IEEE P802.11
Wireless LANs

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| [Draft text for Scheduling for mmWave Distribution Networks] |
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Abstract

[This document proposes draft changes to include scheduling mechanism for mmWave Distribution Networks as described in 17/1323r2.]

**3.1 Definitions**

***Change the following definitions***

**source directional multi-gigabit (DMG) station (STA)**: In a service period (SP) with the TDD Applicable SP subfield equal to 1, it is a DMG STA that is expected to transmit at the start of each time division duplex (TDD) SP. Otherwise, it is the ~~A~~ DMG STA identified by the source association identifier (AID) field contained in a Grant frame or Extended Schedule element that caused the allocation of a service period (SP) or contention based access period (CBAP).

**destination directional multi-gigabit (DMG) station (STA)**: In a service period (SP) with the TDD Applicable SP subfield equal to 1, it is a DMG STA that is expected to receive at the start of each time division duplex (TDD) SP. Otherwise, it is the ~~A~~ DMG STA identified by the destination association identifier (AID) field contained in a Grant frame or Extended Schedule element that caused the allocation of a service period (SP) or a contention based access period (CBAP).

**3.2 Definitions specific to IEEE Std 802.11**

*Insert the following definition*

**Time division duplex (TDD) service period (SP)**: An SP that has the TDD Applicable SP subfield in an Allocation field within an Extended Schedule element equal to 1.

**10.36.6 Channel access in scheduled DTI**

**10.36.6.2 Service period (SP) allocation**

***Insert the following subclause heading before the first paragraph***

**10.36.6.2.1 General**

***Add the following paragraphs following the 1st paragraph:***

If an SP has the TDD Applicable SP subfield in an Allocation field within an Extended Schedule element equal to 1, it is an SP with TDD channel access (i.e., TDD SP) and the rules specified in 10.36.6.2.2 for TDD channel access during the SP shall apply. Otherwise, the TDD channel access rules shall not apply and the SP does not use the TDD channel access rules.

A DMG STA shall transmit or receive in a TDD SP only if the TDD Channel Access Supported subfield in the STA’s DMG Capabilities element is 1.

A TDD SP comprises a sequence of TDD intervals that, in turn, comprise a sequence of TDD slots (see 10.36.6.2.2). TDD intervals and TDD slots exist only in a TDD SP. Unless otherwise specified, the rules applicable to an SP shall also be applicable to TDD slots within a TDD SP.

***Change the 2nd paragraph as follows:***

An SP that is not a TDD SP is assigned to the source DMG STA identified in the Source AID subfield in an Allocation field that is not an obsolete allocation within the Extended Schedule element. The source DMG STA shall initiate the frame exchange sequence that takes place during the SP at the start of the SP, except when the source DMG STA intends to establish a DMG protected period in which case the rules described in 10.36.6.6 shall be followed before the source DMG STA initiates the frame exchange in the SP. The SP allocation identifies the TC or TS for which the allocation is made; however, the type of traffic transmitted is not restricted to the specified TC or TS (11.4.1).

***Change the 3rdparagraph as follows:***

Except when transmitting a frame as part of the SP recovery procedure (10.36.6.7) or transmitting a response to the source DMG STA or transmitting a PPDU as part of an RD response burst (10.28) or in a TDD slot, the STA identified by the Destination AID field in the Extended Schedule element should be in the receive state for the duration of the SP in order to receive transmissions from the source DMG STA. If the Destination AID field of the scheduled SP is equal to the broadcast AID and if the Source AID field of the scheduled SP is not equal to the broadcast AID, then all STAs on the PBSS/infrastructure BSS should be in the receive state in order to receive transmissions from the source DMG STA for the duration of the SP. Subclause 10.36.7 describes the rules for when the scheduled SP has both the Source and Destination AID fields equal to the broadcast AID.

***Change the 8thparagraph as follows:***

When scheduling two adjacent SPs where at least one of the SPs has the TDD Applicable SP subfield set to 0, the AP or PCP should allocate the SPs separated by at least aDMGPPMinListeningTime if one or more of the source or destination DMG STAs participate in both SPs. Otherwise, there is no separation between the SPs (see 10.36..6.2.2).

***Insert the following section***

**10.36.6.2.2 SP with TDD Channel Access**

A DMG AP or DMG PCP shall set the AllocationType subfield to 0 and the TDD Applicable SP subfield to 1 in an Allocation field within an Extended Schedule element to indicate a TDD SP allocation.

When allocating a TDD SP, the AP or PCP shall set both of the Source AID and Destination AID subfields in the corresponding Allocation field to 0.

If an Extended Schedule element includes at least one TDD SP, a DMG PCP or DMG AP shall include the Extended Schedule element in each transmitted DMG Beacon frame.

The structure of TDD SP is shown in Figure 10-xxx1. A TDD SP consists of one or more consecutive identical TDD intervals. A TDD interval comprises one or more TDD slots.



**Figure 10-xxx1---Example of a TDD SP**

The parameters of the TDD structure and guard times that are used within a TDD SP are defined by the TDD Slot Structure element (9.4.2.xxx1). A DMG AP or DMG PCP shall transmit a TDD Slot Structure element to each DMG STA that is expected to transmit or receive during a TDD SP. The TDD Slot Structure element may be included in DMG Beacon or Announce frames transmitted by the DMG AP or DMG PCP. Upon reception of a TDD Slot Structure element corresponding to allocations identified by the Allocation ID subfield value within the element, a DMG STA shall adopt the TDD structure within the element for all the TDD SPs identified by the same Allocation ID subfield value until the time it receives an updated TDD Slot Structure element from the DMG AP or DMG PCP for the allocation. The TDD structure shall be adopted at the time indicated by the value of the Slot Structure Start Time subfield within the element.

A DMG STA shall not transmit during a TDD SP unless it receives a TDD Slot Schedule element that indicates it is assigned to at least one TDD slot within the TDD SP by the DMG AP or DMG PCP. The DMG AP or DMG PCP shall transmit the TDD Slot Schedule element to each DMG STA that is assigned to access the TDD SP through an Announce frame or Association Response frame before the time indicated by the value of the Slot Schedule Start Time within the element. Upon reception of a TDD Slot Schedule element corresponding to allocations identified by the Allocation ID subfield value within the element, a DMG STA shall adopt the schedule within the element at the time indicated by the value of the Slot Schedule Start Time subfield within the element.

The type of a TDD slot can be one of simplex TX, simplex RX or unassigned. Except for an unassigned TDD slot where no transmissions shall occur, the behavior of a DMG AP or DMG PCP in a TDD slot is different from the behavior of a non-AP and non-PCP STA depending if the TDD slot is simplex TX or simplex RX:

* At the start of a simplex TX TDD slot, the DMG AP or DMG PCP should initiate transmissions addressed to the non-AP and non-PCP STA assigned to the TDD slot, and the non-AP and non-PCP STA that is assigned to this TDD slot shall be beamformed towards the AP or PCP and remain in the receive state for the duration of the TDD slot in order to receive transmissions from the AP or PCP.
* At the start of a simplex RX TDD slot, a non-AP and non-PCP STA that is assigned to the TDD slot shall initiate transmissions addressed to the AP or PCP, and the DMG AP or DMG PCP shall be beamformed towards the assigned STA and remain in receive state for the duration of the TDD slot in order to receive transmissions from the STA.

Adjacent TDD slots shall be separated in time by the guard times identified in Figure 10-xxx1 and defined in the TDD Slot Structure element.

The reverse direction protocol (see 10.28) shall not be used in a TDD SP.

**9.4.2.128 DMG Capabilities element**

**9.4.2.128.2 DMG STA Capability Information field**

***Insert a 1 bit field named***“TDD Channel Access Supported” ***in Figure 9-504***

***Insert the following paragraph at the end of the subclause***

The TDD Channel Access Supported subfield is set to 1 to indicate that the STA supports the TDD channel access described in 10.36.6.2.2. The subfield is set to 0 otherwise.

**9.4.2.132 Extended Schedule element**

***Change Figure 9-518 as follows:***

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 B3 | B4 B6 | B7 | B8 | B9 | B10 | B11 | B12 | B13 B15 |
|  | Allocation ID | Allocation Type | Pseudo-static | Truncatable | Extendable | PCP Active | LP SC Used | TDD Applicable SP | Reserved |
| Bits: | 4 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | ~~4~~3 |

**Figure 9-518---Allocation Control subfield format**

***Add the following paragraph at the end of this subclause:***

The TDD Applicable SP subfield is set to 1 to indicate the SP allocation is using TDD channel access as described in 10.36.6.2.2. Otherwise, it is set to 0.

***Insert the following subclauses:***

**9.4.2.xxx1 TDD Slot Structure element**

The TDD Slot Structure element defines the structure of a TDD SP described in 10.36.6.2.2. The format of the TDD Slot Structure element is shown in Figure 9-xxx1.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Element ID Extension | Slot Structure Control | Slot Structure Start Time | Allocation Block Duration | Slot Schedule |
| Octets | 1 | 1 | 1 | 4 | 4 | 2 | M |

**Figure 9-xxx1---TDD Slot Structure element format**

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

The Slot Structure Control field is defined in Figure 9-xxx2.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Number of TDD Slots per TDD Interval | GT1 Duration  | GT2 Duration | GT3 Duration | Allocation ID | Allocation Block Duration Validity | Reserved |
| Bits | 4 | 5 | 5 | 5 | 4 | 1 | 8 |

**Figure 9-xxx2---Slot Structure Control field format**

The Number of TDD Slots per TDD Interval subfield indicates the number of TDD slots in each TDD Interval.

The GT1 Duration, GT2 Duration and GT3 Duration subfields indicate the durations, in microseconds, of the GT1, GT2 and GT3 guard times shown in Figure 10-xxx1.

The Allocation ID subfield is set to the same value of the Allocation ID subfield in Allocation Control field of the Extended Schedule element describing the TDD SP allocation.

The Allocation Block Duration Validity subfield is set to 0 to indicate that the duration of the TDD SP is unlimited across consecutive BIs. Otherwise, if the duration of the SP is limited to the value of the Allocation Block Duration field, this subfield is set to 1.

The Slot Structure Start Time subfield indicates the lower 4 octets of the TSF timer at the start of the first TDD SP in which the slot structure takes effect.

The Allocation Block Duration field indicates the duration, in microseconds, of the SP.

The Slot Schedule field is defined in Figure 9-xxx3. The size of this field in octets, *M*, is equal to the value of the Number of TDD Slots per TDD Interval subfield (see Figure 9-xxx2).

|  |  |  |  |
| --- | --- | --- | --- |
|  | TDD slot 1 Duration | … | TDD slot M Duration |
| Bits | 8 | 8 | 8 |

**Figure 9-xxx3--- Slot Schedule field format**

The TDD slot *i* Duration subfield, 1 ≤ *i* ≤ *M*, indicates the duration, in microseconds, of the ith TDD slot in each TDD interval.

**9.4.2.xxx2 TDD Slot Schedule element**

The TDD Slot Schedule element defines the access assignment of DMG STAs to TDD slots within a TDD SP (see 10.36.6.2.2). The format of the TDD Slot Schedule element is shown in Figure 9-xxx4.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Element ID Extension | Slot Schedule Control | Bitmap and Access Type Schedule |
| Octets | 1 | 1 | 1 | 7 | $$\left⌈\frac{Q×M}{4}\right⌉$$ |

**Figure 9-xxx4---TDD Slot Schedule element format**

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

The Slot Schedule Control field is defined in Figure 9-xxx5.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Channel Aggregation | BW | Slot Schedule Start Time | Number of TDD Intervals in the Bitmap | Allocation ID | Reserved |
| Bits | 1 | 8 | 32 | 10 | 4 | 1 |

**Figure 9-xxx5--- Slot Schedule Control field format**

The Channel Aggregation and BW subfields are defined in Table 24.

The Slot Schedule Start Time subfield indicates the lower 4 octets of the TSF timer at the start of the first TDD interval in which the schedule takes effect.

The Number of TDD Intervals in the Bitmap subfield indicates the number of TDD intervals in the bitmap following the time indicated by the Slot Schedule Start Time subfield.

The Allocation ID subfield is set to the same value of the Allocation ID subfield in Allocation Control field of the Extended Schedule element describing the SP allocation.

The Bitmap and Access Type Schedule field defines the type of a TDD slot and the access permission of a DMG STA to the TDD slots covered by this bitmap. Each pair of consecutive 2 bits indicates the type and access permission of the TDD slot. A value of 00 (binary) indicates that the TDD slot is unassigned. A value of 01 (binary) indicates the STA is assigned to a simplex TX TDD slot. A value of 10 (binary) indicates the STA is assigned to a simplex RX TDD slot. Value 11 (binary) is reserved. The size of the Bitmap and Access Type Schedule field is a function of the value of the Number of TDD Slots per TDD Interval subfield in the TDD Slot Structure element, *M*, and the value of the Number of TDD Intervals in the Bitmap subfield, *Q*.

**Straw Poll:**

* **Do you agree to include the text changes proposed in (11-17-1640-00-00ay-Draft text for Scheduling for mmWave Distribution Networks) to the spec draft?**

References:

1. 11-17-1323-02-00ay-scheduling-for-mmwave-distribution-networks.pptx
2. 802.11ay D0.8