | Size | Notes |
| Extended\_BW\_ Request\_Subheader\_Format() { |  |  |
| Extended Subheader Type | 8 bits | 0x00 = Extended BW Request Subheader |
| Number of BR CPEs ; n | 8 bits | The number of CPEs, which require bandwidth request |
| For (i=1; i<= n; i++){ | Variable |  |
| BW Request Type | 2 bits | 00: CDMA bandwidth request  01: Bandwidth request subheader  10-11: Reserved |
| SID | 13 bits | SID of CPE, which require bandwidth request when BW Request Type is set to 1 |
| Type | 1 bit | Indicates the type of the bandwidth request adjustment when BW Request Type is set to 1  0: incremental  1: aggregate |
| BR | 20 bits | The number of bytes of upstream bandwidth requested by the CPE. The request shall not include any PHY overhead when BW Request Type is set to 1. |
| CRZ bandwidth ranging code | 8 bits | CRZ bandwidth ranging codes when BW Request Type is set to 0 |
| } |  |  |
| } |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Table 31 - UCD Channel IE** | | | |
| **Name** | **Element ID** | **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 Table3). |
| CRZ Bandwidth request opportunity size | 5 | 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). |
| CRZ UCS Notification request opportunity size | 6 | 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 Table3). |
| 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 CDM 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 56). 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. |
| CRZ initial ranging codes | 155 | 1 | Number of centralized relay zone (CRZ) initial ranging CDMA codes. Possible values are 0–255. |
| CRZ periodic ranging codes | 156 | 1 | Number of centralized relay zone (CRZ) periodic ranging CDMA codes. Possible values are 0–255. |
| CRZ UCS notification codes | 157 | 1 | Number of centralized relay zone (CRZ) UCS notification CDMA codes. Possible values are 0–255. |
| CRZ bandwidth request code | 158 | 1 | Number of centralized relay zone (CRZ) bandwidth request CDMA codes. Possible values are 0–255. |

1. Frame Modifications
   1. Downstream Frame Modifications

* DS-MAP message is transmitted by only BS, A-BS and Distributed Scheduling A-CPE.
* DS-MAP IE [] can be defined by AZDS-MAP IE, CRZDS-MAP IE and DRZDS-GRA-IE from DIUC value, then AZDS-MAP IE, CRZDS-MAP IE, DRZDS-MAP IE and DRZDS-GRA-IE defined in DS-MAP IE[] are duplicated. Then, remove them from DS-MAP message.

|  |  |  |
| --- | --- | --- |
| * **DS-MAP message format** | | |
| **Syntax** | **Size** | **Note** |
| 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. |
| If (transmitted by BS or A-BS or distributed scheduling A-CPE) { |  |  |
| Begin PHY Specific Section { |  |  |
| Number of IEs: n | 12 bits | Number of IEs in the downstream map |
| for (*i* = 1; *i*=< n; i++) { |  | PHY specific (7.7.2.1) |
| DS-MAP\_IE() | Variable |  |
| } |  |  |
| } |  |  |
| } |  |  |
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| If(!byte\_boundary) |  |  |
| Padding bits | 0-7 bits |  |
| } |  |  |

* DRZDS-MAP IE is considered to use DS-MAP Information in DRZ, thus DRZDS-MAP IE is the duplication of DS-MAP IE. Then remove it.

|  |  |
| --- | --- |
| **Table 28a** **- Extended DIUC IE Type** | |
| **Extended DIUC** | **Usage** |
| 0x00 | DS-MAP Dummy Extended IE |
| 0x01 | DS Multi-Zone Configuration IE |
| 0x02 | AZDS-MAP IE |
| 0x03 | CRZDS-MAP IE |
|  |  |
| 0x04 | DRZDS-MAP GRA IE |
| 0x05-0xFF | Reserved |

* DS Multi-Zone Configuration IE is only defined in Multi-Zone Configuration, then any MAP IE is not necessary in this IE.
* Zone Index indicates what kind of zone is used.
* AZ is dedicated in A-BS.
* CRZ can be used by multiple centralized scheduling A-CPEs, however DRZ is dedicated by one distributed scheduling A-CPE.

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| **Table F1 - DS Multi-Zone Configuration IE format** | | |
| **Syntax** | **Size** | **Notes** |
| DS Multi-Zone Configuration\_IE() { |  |  |
| Multi-Zone Configuration{ |  |  |
| Number of zones | 8 bits | Number of zones including access and relay zones. Number of zones (0) is not available of DS. Number of zone (1) shall be access zone. |
| For(i=1; i =< Number of zones; i++){ |  |  |
| Zone Index | 8 bits | Increase the index from 0 to Number of Zones-1 |
| Zone Mode | 2 bits | 0: access zone  1: centralized relay zone  2: distributed relay zone |
| Used Segment Bitmap | 4 bits | Bit 1: Segment 0  Bit 2: Segment 1  Bit 3: Segment 2  Bit 4: Reserved  Segmentation is only used in distributed relay zone |
| } |  |  |
| } |  |  |
| for(Zone index=0; Zone index < Number of zones; Zone index++){ |  |  |
| 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 zone duration starting from the OFDMA symbol offset. The unit of duration is an OFDMA symbol |
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|  |  |  |
| if (Zone mode == 2) { |  | Distributed Relay Zone (DRZ) mode |
| SID | 13 bits | SID of distributed scheduling A-CPE |
| } |  |  |
| } |  |  |
| } |  |  |

* Zone Index indicates whether the current slot is allocated for AZ, CRZ or DRZ.
* When A-BS may transmit a downstream burst to a S-CPE, there are two choices. One is direct transmission to S-CPE, and another is a relay transmission through the centralized scheduling A-CPE. For a direct transmission, SID is a final destination of S-CPE, and then no relay A-CPE is necessary. But, for a relay transmission, at first A-BS sends the burst to the centralized scheduling A-CPE.In this case, relay mode is “on” and set to relay node of a relay node ID (a centralized scheduling A-CPE). A centralized scheduling A-CPE relays the received burst to S-CPE indicated in SID.

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| **Table G1 - AZDS-MAP IE** | | |
| **Syntax** | **Size** | **Notes** |
| AZDS-MAP\_IE(){ |  |  |
| Zone Index | 8 bits | See Table F1 |
| DIUC | 6bits | 7.7.2.1.1 |
| if (DIUC == 12) |  |  |
| Extended DIUC Value | 6 bits | See Table 27a |
| SID | 13 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 |
| Relay Mode | 1 bit | 0: No relay  1: Relay mode on |
| Relay Node | 13 bits | Centralized Scheduling A-CPE’s SID when relay mode is set 1 |
| } |  |  |

* Zone Index indicates whether the current slot is allocated for AZ, CRZ or DRZ.
* A centralized scheduling A-CPE relays the received burst to S-CPE indicated in SID.

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| **Table H1 - CRZDS-MAP IE** | | |
| **Syntax** | **Size** | **Notes** |
| CRZDS-MAP\_IE(){ |  |  |
| Zone Index | 8 bits | See Table F1 |
| DIUC | 6bits | 7.7.2.1.1 |
| if (DIUC == 12) |  |  |
| Extended DIUC Value | 6 bits | See |
| SID | 13 bits | Station ID of CPE or multicast group. |
| CRZ Start Offset | 12 bits | Number of OFDMA slots counted after the centralized relay zone mode start |
| Length | 12 bits | Number of OFDM slots linearly allocated to the CRZDS 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 |
| } |  |  |

* DRZDS-MAP IE is duplication of DS-MAP IE.

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* 1. Upstream Frame Modifications

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| * **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. |
| If (transmitted by BS or A-BS or distributed scheduling A-CPE) { |  |  |
| 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 Table36). |
| } |  |  |
| } |  |  |
| } |  |  |
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| If(!byte\_boundary) |  |  |
| Padding bits | 0-7 bits |  |
| } |  |  |

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| --- | --- |
| **Table 39- Extended** **UIUC IE Type code assignment** | |
| **Extended UIUC** | **Usage** |
| 0x00 | US-MAP Dummy Extended IE |
| 0x01 | US Multi-Zone Configuration IE |
| 0x02 | AZUS-MAP IE |
| 0x03 | CRZUS-MAP IE |
|  |  |
| 0x04 | DRZUS-MAP GRA IE |
| 0x05-0xFF | Reserved |

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| --- | --- | --- |
| **Table K1- US Multi-Zone Configuration IE format** | | |
| **Syntax** | **Size** | **Notes** |
| US Multi-Zone Configuration\_IE() { |  |  |
| Multi-Zone Configurationonfiguration{ |  |  |
| Number of zones | 8 bits | Number of zones including access and relay zones. Number of zones (0) is not available of DS. Number of zone (1) shall be access zone. |
| For(i=1; i =< Number of zones; i++){ |  |  |
| Zone Index | 8 bits | Increase the index from 0 to Number of Zones-1 |
| Zone Mode | 2 bits | 0: access zone  1: centralized relay zone  2: distributed relay zone |
| Used Segment Bitmap | 4 bits | Bit 1: Segment 0  Bit 2: Segment 1  Bit 3: Segment 2  Bit 4: Reserved  Segmentation is only used in distributed relay zone |
| } |  |  |
| } |  |  |
| for(Zone index=0; Zone index < Number of zones; Zone index++){ |  |  |
| 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 zone duration starting from the OFDMA symbol offset. The unit of duration is an OFDMA symbol |
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| if (Zone mode == 2) { |  | Distributed Relay Zone (DRZ) mode |
| SID | 13 bits | SID of distributed scheduling R-CPE (CID 91) |
| } |  |  |
| } |  |  |
| } |  |  |

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| --- | --- | --- |
| **Tabel M1- CRZUS-MAP IE** | | |
| **Syntax** | **Size** | **Notes** |
| CRZUS-MAP\_IE() { |  |  |
| Zone Index | 8 bits | See TableK1 |
| SID | 13 bits | Station ID of the CPE. |
| UIUC | 76 bits | 7.7.4.1.1 (see Table36). |
| If (UIUC == 12) |  |  |
| Extended UIUC Value | 6 bits | See 7.7.4.1.1.1 |
| If ((UIUC=> 0) && (UIUC=<1)) { |  | Frame number where the active or passive CBP action is to take place. |
| CBP Frame Number | 4 bits | Active SCW mode (CPE to transmit a CBP burst as requested by the BS). |
| If(UIUC==0) { |  |  |
| 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 Relay BW Request/UCS Notification opportunistic window. |
| Number of Symbols | 5 bits | Number of symbols reserved for the Relay BW Request/UCS/Notification opportunistic window. |
| } else if (UIUC =>4) && (UIUC=<6) ) { |  |  |
| Number of Subchannels | 4 bits | Number of subchannels reserved for the Relay CDMA Periodic 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 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 Relay 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) { |  |  |
| Number of Subchannels | 4 bits | Number of subchannels reserved for the Relay 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. |
| Number of Symbols | 5 bits | Number of symbols reserved for the Relay initial ranging burst. |
| } else if (UIUC == 9) { |  |  |
| US-MAP EIRP Control IE | Variable | See 7.7.4.1.3. |
| } 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 |
| } |  |  |
| } |  |  |
| } |  |  |