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Wireless LANs

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| Improvements to enhanced SLS beamforming - draft text |
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Abstract

This document proposes draft changes to beamforming SP. Baseline for this docment is presentation 11-17/0770 “Improvements to enhanced SLS beamforming” shown in May meeting.

**9.4.2.252 EDMG Extended Schedule element**

The EDMG Extended Schedule element defines the channel scheduling for an EDMG BSS, including an indication of which channels an allocation is scheduled on. The format of the EDMG Extended Schedule element is shown in Figure 35.



**Figure 35 —EDMG Extended Schedule element format**

The Element ID, Length and Element ID Extension fields are defined in 9.4.2.1.

The Number of Allocations field indicates the number, *N*, of Channel Allocation fields following it.

Each Channel Allocation field starts with a Scheduling Type subfield, which defines the format of the remaining of the Channel Allocation field.

If the Scheduling Type subfield is 0, the Channel Allocation field contains incremental signaling to the Extended Schedule element. In this case, the Channel Allocation field is defined in Figure 36 and specifies the allocation and the bandwidth that the allocation occupies.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 | B1-B24 | B25 | B26-B33 | B34 | B35-B43 | B44-B45 | B46-B47 |
|  | Scheduling Type | Allocation Key | Channel Aggregation | BW | Asymmetric Beamforming Training | Receive Direction | Nmax STS | Reserved |
| Bits: | 1 | 24 | 1 | 8 | 1 | 9 | 2 | 2 |

**Figure 36 —Channel Allocation field format when Scheduling Type is 0**

The contents of the Allocation Key subfield are used to identify the allocation. This is done by matching the contents of this subfield with the information obtained from the Extended Schedule element transmitted in the same frame containing the EDMG Extended Schedule element. The Allocation Key subfield is formatted as shown in Figure 37.

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**Figure 37 —Allocation Key field format**

The Allocation ID, Source AID and Destination AID subfields are collectively used to identify the allocation included as part of the Extended Schedule element. The Channel Aggregation and BW subfields are defined in Table 16. These fields specify the channel(s) over which the allocation is scheduled on. The Asymmetric Beamforming Training subfield is set to 1 to indicate that this allocation is dedicated to performing the procedure specified in 10.38.9. Otherwise, this field is set to 0.

The Receive Direction subfield indicates the receive antenna configuration that the PCP or AP uses during the allocation and is formatted as shown in Figure 38. The Receive Direction subfield is reserved if the Asymmetric Beamforming Training is zero.

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**Figure 38 —Receive Direction subfield format**

The IsDirectional subfield is set to 1 to indicate that the PCP or AP uses a directional, non quasi-omni antenna pattern to receive frames during the allocation, and is set to 0 otherwise. The Sector ID subfield is reserved if the IsDirectional subfield is 0. Otherwise, the Sector ID subfield indicates the sector that the AP or PCP uses to receive frames during this allocation.

The DMG Antenna ID subfield is reserved if the IsDirectional subfield is 0. Otherwise, the DMG Antenna ID subfield indicates the DMG antenna that the AP or PCP uses to receive frames during this allocation.

The Nmax STS field indicates the maximum number of consecutive space-time slots a responder can occupy within a listen period of Asymmetric Beamforming Training. The actual value is given by 2Nmax STS in which case the Nmax STS field content is interpreted as an integer value. The Nmax STS field is reserved if the Asymmetric Beamforming Training is zero.

If the Scheduling Type subfield is 1, the Channel Allocation field contains the complete allocation scheduling information. In this case, the Channel Allocation field is defined in Figure 39.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 | B1 | B2-B9 | B10 | B11-B19 | B20-B21 | B22-B23 | B24-B143 |
|  | Scheduling Type | Channel Aggregation | BW | Asymmetric Beamforming Training | Receive Direction | Nmax STS | Reserved | Allocation |
| Bits: | 1 | 1 | 8 | 1 | 9 | 2 | 2 | 8×15 |

**Figure 39 —Channel Allocation field** 1 **format when Scheduling Type is 1**

The Allocation subfield is defined in Figure 9-517. Other subfields are defined in the paragraphs above.

**10.38.9.3.3 Beamforming training allocation in DTI**

A beamforming training allocation in the DTI is scheduled through the EDMG Extended Schedule element. A beamforming training allocation has the Asymmetric Beamforming Training subfield for the allocation equal to 1. Channel access during a beamforming training allocation is as follows:

The PCP or AP shall sequentially listen on each combination of sector and DMG antenna which was used for DMG Beacon transmission during the last BTI. The period of listen time spent of each sector is equal to TXTIME(SSW) and the interval between each listen period is equal to MBIFS. The sector listen order shall be the same that was used for DMG Beacon transmission during the BTI.

A responder transmits an SSW or Short SSW packet during the intiator’s listen period that corresponds to the best sector during the last BTI. The responder’s transmission is performed in directional mode using the sector trained by TRN-R in the last BTI (some level of antenna reciprocity is required).

To avoid collisions inside one sector, several time slots (space-time slots) may be assigned by the PCP or AP for responders’ transmissions.

A responder may transmit more than one consecutive SSW or short SSW packets within one listen period but shall not exceed the maximum number of space-time slots a responder can occupy which is given by 2Nmax STS.

After transmitting the SSW or Short SSW packet(s), the responder switches to directional receive in the sector trained by TRN-R in the last BTI.

After the PCP or AP completes cycling through all sectors, it transmits a Sector ACK frame in each sector where it received an SSW or Short SSW packet. The Sector ACK frame contains the information about the STAs that have been during the allocation. In case several SSW or short SSW packets have been received from a STA, the Sector ACK refers to that received SSW or short SSW packet which has been received with best quality. The determination of which packet has been received with best quality is implementation dependent.

An example of beamforming training for asymmetric links of two EDMG STAs and an EDMG PCP or AP is shown in Figure 53. In the example, STA#1, which selected SectorID equal to 0 during the BTI, transmits the SSW frame with a beamforming link determined by the TRN-R appended during the last BTI. For the transmission, STA#1 selects the second (out of four) slot corresponding to the SectorID equal to 0 slot time. After the reception of all slots, the AP or PCP determines the sectors of each discovered STA and can transmit a Sector ACK frame using a directional antenna pattern, A Sector ACK is sent through each desired sector sequentially, while responder STAs listen directionally with their beamforming link.