IEEE P802.11
Wireless LANs

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| OPS |
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Abstract

Rev 2:

* Change HE capabilities
* FILS DF row number changes
* Section 27: OPS general section: better describe the modes
* Clarify that during the OPS period, the AP does not transmit to the STA. Clarify behavior for STAs.

Rev 3:

* Corrected AP behaviour
1. **Introduction**

Interpretation of a Motion to Adopt

A motion to approve this submission means that the editing instructions and any changed or added material are actioned in the TGax Draft. The introduction and the explanation of the proposed changes are not part of the adopted material.

***Editing instructions formatted like this are intended to be copied into the TGax Draft (i.e. they are instructions to the 802.11 editor on how to merge the text with the baseline documents).***

***TGax Editor: Editing instructions preceded by “TGax Editor” are instructions to the TGax editor to modify existing material in the TGax draft. As a result of adopting the changes, the TGax editor will execute the instructions rather than copy them to the TGax Draft.***

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| **CID** | **Clause Number(C)** | **Page** | **Comment** | **Proposed Change** | **Resolution** |
| 11019 | 9.4.2.237.2 | 137 | OPS Support subfield applies only if the STA supports Broadcast TWT | Replace text in 'Encoding' column to:"If Broadcast TWT Support subfield is 1 Set to 1 if supported. Set to 0 otherwise.Reserved otherwise." | Revised – OPS is currently using only the TWT element to determine when the TIM frame is sent. Support on STA or AP side of BC TWT is not needed. OPS works without BC TWT in a much simpler way. Define OPS frame to be self contained. Apply the changes proposed in doc 768r4. |
| 12032 | 9.4.2.6 | 119 | Please ensure that TIM element used in TIM frame or FILS Discovery frame also describes "traditional TIM bit setting rule" that is used for non-OPS STAs. | Add the folllowing bulleted text to line 44:" Bit Number N that corresponds to non-OPS STA with AID N is 1 to indicate that AP has buffered frames for the STA and set to 0 otherwise." | Revised – agree with the commenter. Apply the changes in doc 768r4. |

1. **Discussion**

TWT is designed for STAs in PS mode. It allows to schedule the time spent in awake and doze state.

OPS on the contrary is meant for STAs in active mode. The main use case is STAs with bursty traffic that stay in PS mode (doze state) for long period of time (few seconds) between the bursts of data, and then move to active when the burst happens (as the burst is usually a large amount of data – typical youtube traffic pattern for instance). Those STAs stay in the active mode to try and finish the burst as fast as possible, and to be able to go back to sleep as soon as possible.

In non-congested environments, these STAs don’t need anything for power save, they stay active for just the time they need to finish the DL or UL buffer and go back to sleep. In congested environment, these STAs stay in the active mode for longer time as they need to share the airtime with other STAs. OPS is used in that particular scenario. It allows the AP to send an information to the STAs to tell them if they will not be scheduled in the incoming period (20ms for instance). In such case, the STAs can go to power save and come back active after 20ms. This is a very lightweight solution where the AP does not need to negotiate anything or renegotiate if new STAs get active or leave active mode…

OPS is therefore fully orthogonal from TWT.

OPS got to use TWT for the argument that it is a good way to determine when the TIM frame will be transmitted, and that it was the only thing that would be used in TWT. The issue is that TWT comes with many rules for scheduled and scheduling STAs, for power save and others. This adds unnecessary complexity for supporting this feature. What is needed is just the ability for the STA and AP to know when a frame will be transmitted. The negotiation, rules for operation inside and outside the TWT SP and power save rules are not needed.

For us, the best approach is to not use TWT and simply define a new OPS frame (which solves also coexistence with TIM Broadcast procedure), which contains a TIM element (for the bitmap indicating who will be scheduled and who will not be scheduled) and the duration after the frame for which the OPS information is valid. In such case, we don’t even need to schedule the OPS frame, this is purely unscheduled.

The second option is to define a specific mode inside TWT, with a specific capability element associated to it, for which the only function is to define a time at which a frame will be transmitted.

1. **Proposed changes**

***CID 11019***

***Editor: Insert the following new row into Table 9-262z— Subfields of the HE MAC Capabilities Information field (header row shown for convenience):***

|  |
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| * Subfields of the HE MAC Capabilities Information field
 |
| Subfield | Definition | Encoding |
| OPS Support | For an AP, indicates support for encoding OPS information in the TIM element of FILS Discovery frames or TIM frames or OPS frames as described in 27.14.3.2 (AP operation for opportunistic power save). For a non-AP STA, indicates support for receiving the opportunistic power save encoded TIM elements. | Set to 1 if supported.Set to 0 otherwise. |

* Elements
* General

***Editor: Insert the following new row into Table 9-77 (Element IDs) (header row shown for convenience):***

|  |
| --- |
| * Element IDs
 |
| Element | Element ID | Element ID Extension | Extensible |
| OPS Information (see 9.4.2.xxx OPS Information element) | 255 | ANA | Yes |

Editor: Add a new subclause 9.4.2.xxx OPS Information element

9.4.2.xxx OPS Information element

The OPS Information element provides information needed by STAs when operating with OPS as defined in 27.14.3 (Opportunisitic power save). The format of the OPS Information element is defined in OPS Information element).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Element ID | Length | Element ID Extension | OPS Duration |
| Octets:  | 1 | 1 | 1 | 1 |
| * OPS Information element
 |

The Element ID, Element ID extension and Length fields are defined in 9.4.2.1 (General).

When the OPS Information element is included in an OPS frame or a FILS Discovery frame, the OPS Duration field indicates the OPS period duration, during which a STA may go to doze state if it is explicitly not scheduled during that period, as defined in 27.14.3 (Opportunistic power save). The OPS duration field is encoded in ms.

* HE Action field

***Editor: Insert the following new row into Table 9-421z (HE Action field values):***

|  |
| --- |
| * HE Action field values
 |
| Value | Meaning |
| 2 | OPS |
| 3-255 | Reserved |

Editor: Add a new subclause 9.6.28.xxx OPS frame format:

9.6.28.xxx OPS frame format

The OPS frame is an Action No Ack frame of category HE. The Action field of an OPS frame contains the information shown in Table xxx (OPS frame Action field format).

|  |
| --- |
| Table xxx - OPS frame Action field format  |
| Order | Information |
| 1 | Category |
| 2 | HE Action |
| 3 | TIM element |
| 4 | OPS Information element |

The Category field is defined in Table 9-47 (Category values).

The HE Action field is defined in Table 9-421z (HE Action field values).

The TIM element is defined in 9.4.2.6 (TIM element) is always present in the frame.

The OPS Information element is defined in 9.4.2.xxx (OPS Information element) is always present in the frame.

Editor Change Table 9-325a (FILS Discovery frame format) as follows by adding row 9:

|  |
| --- |
| * FILS Discovery frame format
 |
| Order | Information | Notes |
| ~~6~~ | ~~Vendor Specific element~~ | ~~One or more Vendor Specific elements are optionally~~~~present.~~ |
| 7 | TIM element | The TIM element is optionally present if(#Ed) dot11HEOptionImplemented is true, otherwise it is not present. |
| 8 | TWT element | The TWT element is optionally present if(#Ed) dot11HEOptionImplemented is true, otherwise it is not present. If present, the Broadcast field of the TWT element is 1(#12046) |
| 9 | OPS information element | The OPS element is optionally present if(#Ed) dot11HEOptionImplemented is true, otherwise it is not present. |

Editor: Modify subclause 27.14.3 Opposrtunistic power save as follows:

* Opportunistic power save(#6041)
* General

An OPS STA is a non-AP HE STA that sets the OPS Support subfield in the HE MAC Capabilities Information field of the HE Capabilities element to 1(#Ed).

An OPS AP is an AP HE STA that sets the OPS Support subfield in the HE MAC Capabilities Information field in HE Capabilities element to 1(#Ed).

Opportunistic power save mechanism has the objective to allow OPS STAs to opportunistically go to doze state for a defined period.In the unscheduled mode, an OPS AP sends an OPS frame or a FILS discovery frame at any time to provide the scheduling information for all OPS STAs for the OPS period that follows the transmission of the OPS frame or FILS discovery frame. Based on this information, the OPS STAs may opportunistically go to doze state during the OPS period.

In the scheduled mode, an OPS AP splits a beacon interval into several periodic broadcast TWT SPs and provides, at the beginning of each SP, the scheduling information for all OPS STAs. Based on this information, the OPS STAs may opportunistically go to doze state until the next TWT SP.

* AP operation for opportunistic power save

(#5509)To enable unscheduled opportunistic power save, an OPS AP shall transmit an OPS frame or a FILS Discovery frame that includes a TIM element (see 9.4.2.6 (TIM element)) and an OPS Information element (see 9.4.2.xxx (OPS Information element)). The AP should transmit a FILS Discovery frame instead of an OPS frame if the target transmission time aligns with the transmission time of a FILS Discovery frame. The OPS Information element includes the duration of the OPS period that immediately follows the transmission of the OPS frame or FILS Discovery frame. The TIM element is encoded specifically as defined in 9.4.2.6 (TIM element) in order to provide the information of which STAs are scheduled and not scheduled during the OPS period. If the OPS AP sets the bit corresponding to an OPS STA in the traffic indication virtual bitmap field of the TIM element of the OPS frame or FILS Discovery frame to 0, the AP should not send individually addressed to the STA, including to trigger the STA to send HE UL TB PPDUs during the OPS period.

To enable scheduled opportunistic power save, an OPS AP shall include a TWT element in beacons to set a periodic Broadcast TWT SP with the following information:

* The TWT flow identifier field set to 3
* The Broadcast TWT ID subfield is set to 0

At the beginning of these periodic TWT SPs with the TWT Flow Identified field set to 3, the AP shall transmit a TIM frame or a FILS Discovery frame that includes a TIM element (see 9.4.2.6 (TIM element)). The AP should transmit a FILS Discovery frame instead of a TIM frame if the TWT SP start time aligns with the transmission time of a FILS Discovery frame. If the OPS AP also operates with TIM Broadcast and uses TIM frames for Opportunistic power save mechanism, the OPS AP should align the transmission time of a TIM frame for TIM Broadcast, with the target time of the broadcast TWT SP(#13513) with the TWT flow identifier field set to 3. If the OPS AP sets the bit corresponding to an OPS STA in the traffic indication virtual bitmap field of the TIM element of the TIM frame or FILS Discovery frame to 0, the AP should not send individually addressed frames to the STA, including to trigger the STA to send an HE TB PPDU during the TWT SP and until the next TWT SP with the TWT Flow Identifier field set to 3.

(#7594, #9959)

* STA operation for opportunistic power save

With unscheduled opportunistic power save, when an OPS STA in the awake state (#12034), either in active mode or in power save mode, with AID *N* receives a TIM element and an OPS information element in an OPS frame or a FILS Discovery frame from the associated OPS AP, the STA may not be available until the end of the OPS period indicated in the OPS Information element, if the bit *N* in the traffic indication virtual bitmap field of the current TIM element is set to 0. At the end of the OPS period, the STA shall be in the awake state, unless determined otherwise by other power save protocols.

With scheduled opportunistic power save, when an OPS STA with AID *N* that is in the awake state, either in active mode or in power save mode, and that receives from the OPS AP with which it associated a TIM element with bit *N* of the traffic indication virtual bitmap field equal to 0 in a TIM frame or FILS Discovery frame within a broadcast TWT SP with the TWT Flow Identifier field set to 3 may not be available during the TWT SP and until the next TWT SP with the TWT Flow Identifier field set to 3.

NOTE—The opportunistic power save protocol does not restrict the OPS STA's channel access. The OPS STA can always access the channel with EDCA.(#5674)

***CID 12032***

***11ax Editor: Modify 9.4.2.6 TIM element as follows: (#12032)***

* TIM element

Change the 4th paragraph as follows:

The DTIM Count field indicates how many Beacon frames (including the current frame) appear before the next DTIM. A DTIM count of 0 indicates that the current TIM is a DTIM. The DTIM Count field is a single octet. When a TIM element is included in a TIM frame or FILS Discovery frame, the DTIM Count field is reserved.

Insert the following at the end of the subclause:

When included in a TIM frame, an OPS frame or a FILS Discovery frames by an OPS AP the following apply:

* The DTIM Count field is reserved
* The DTIM Period field is reserved
* The bit number *N* in the traffic indication virtual bitmap that corresponds to an OPS STA with AID *N* is determined as follows:
* Bit number *N* in the traffic indication virtual bitmap is 0 if the OPS AP does not intend to transmit to the OPS STA including to trigger the OPS STA for an UL MU transmission during the TWT SP and before the next TWT SP.
* Otherwise, bit number *N* in the traffic indication virtual bitmap for the OPS STA is 1.
* The bit number *N* in the traffic indication virtual bitmap that corresponds to an non-OPS STA with AID *N* is determined as follows:

"Bit number *N* in the traffic indication virtual bitmap is 1 to indicate that AP has buffered frames for the STA and set to 0 otherwise.