### IEEE P802.11Wireless LANs

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| PDT MAC Power Save |
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Introduction

Trying to make progress to meet the TGbn timeline, several contributors on the topic of power save have worked together to prepare this document detailing the proposals in text style to further clarify the proposals. The intent is to work with all TTT members of Power Save topic to prepare an official spec text proposal.

This document is based on the following SFD agreements related to Dynamic Power Save and eMLSR topic:

* [Motion #9] TGbn defines a power save mode for a STA that is a UHR Mobile AP or a UHR non-AP STA wherein the STA may transition from a lower capability mode to a higher capability mode upon reception of an initial control frame
	+ Lower capability mode (e.g., 20 MHz BW, one SS, limited data rates, PPDU format)
	+ Higher capability mode (e.g., operating BW, NSS and MCSs, with at least one higher capability than that in the lower power capability mode)
	+ Initial Control frame is TBD
	+ Whether that applies for a non-mobile AP is TBD
* [Motion #10] TGbn defines cross link power save signaling mechanism
* Allowing a non-AP MLD to indicate to its associated AP MLD that supports the mechanism, in a frame sent on one enabled link, the power management mode for one or more of its affiliated non-AP STAs
* Whether support for the mechanism is mandatory or optional is TBD
* [Motion #45] An UHR STA that uses the power save mode to transition from lower capability (LC) mode to higher capability (HC) mode, advertises the amount of padding it needs in a received initial control frame
	+ Padding values range between 0 and a maximum value that is TBD with a TBD resolution
* ~~[Motion #49] Define a new mechanism and/or enhance existing mechanism for AP power save~~
* [Motion #122] If a UHR STA (UHR non-AP STA or UHR Mobile AP) operates with the power save mode where the STA transitions from a lower capability mode to a higher capability mode upon reception of an initial control frame (that we call power save mode dynamic power save (DPS)), then its associated peer UHR STA shall include an intermediate FCS, if needed by the STA, in the initial control frame that it transmits to the STA
	+ Note: intermediate FCS may not be needed, for instance, if the STA requires no padding
* ~~[Motion #161] Scheduled periodic power save on AP side is performed in UHR using Broadcast TWT with TWT ID=0 with Responder PM=1 as described in 26.8.3.2 (Rules for TWT scheduling AP)~~
* [Motion #154] If a UHR non-AP MLD operates in the eMLSR mode, then its associated UHR AP MLD, that supports transmitting intermediate FCS, shall include an intermediate FCS, if needed by the non-AP MLD, in every Initial Control Frames for eMLSR transmitted to the non-AP MLD through its affiliated APs on the eMLSR links?
	+ Mandatory/optional support for transmitting intermediate FCS is TBD
	+ The field that carries the Intermediate FCS shall be designed to be ignored by legacy STAs if they are scheduled in the same initial control frame
	+ Note: intermediate FCS may not be needed, for instance, if the STA requires no padding.
* [Motion #12] TGbn defines a way in 11bn to include in an initial control frame (ICF) an intermediate FCS for UHR STA(s) that precedes padding and the FCS field
* [Motion #47] If an ICF includes an intermediate FCS for UHR STA(s) that precedes padding and the FCS field, the intermediate FCS has the size of 32 bits.

***TGbn editor: Please modify the following subclause 9.2.4.6.4 HE variant***

**9.2.4.6.4 HE variant
*Change Table 9-25 (Control ID subfield values) as follows:***

**Table 9-25—Control ID subfield values**

|  |  |  |  |
| --- | --- | --- | --- |
| **ControlID value**  | **Meaning** | **Length of theControlInformationsubfield (bits)** | **Content of the Control Informationsubfield** |
| **…** |  |  |  |
| 10 | Multi-link power management (MLPM) | TBD | See 9.2.4.7.12 (MLPM Control) |
| 11–14~~7–14~~ | Reserved |  |  |
| 15  | Ones need expansion surely (ONES)  | 26  | Set to all 1s |

***TGbn editor: Please add the following subclause 9.2.4.7.12 MLPS Control after 9.2.4.7.11 ELA Control in D2.3***

**9.2.4.7.12 MLPM Control**

The Control Information subfield in an MLPM Control subfield that contains the power management mode of non-AP STA(s) affiliated with a non-AP MLD.

The format of this subfield is TBD.

**9.3.1.22 Trigger frame format**

***TGbn editor: Please add a new subclause as follows***

**9.3.1.22.X Intermediate FCS** [Motion #12]

The Intermediate FCS contains a CRC that is calculated following the rules in 9.2.4.9 (FCS field) except that the *calculation fields* only include all of the fields of the MAC header and the Frame Body field up to and excluding the field(s) that contains the intermediate FCS field. How the intermediate FCS field is carried in the Trigger frame is TBD.

The intermediate FCS is 32 bits. The intermediate FCS is located before the padding and the FCS field of the Trigger frame, with specific location and format that is TBD. [Motion #47]

The Intermediate FCS field is not present except in a Trigger frame that is used as an initial Control frame subject to the requirements defined in 37.x.x (Padding for an Initial Control Frame).

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**9.4.1 Fields that are not elements**

***TGbn editor: Please add the following subclause in 9.4.1:***

**9.4.1.xx DPS Operation Parameters field** [Motion #45][Location TBD]

The DPS Operation Parameters field is defined in Figure 9-xx (DPS Operation Parameters field format).

 B0 B7 B8 B15

|  |  |
| --- | --- |
| DPS Padding Delay | DPS Transition Delay |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Bits: | 8 |  | 8 |  |

Figure 9-xx DPS Operation Parameters field format

The DPS Padding Delay field indicates the minimum MAC padding duration that is required by a DPS STA in an initial Control frame to cause the STA to transition from the lower capability mode to the higher capability mode and is calculated as defined in 37.x.x (Padding for an Initial Control frame). The DPS Padding Delay field contains an unsigned integer, in TBD units, that indicates a delay between 0 and TBD µs.

[TBD] The DPS Transition Delay field indicates the minimum amount of time required by a DPS STA to transition from the higher capability mode to the lower capability mode. The DPS Transition Delay field contains an unsigned integer, in TBD units, that indicates a delay between 0 and TBD µs.

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**9.4.2 Elements**

**9.4.2.1 General**

 ***TGbn editor: Please insert a new row as follows:***

**Table 9-128—Element IDs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Element** | **Element ID** | **Element ID Extension** | **Extensible** | **Fragmentable** |
| … |  |  |  |  |
| UHR Capabilities (see [9.4.2.x (UHR](#_bookmark180)  [Capabilities element)](#_bookmark180)) | 255 | <ANA> | Yes | No |
| UHR Operation (see [9.4.2.x (UHR](#_bookmark180)  [Operation element)](#_bookmark180)) | 255 | <ANA> | Yes | No |

**9.4.2.xx UHR Capabilities**

~~A STA declares that it is an UHR STA by transmitting the UHR Capabilities element.~~

~~The UHR Capabilities element contains a number of fields that are used to advertise the UHR capabilities of a UHR STA. The UHR Capabilities element is defined in Figure 9-xxxx (UHR Capabilities element for[mat)](#bookmark249).~~

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ~~Element ID~~ | ~~Length~~ | ~~Element ID Extension~~ | ~~UHR MAC~~~~Capabilities Information~~ | ~~UHR PHY~~~~Capabilities Information~~ | ~~Supported UHR-MCS~~~~And NSS Set~~ |

~~Octets: 1 1 1 TBD TBD variable~~

**~~Figure 9-xxx—UHR Capabilities element format~~**

**9.4.2.xx.2** **UHR MAC Capabilities Information field**

The format of the UHR MAC Capabilities Information field is defined in [Figure 9-xxxx (UHR MAC](#bookmark2) [Capabilities Information field format)](#bookmark3). [TBD]

 B0 B1 B2 B3 Bx

|  |  |  |  |
| --- | --- | --- | --- |
| DPS Support | DPS Assisting Support | Multi-Link Power Management | Reserved |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Bits: | 1 |  1  |  1  |  |  TBD  |

[Figure 9-xxxx UHR MAC](#bookmark2) [Capabilities Information field format](#bookmark3)

The fields of the UHR MAC Capabilities Information field are defined in [Table 9-xxxx (Fields of the](#bookmark4) [UHR MAC Capabilities Information field)](#bookmark5).

**Table 9-xxxx Fields of the UHR MAC Capabilities Information field**

|  |  |  |
| --- | --- | --- |
| **Field** | **Definition** | **Encoding** |
| DPS Support | Indicates whether or not DPS is supported | Set to 1 if dot11DynamicPowerSaveSupport is true (see 37.X.1 (Dynamic Power Save (DPS) operation).Set to 0 otherwise. |
| DPS Assisting Support | Indicates whether or not the transmission of an ICF for DPS is supported. | Set to 1 if dot11DynamicPowerSaveAssistingSupport is true (see 37.X.1 (Dynamic Power Save (DPS) operation).Set to 0 otherwise. |
| Multi-Link Power Management Support | Indicates whether or not the multi-link power management is supported | For an AP MLD Set to 1 if the AP MLD supports the reception of frames with the multi-link power management signal. Set to 0 otherwise.For an non-AP MLD Set to 1 if the non-AP MLD supports the transmission of frame with multi-link power management signal. Set to 0 otherwise. |

 ***TGbn editor: Please insert a new subclause as follows:***

**9.4.2.x UHR Operation element**

The operation of UHR STAs in an UHR BSS is controlled by the following:

* The HT Operation element, HE Operation element, EHT Operation element, and UHR Operation element if operating in the 2.4 GHz band
* The HT Operation element, VHT Operation element (if present), HE Operation element, EHT Operation element, and UHR Operation element if operating in the 5 GHz band
* The HE Operation element, EHT Operation element and UHR Operation element if operating in the 6 GHz band

The format of the UHR Operation element is shown in [Figure 9-X (UHR Operation element format)](#bookmark181).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Element ID | Length | Element ID Extension | UHR Operation Parameters | Basic UHR-MCS And Nss Set | DPS Operation Parameters |

Octets: 1 1 1 TBD TBD 0 or TBD

**Figure 9-X—UHR Operation element format**

The Element ID, Length, and Element ID Extension fields are defined in [9.4.2.1 (General)](#bookmark6).

The format of the UHR Operation Parameters field is defined in [Figure 9-Y (UHR Operation Parameters field format(11bn))](#bookmark182).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | B0 | B1 | B2 | B3 | B4 B5 | B6 BX |
|  | DPS Enabled | Reserved | Reserved | Reserved | Reserved | Reserved |
| Bits: | 1 | 1 | 1 | 1 | 2 | Y |
|  |

**Figure 9-Y—UHR Operation Parameters field format**

The DPS Enabled field is set to 1 if the AP sending a frame containing the UHR Operation Parameters field is a mobile AP (TBD for non-mobile AP) and dynamic power save (DPS) is enabled at the AP and set to 0 otherwise.

[field location TBD] The DPS Operation Parameters field contains parameters for dynamic power save operation as defined in 9.4.1.xx (DPS Operation Parameters). The DPS Operation Parameters field is present if the DPS Enabled field is 1. The DPS Operation Parameters field is not present if the DPS Enabled field is 0.

***T***

**~~9.6.39 Protected UHR Action frame details~~**

**~~9.6.39.1 Protected UHR Action field [TBD]~~**

~~A Protected UHR Action field, in the octet immediately after the Category field, differentiates the Protected UHR Action frame formats. The Protected UHR Action field values associated with each frame format within the UHR category are defined in [Table 9-xxx (Protected UHR Action field values)](#_bookmark328).~~

**~~Table 9-xxx—Protected UHR Action field values~~**

|  |  |  |
| --- | --- | --- |
| **~~Value~~** | **~~Meaning~~** | **~~Time priority~~** |
| ~~0~~ | ~~UHR Operating Mode Notification~~ | ~~No~~ |
| ~~3–255~~ |  |  |

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**37. Ultra High Reliability (UHR) MAC specification**

***TGbn editor: Please insert a new subclause as follows***

**37.X Power Management**

**37.X.1 Dynamic Power Save (DPS) operation**

A UHR non-AP STA that has dot11UHRDPSAssistingSupported equal to 1 is called a DPS assisting non-AP STA and shall set the DPS Assisting Support field to 1 in the UHR Capabilities element in Management frames that it transmits. A UHR AP that has dot11UHRDPSAssistingSupported equal to 1 is called a DPS Assisting AP and shall set the DPS Assisting Support field to 1 in the UHR Capabilities element in Management frames that it transmits. Otherwise the UHR AP or non-AP STA shall set the DPS Assisting Support subfield to 0.

A UHR non-AP STA that has dot11UHRDPSSupported equal to 1 and that has enabled its DPS mode is called a DPS non-AP STA.

[TBD] A UHR non-AP STA may enable the DPS mode only if its associated AP is a DPS Assisting AP. When a UHR non-AP STA intends to enable the DPS mode, then:

* the non-AP STA shall transmit an TBD Request frame with the DPS Mode field of the UHR Control field set to 1 to the AP, and include a DPS Operation Parameters field in the TBD Request frame.
* The AP shall respond with a TBD Response frame to the non-AP STA, after the AP is ready to serve the non-AP STA in the DPS mode, .

[TBD] When a DPS non-AP STA intends to disable the DPS mode, then:

* the non-AP STA shall transmit an TBD request frame with the DPS Mode field of the frame set to 0 to its associated AP.
* the associated AP shall transmit an TBD response frame to the non-AP STA, after the AP is no longer serving the non-AP STA in the DPS mode, .

A UHR AP that has dot11UHRDPSSupported equal to 1 and that has enabled its DPS mode is called a DPS AP.

A AP may enable its DPS mode only under TBD conditions. A DPS AP shall have value 1 in its transmitted DPS Enabled field to announce that it has enabled DPS and 0 otherwise. The mechanism for enablement/disablement of DPS by anAP is TBD.

A DPS STA is either a DPS non-AP STA or a DPS mobile AP. It is TBD whether an AP that is not a Mobile AP may be a DPS AP or not.

The DPS operation allows a DPS STA to operate in lower capability (LC) mode and to transition to higher capability (HC) mode upon reception of an initial Control frame [TBD] transmitted by its associated DPS assisting STA. The DPS STA in higher capability (HC) mode transitions back to the LC mode under TBD conditions.

Motion #9] A DPS STA that is in LC mode shall be capable of receiving TBD PPDUs (e.g., with non-HT (dup)format using a rate of 6 Mbps, 12 Mbps, 24Mbps?). A DPS STA that is in HC mode (e.g., operating BW, NSS and MCSs) shall be capable of receiving all supported PPDU formats corresponding to the HC mode.

[Motion #9] [Motion #122] A DPS assisting STA shall solicit the transition of the peer DPS STA to HC mode by sending an initial control frame, which is transmitted in non-HT (dup) PPDU using a rate of 6 Mb/s, 12 Mb/s, or 24 Mb/s [TBD]. The initial control frame addressed to the DPS STA shall include an intermediate FCS field if the DPS STA has indicated a non zero DPS padding delay and shall include sufficient padding to ensure that the padding requirement(s) of the DPS STA(s) that are addressed by that ICF are satisfied as defined in 37.5.2.2.3 (Padding for a UHR initial Control frame). It is TBD whether a DPS assisting STA shall initiate any frame exchange with a DPS STA by sending an ICF or only some frame exchanges.

**~~37.x.2 AP power save~~**

~~An AP can use a new mechanism and/or enhance existing mechanism for AP power save.~~

~~An AP~~ ~~may announce the Broadcast TWT schedule with TWT ID field equal to 0 and Responder PM field equal to 1 as described in 26.8.3.2 (Rules for TWT scheduling AP) to implement the scheduled periodic power.~~

**37.x.2 Multi-Link power management signaling**[Motion #10]

A non-AP MLD that has dot11UHRMLPMImplemented set to 1 supports Multi-Link power management signaling, is called an MLPM non-AP MLD and shall set to 1 the Multi-Link Power Management Support field in the UHR MAC Capabilities Information field in Management frames that it transmits.

An AP MLD that has dot11UHRMLPMImplemented set to 1 supports Multi-Link power management signaling, is called an MLPM AP MLD and shall set to 1 the Multi-Link Power Management Support field in the UHR MAC Capabilities Information field in Management frames that it transmits.

A non-AP STA affiliated with an MLPM non-AP MLD may transmit a frame that carries an MLPM Control field to indicate the power management mode of the other non-AP STA(s) affiliated with the same non-AP MLD and operating on an enabled link. (Signaling TBD)

A non-AP STA affiliated with the MLPM non-AP MLD, for which a power management mode change has been indicated through the MLPM signaling, follows the rules defined in 11.2.3.2 (non-AP STA power management modes) for that changed power management mode.

If an MLPM AP MLD receives, via an affiliated AP, a power management mode change for a non-AP STA affiliated with an associated MLPM non-AP MLD and operating on an enabled link, then the AP affiliated with the MLPM AP MLD and operating on the corresponding enabled link follows the rules defined in 11.2.3.6 (AP operation) and 35.3.12 (ML power management) for the changed power management mode of the non-AP STA, as if it had received, on the link, a frame, from the non-AP STA, that indicates the same power management change..

***TGbn editor: Please insert a new subclause as follows***

**37.x1 Enhanced multi-link single-radio (EMLSR) operation for a UHR non-AP MLD [**Motion #154**]**

A UHR AP MLD with dot11EHTEMLSROptionActivated equal to true shall follow the rules defined in 35.3.17 (Enhanced multi-link single-radio (EMLSR) operation) and in this subclause.

In EMLSR mode, a UHR non-AP MLD shall follow the rules defined in 35.3.17 (Enhanced multi-link single-radio (EMLSR) operation) and in this subclause.

If a UHR non-AP MLD operates in the EMLSR mode and is associated to a UHR AP MLD, then:

* the UHR AP MLD shall include an intermediate FCS in the initial Control frame on an eMLSR link, if needed by the non-AP MLD..
* The AP affiliated with the AP MLD shall set the length of the Padding field of the initial Control frame based on the rules defined in 37.x2.x (Padding for a Trigger frame) when the intermediate FCS field is present),.

***TGbn editor: Please insert a new subclause as follows***

**37.x2.x Padding for an Initial Control Frame**

[TBD] If an intermediate FCS and padding are required, then a UHR STA affiliated with an MLD shall set the length of the Padding field of a Trigger frame, that is an initial Control frame, based on the rules defined in 35.5.2.2.3 (Padding for a Trigger frame), with the following superseding requirements:

* If a DPS STA is an intended receiver of the Trigger frame and the value in the DPS Padding Delay field received from the DPS STA is more than MinTrigProcTime, then the MinTrigProcTimeis replaced by the value in the DPS Padding Delay field, and the last bit of the field that contains the intermediate FCS is at least *LPAD, MAC*, defined in Equation (35-1), where EMLSR\_PADDING\_DELAY is replaced by the value of the DPS Padding Delay field received from the DPS STA.

Annex C

(normative)

## ASN.1 encoding of the MAC and PHY MIB

### C.3 MIB Detail

WORK IN PROGRESS.