IEEE P802.11
Wireless LANs

|  |
| --- |
| EHT Dynamic SM Power Save |
| Date: 2022-08-31 |
| Author(s): |
| Name | Affiliation | Address | Phone | email |
| Xiaogang Chen | ZEKU  |  |  | Xiaogang.chen@zeku.com |

Abstract

This document proposes the mechanism of EHT dynamic SM power save.

Revisions:

 R0: The initial version of the draft.

R1: adding more discussions.

R2: incorporating comments from Michail

Discussions:

More background can refer to <https://mentor.ieee.org/802.11/dcn/22/11-22-1414-00-0uhr-low-power-listening-mode.pptx> regarding power consumption of listening. EHT SMPS works under the architecture of HE SMPS and EMLSR to enable STR STA leveraging the power saving of listening mode.

**High levels on the proposal:**

Similar with dynamic SMPS, two modes are defined: 1) Listening mode: stand by for the coming packets with one chain. 2) Receiving mode: capable of receiving a PPDU with multiple chains.

**Difference with SMPS:**

1. in the listening mode, receiver is not supposed to receive 1ss with high QAM (e.g. 256 or 1kQAM) but only prepare for a 11a PPDU upto 24Mbps (maximum mandatory rate of 11a).
2. A configurable padding duration is used in the initial control (solicit a transition from listening mode to receiving mode for the STA). This is similar with the padding in EMLSR but could be shorter.



**Complexity analysis:**

**STA:** Same as legacy SMPS, this is optional for STA. STA that implemented STR and want to leverage the power saving in this scheme can implement, otherwise there is no impact on implementation.

**AP:** AP is already required to process the SMPS control field, and AP will need to support initial frame exchange in EMLSR. So, the **extra work** to support EHT SMPS is minimized…AP needs to parse some new capabilities in SMPS control field which are similar with the ones defined in EMLSR.

**Standards**: SMPS is relatively independent to other features because it’s not MLO level(searching D2.2 with “SM power save” get two instances).As long as the process is clearly defined in the following subclause, it won’t impact other features.

**SMPS will not change any existing behavior of EMLSR, because SMPS shall not be conducted on EMLSR link(s).**

-------------------------------------------------------------------------End of discussions--------------------------------------------------------------

To TGbe editor:

***Changes to the following paragraphs in 11.2.6 SM power save***

* SM power save

The basic rules for a STA are defined below. Additional rules for an HE STA in dynamic SM power save mode that sets the HE Dynamic SM Power Save subfield to 1 in the HE MAC Capabilities Information field in the HE Capabilities element it transmits are defined in 26.14.4 (HE dynamic SM power save). Additional rules for an EHT STA in dynamic SM power save mode that sets the EHT Dynamic SM Power Save subfield to 1 in the EHT MAC Capabilities Information field in the EHT Capabilities element it transmits are defined in 35.18 (EHT dynamic SM power save).

***Add the following subclause after the end of clause 35***

35.18 EHT dynamic SM power save

The EHT dynamic SM power save (DSMPS) mode allows a non-AP EHT STA to operate in listening mode and receive a PPDU modulated with low MCS, single spatial stream using a single chain. The listening mode can transit to receiving mode by an initial control frame exchange between AP and non-AP STA, after which the non-AP EHT STA can receive a PPDU subjected to its maximum supported MCS and the maximum supported number of spatial streams.

A non-AP STA that supports EHT DSMPS has dot11EHTDSMPSModeOptionImplemented set to true and shall set the EHT dynamic SM power save support subfield in the EHT capability element it transmits to 1.

A Non-AP EHT STA operates in the EHT DSMPS mode shall follow the rules defined in this subclause.

When a non-AP STA with dot11EHTDSMPSModeImplemented equal to true intends to enable the EHT DSMPS mode, the STA shall transmit an SM Power Save frame to the associated AP with the SM Power Save Enabled field in the SM Power Save frame set to 1. After the successful transmission of the SM Power Save frame (confirmed by the acknowledgement frame from the AP) and after a period of transition delay (indicated in the EHT DSMPS Transition Delay subfield in the SM Power Save frame) following the end of the acknowledgement frame sent by AP, the STA shall operate in the listening mode and shall be able to receive a non-HT or non-HT duplicated PPDU with a rate up to 24 Mbps.

When a non-AP STA with dot11EHTDSMPSModeImplemented equal to true intends to disable the EHT DSMPS mode, the STA shall transmit an SM Power Save frame to the associated AP with the SM Power Save Enabled field in the SM Power Save frame set to 0. After the successful transmission of the SM Power Save frame with the SM Power Save Enabled field in the SM Power Save frame set to 0 (confirmed by the acknowledgement from AP) and after a period of transition delay(indicated by the EHT DSMPS Padding Duration subfield in the SM Power Save frame) following the end of the acknowledgement frame sent by AP, the STA shall be able to receive a PPDU subject to its spatial stream capabilities (see 9.4.2.55.4 (Supported MCS Set field), 9.4.2.157.3 (Supported VHT-MCS and NSS Set field), 9.4.2.248 (HE Capabilities element(11ax))) and 9.4.2.313.4 (Supported EHT-MCS And NSS Set field) and operating mode (see 11.40 (Notification of operating mode changes), 26.9 (Operating mode indication) and 35.10 (Operating mode indication).

Before an EHT AP initiates frame exchange with the EHT non-AP STA(s) operating in the listening mode, the AP shall transmit an initial control frame with the following requirements:

* The initial control frame shall be sent using non-HT or non-HT duplicate PPDU with a rate up to 24Mbps.
* The initial control frame is an MU-RTS Trigger frame, BSRP Trigger frame, or BQRP Trigger frame that includes a User Info field with the AID12 subfield equal to the 12 LSBs of the AID of the non-AP EHT STA.
* The padding duration in the trigger frame shall be greater than or equal to the EHT DSMPS Padding Duration subfield indicated in the SM Power Save frame transmitted by the non-AP EHT STA. If the trigger frame is addressed to multiple non-AP STAs, the padding duration shall be greater than or equal to the maximum EHT DSMPS Padding Duration indicated by all the non-AP STAs.

Note: AP is required to add the padding duration indicated in the EHT DSMPS Padding Duration subfield to the padding field of the trigger frame only if AP intends to solicit a transition for a non-AP STA from listening mode to receiving mode. Otherwise, AP is only required to add the padding duration indicated in the *MinTrigProcTime* subfield indicated by the non-AP STA to the padding field of the trigger frame.

If a non-AP EHT STA indicates support of EHT dynamic SMPS, the EHT AP shall only use the initial control frames that meet the requirements defined in this subclause to solicit the non-AP STA switching from listening mode to receiving mode. If a non-AP EHT STA does not indicate support EHT dynamic SMPS and indicates support of HE dynamic SM power save or SM power save, AP may use the frame exchange defined in 26.14.4 (HE dynamic SM power save) or 11.2.6 (SM Power Save) to enable the multiple receive chains of the non-AP STA.

When a non-AP STA operates in EHT dynamic SM power save mode, the STA shall be able to receive a PPDU subject to its capabilities defined in 9.4.2.55.4 (Supported MCS Set field), 9.4.2.157.3 (Supported VHT-MCS and NSS Set field), 9.4.2.248 (HE Capabilities element(11ax))) and 9.4.2.313.4 (Supported EHT-MCS And NSS Set field) and operating mode defined in 11.40 (Notification of operating mode changes), 26.9 (Operating mode indication) and 35.10 (Operating mode indication) if one of the following conditions is met:

* The STA send an immediate response frame as a response to the initial control frame sent by AP.
* The STA proactively initiates a TXOP with the AP.

The non-AP EHT STA operating in EHT dynamic SM power save mode shall switch back to the listening mode after the end of the frame exchange sequences, followed by the duration indicated in the EHT DSMPS Transition Delay subfield in the SM Power Save frame if any of the following conditions is met and this is defined as the end of the frame exchanges:

* + The MAC of the STA that received the initial Control frame does not receive a PHY-RXSTART.indication primitive during a timeout interval of aSIFSTime + aSlotTime + aRxPHYStartDelay starting at the end of the PPDU transmitted by the STA as a response to the most recently received frame from the AP or starting at the end of the reception of the PPDU containing a frame for the STA from the AP that does not require immediate acknowledgement.
	+ The MAC of the STA that received the initial Control frame receives a PHY-RXSTART.indication primitive during a timeout interval of aSIFSTime + aSlotTime + aRxPHYStartDelay starting at the end of the PPDU transmitted by the STA as a response to the most recently received frame from the AP or starting at the end of the reception of the PPDU containing a frame for the STA from the AP that does not require immediate acknowledgement and the STA does not detect, within the PPDU corresponding to the PHY- RXSTART.indication any of the following frames:
		- an individually addressed frame with the RA equal to the MAC address of the STA
		- a Trigger frame that has one of the User Info fields addressed to the STA
		- a CTS-to-self frame with the RA equal to the MAC address of the AP
		- a Multi-STA BlockAck frame that has one of the Per AID TID Info fields addressed to the STA
		- a NDP Announcement frame that has one of the STA Info fields addressed to the STA
	+ The STA that received the initial Control frame does not respond to the most recently received frame from the AP that requires immediate response after a SIFS.

The AP should transmit before the TXNAV timer expires another initial Control frame addressed to the non-AP STA if the AP intends to continue the frame exchanges with the STA and did not receive the response frame from this STA for the most recently transmitted frame that requires an immediate response after a SIFS.

-----------------------------------------------------------------end of 35.18 EHT dynamic SM power save ------------------------------

***Replace figure 9-154 with the figure below and add the definition of the new subfields as following***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | SM Power Save Enabled | SM Mode | EHT DSMPS Padding Duration | EHT DSMPS Transition Delay | Reserved |
| Bits | 1 | 1 | 2 | 2 | 2 |

Figure 9-154. SM Power Control field format.

The EHT DSMPS Padding Duration subfield indicates the minimum MAC padding duration of the padding field in the trigger frame sent by AP to the non-AP EHT STA in the initial control frame. The encoding of the EHT DSMPS Padding Duration subfield is defined in Table-1x (Encoding of the EHT DSMPS Padding Duration subfield)

Table-1x (Encoding of the EHT DSMPS Padding Duration subfield)

|  |  |
| --- | --- |
| EHT DSMPS Padding Duration subfield value | Minimum MAC padding duration in the trigger frame |
| 0 | Equal to the *MinTrigProcTime* indicated by the non-AP STA |
| 1 | 32 us |
| 2 | 64 us |
| 3 | Reserved |

The EHT DSMPS Transition Delay subfield indicates the minimum duration a non-AP EHT STA required to transit from receiving mode to the listening mode. The encoding of the EHT DSMPS Transition Delay subfield is defined in Table-1y (Encoding of the EHT DSMPS Transition Delay subfield)

Table-1y (Encoding of the EHT DSMPS Transition Delay subfield)

|  |  |
| --- | --- |
| EHT DSMPS Transition Delay subfield value | EHT DSMPS Transition Delay |
| 0 | 0 us |
| 1 | 32 us |
| 2 | 64 us |
| 3 | Reserved |

***Add the following EHT MAC capability in B11 in figure 9-1002ae with the definition of the new capability bit in table 9-401k***

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | B5 | B6 |  | B7 | B8 | B9 | B10 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SCS Traffic Description Support | Maximum MPDU Length | MaximumA-MPDU Length Exponent Extension | EHT TRS Support | TXOP Return Support In TXOP Sharing Mode 2 |

Bits: 1 2 1 1 1

 B11 B12 B15

EHT Dynamic SMPS

Reserved

**Figure 9-1002ae—EHT MAC Capabilities Information field format**

**Table 9-401k—Subfields of the EHT MAC Capabilities Information field**

|  |  |  |
| --- | --- | --- |
| Subfield | Definition | Encoding |
| EHT Dynamic SM Power Save | Indicates support for the EHT dynamic SM power save defined in 35.18 | For a non-AP STA:Set to 1 if supported.Set to 0 if not supported.Reserved for an AP. |

*Add the following MIB Variables in annex C*

Dot11EHTStationConfigEntry ::=
SEQUENCE {

|  |  |
| --- | --- |
| dot11EHTPPEThresholdsRequired dot11TIDtoLinkMappingActivated dot11EHTEPCSPriorityAccessActivated dot11MSDTimerDuration dot11MSDTXOPMAX  | TruthValue,TruthValue,TruthValue,Unsigned32,Unsigned32, |
| dot11EHTDSMPSModeOptionImplemented | TruthValue} |

dot11EHTDSMPSModeOptionImplemented OBJECT-TYPE
SYNTAX TruthValue
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"This is a capability variable. Its value is determined by device
capabilities.
This attribute, when true, indicates that the STA implementation is
capable of operating in EHT dynamic SM power save mode. The capability is disabled otherwise."
DEFVAL { false }
::= { dot11EHTStationConfigEntry 6 }