IEEE P802.11
Wireless LANs

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| CR for Opportunistic power save – 27.14.3 |
| Date: 2017-01-16 |
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Abstract

This submission proposes resolutions for multiple comments related to TGax D1.0 with the following CIDs (3028, 3029, 4452, 4460, 4686, 4697, 7918, 7919, 9660, 9841, 9842, 3093, 5509, 5510, 5674, 5675, 5782, 6041, 6045, 6046, 7593, 7594, 7595, 7596, 7597, 9753, 9959, 9960, 3046, 8316)

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. This introduction is 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** | **Commenter** | **Page** | **Comment** | **Proposed Change** | **Resolution** |
| 3028 | Abhishek Patil | 67.57 | Either TIM frame or FILS Discovery frame will included at the beginning of a broadcast TWT - replace and with or | replace 'and' with 'or' | Revised – agree in principle with the comment.Modify the spec as defined in the proposed modifications in doc 325r4. |
| 3029 | Abhishek Patil | 68.02 | The operation applies to current TWT SP - the sentence doesn't need to discuss about what happens outside the current TWT SP | Remove: "and before the next TWT SP" and make reference to "current" TWT SP. Change sentence as following: "Bit number N in the traffic indication virtual bitmap is 0 if the AP does not intend to transmit to the STA or to trigger the STA for an UL MU transmission during the current TWT SP." | Rejected – The concept is to split the beacon interval into several consecutive periods, separated by TIM frames or FILS discovery frames, and the TIM element provides scheduling information until the next TIM element. |
| 4452 | Albert Petrick | 68.60 | Period missing at end of sentence | Add period at the of sentence after "reserved" | Revised – agree in principle with the comment.Add a period as defined in the proposed modifications in doc 325r4. |
| 4460 | Albert Petrick | 68.62 | Period missing at end of sentence | Add period at the of sentence after "reserved" | Revised – agree in principle with the comment.Add a period as defined in the proposed modifications in doc 325r4. |
| 4686 | Albert Petrick | 68.60 | Period missing at end of sentence | Add period at the of sentence after "reserved" | Revised – agree in principle with the comment.Add a period as defined in the proposed modifications in doc 325r4. |
| 4697 | Albert Petrick | 68.62 | Period missing at end of sentence | Add period at the of sentence after "reserved" | Revised – agree in principle with the comment.Add a period as defined in the proposed modifications in doc 325r4. |
| 7918 | Mark RISON | 67.60 | The field names are not referred to correctly | Change to "DTIM Count field" and "DTIM Period field" | Revised – agree in principle with the comment.Make the changes as defined in the proposed modifications in doc 325r4. |
| 7919 | Mark RISON | 68.01 | " the AP does not intend to transmit tothe STA or to trigger the STA for an UL MU transmission" -- triggering is done by transmitting to the STA | Delete "or trigger the STA for an UL MU transmission" | Revised – Agree in principle with the comment.Modify the sentence to clarify that triggering a STA is a transmission to the STA. Include the proposed modifications in doc 325r4. |
| 9660 | Yongho Seok | 67.57 | "When included in TIM frames and FILS discovery frames at the beginning of a broadcast TWT SP by an HE AP:"The TIM element is differently interpreted according to the reception timing of it.If an Non-AP HE in a doze state wakes up after long time, it can loss any timing information related with TBTT from its associated AP. In such case, when the Non-AP HE receives a FILS discovery frame transmitted at the beginning of a broadcast TWT SP, it can't determine a content of TIM between an original TIM element and opportunistic power save TIM element. | Instead of redefining a TIM element, make a new information element for an opportunistic power save operation. | Revised – agree in principle with the comment. Clarify the spec so that when TIM element is included in TIM frames and FILS discovery frame, the interpretation for an HE STA is for OPS. Makes the changes as proposed in doc 325r4. |
| 9841 | Young Hoon Kwon | 67.57 | TIM frames and FILS frames may have different meaning depending on the timing of the frame sent, and this make cause wrong interpretation from STAs. For example, if TIM frames or FILS discovery frames are received from an Non-AP HE that don't support broadcast TWT, these STAs don't know if these frames are at the beginning of a broadcast TWT SP or not, and thus, cannot figure out correct status. It needs further clarification. | Modify the third bullet to "Bit number N in the traffic indication virtual bitmap that corresponds to a broadcast TWT scheduled Non-AP HE with AID N is determined as follows:". | Rejected – the new encoding of the TIM element is valid for all Non-AP HE. These STAs know that when transmitted in TIM frames and FILS discovery frames, these frames are encoded differently. |
| 9842 | Young Hoon Kwon | 68.02 | The first bullet is wrong. In case an AP schedules for DL transmission, but not intends to schedule UL MU transmission for a STA with bit number N, the AP shall set the bit number N to 1. But, based on current sentence, that bit is set to 0 in this case. | Modify the first bullet to "Bit number N in the traffic indication virtual bitmap is 0 if the AP does not intend to transmit to the STA and does not intend to trigger the STA for an UL MU transmission during the TWT SP and before the next TWT SP.". | Revised – agree in principle with the comment. Make the changes as proposed in doc 325r4 . |

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| **CID** | **Commenter** | **Page** | **Comment** | **Proposed Change** | **Resolution** |
| 3093 | Abhishek Patil | 200.63 | The operation applies to current TWT SP - the sentence doesn't need to discuss about what happens outside the current TWT SP. Replace "before the next TWT SP" with "in the current TWT SP" | Change sentence as following: "For an Non-AP HE for which their associated AP set their corresponding bit in the traffic indication virtual bitmap field of the TIM element to 1, if the STA was not served in the current TWT SP then the AP shall set its corresponding bit in the traffic indication virtual bitmap field of the TIM element to 1 in the subsequent TWT SP." | Rejected – The concept is to split the beacon interval into several consecutive periods, separated by TIM frames or FILS discovery frames, and the TIM element provides scheduling information until the next TIM element. |
| 5509 | Graham Smith | 44.00 | "Opportunistic power save mechanism has the objective for an AP to split a beacon interval into several periodic broadcast TWT SPs and to provide, at the beginning of each SP, the scheduling information to all non-AP STAs" The objective is to allow power saving not the splitting of a beacon interval. Needs to be re-written . | Reword "To implement Opportunistic power save, an AP may split a beacon interval into several periodic broadcast TWT SPs and provide, at the beginning of each SP, the scheduling information to all non-AP STAs." | Revised – agree in principle with the comment. Modify the sentence as proposed in document 325r4. |
| 5510 | Graham Smith | 58.00 | For any Non-AP HE for which their associated AP set their corresponding bit in the traffic indication..." This reads wrong, this appears to be about APs not STAs so why does it start off talking about a STA? | Reword para. " If an AP sets the bit corresponding to an Non-AP HE in the traffic indication virtual bitmap field of the TIM element to 0, the AP shall neither send unicast or multicast frames to that STA, nor trigger that STA for UL MU transmissions during the TWT SP and, unless otherwise specified, until the next TWT SP." | Revised – agree in principle with the comment.Makes the changes as in doc 325r4. |
| 5674 | Guoqing Li | 200.59 | Can a non-AP STA still send data through EDCA in this TWT SP when the AP set its TIM bit to 0? It's better to clarify this point. | Clarify | Revised – agree in principle with the comment. Add a sentence to clarify this point as described in doc 325r4. |
| 5675 | Guoqing Li | 200.63 | in "if the STA was not served before...", what does "served" mean here? The AP send trigger to the STA? or the AP send the STA's DL BU to the STA? | Clarify | Revised – It can either be sending DL traffic or sending a trigger for UL MU.Add a sentence to clarify this point as described in doc 325r4. |
| 5782 | Hanseul Hong | 200.39 | Since the details of using TIM element is about broadcast TWT, it should be merged to 27.7.3 (Broadcast TWT operation) | As in the comment | Rejected – This section defines power save modes and the description is well fitted there. |
| 6041 | Jarkko Kneckt | 200.37 | The title of the opportunistic power save does not need to mention congested environment | Delete the congested environment from the title of the clause 27.14.3. | Revised – agree with the comment. Change the title of the clause as in the proposed changes in doc 325r4. |
| 6045 | Jarkko Kneckt | 201.15 | Please clarify that STAs in power save mode may establish a membership with opportunistic TWT if the power save mode STA desires to wake up at the beginning of the opportunistic TWT SP. Just to set a STA to Doze in opportunistic TWT SP does not need a membership establishment. | Please add a clarification that a non-AP STA should establish a BC TWT membership with opportunistic PS, if tnon-AP HE desires to wake up at the beginning of the TWT SP. | Rejected – Opportunisitic power save is used for all STAs. STAs that want to use this simply need to read the TIM element and the TWT element (only if it wants to know the periodicity). No membership/negotiation is needed. |
| 6046 | Jarkko Kneckt | 200.62 | The TIM, FILS Discovery and Beacon frame should contain two TIM elements for two different use: 1. for Opportunistic PS to indicate which STAs may get service 2. To indicate to STAs in power save mode DL Buffered traffic and which HE STAs should be available to receive and respond to a Trigger frame. Two TIM elements improve non-AP STA stand-by power save as well as opportunistic PS is available for the whole TXOP duration. | Please specify two TIM elements to Beacon, FILS Discovery and TIM frames. One TIM element is for opportunistic PS indicating will the AP Trigger the STA and the other TIM element is for stand-by PS indicating buffered DL traffic and whether the AP expects the STA to respond to the Trigger frame. If the AP does not expect the STA to respod to the Trigger, the STA may return immediately to Doze. | Rejected – Two TIM elements will create signalling overhead. |
| 7593 | Liwen Chu | 200.39 | The following behavior should be added: the AP shall send DL PPDU to STA or trigger UL transmission from STA if the STA has its bit in TIM element being set to 1. | As in comment | Revised – agree in principle with the comment. Add this sentence as in the proposed modifications in doc 325r4, but with a should instead of a shall. |
| 7594 | Liwen Chu | 200.62 | The bahavior is too restrict. When the AP has only DL PPDUs to be transmitted to a STA in TWT broadcast SP and all the buffered frames are discarded, the AP doesn't need to set the bit for the STA in TIM element to 1 in the following TWT SP. | As in comment | Revised – agree with the commenter. Remove the sentence as in the proposed modifications in doc 325r4. |
| 7595 | Liwen Chu | 200.45 | What is the type of the TWT SP? | Clarify it. | Revised, agree with the commenter. Include the type of the TWT SPs as defined in the proposed changes in doc 325r4. |
| 7596 | Liwen Chu | 200.49 | Change "At the beginning of these periodic TWT SPs," to "At the beginning of these periodic TWT SPs with the TWT flow identifier field set to 3," | As in comment | Revised – agree.Add the proposed text to the sentence as in the proposed modifications in doc 325r4. |
| 7597 | Liwen Chu | 200.60 | What is the type of the TWT SP? | Clarify it. | Revised, agree with the commenter. Include the type of the TWT SPs as defined in the proposed changes in doc 325r4. |
| 9753 | Yongho Seok | 200.51 | "At the beginning of these periodic TWT SPs, 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 use case of a frame transmitted at the beginnng of the periodic TWT SPs is totally different with the original use of the TIM frame and the FILS Discovery frame.If it is needed, please define a new action frame. | As per comment. | Rejected. The TIM frame has precisely defined schedule that can be transmitted in a BC TWT flow by adjusting the timing parameters of the TIM frame transmission interval and BC TWT parameters. Also FILS Discovery frame transmission time may match. The use of the existing frames allowes the legacy STAs to receive information that improves the efficiency of the system. New frame would add more overheads.  |
| 9959 | Young Hoon Kwon | 201.01 | This can not be a "shall" sentence. For example, what if the buffered traffic is expired and dequeued before the start of the next TWT SP? For tnon-AP HE, regardless the STA is served or not during one TWT SP, the STA will wake up and check the TIM element in the subsequent TWT SP. And, the STA will figure out if there's RU scheduled for the STA or not based on the TIM information. How to set or how to schedule each STA is totally the serving AP's implementation issue. If spec. strongly recommend the AP to serve this STA in the subsequent TWT SP, it can be at most "should" sentence. | As in the comment. | Revised – agree with the comment. Remove the sentence. Make the changes as in the proposed changes in doc 325r4. |
| 9960 | Young Hoon Kwon | 201.07 | Actual transmission time of TIM frame can be different from target start time of a broadcast TWT SP due to lots of reasons. (One example is that wireless medium is busy at the start of the broadcast TWT SP.) Therefore, when a STA receives a TIM frame, there's no guarantee that it is sent at the beginning of a broadcast TWT SP. And, as the meaning of TIM element is different based on this, the protocol is not complete enough. Further clarification is needed. | As in the comment. | Rejected – the STA is aware of the opportunistic power save service period, so can know the end time of the service period. |
| 3046 | Abhishek Patil | 99.61 | Presence of TIM Element in FILS Discovery can have wider application, and doesn't have to be tied to TWTOperation only | Remove the restriction, as in the comment | Revised – agree with the comment.Remove the restriction as in the proposed changes in doc 325r4. |
| 8316 | Peter Ecclesine | 99.56 | Keep Vendor Specific element as order 6 in FILS Discovery frame format as it is in 11ax baseline, do not delete it. | Do not change order 6 text | Rejected – There is no change to actual behaviour. Vendor Specific elements can still be used in FD frames based on the generic Action frame rules |

***Modify section 3.2 Definitions specific to IEEE 802.11:***

**3.2 Definitions specific to IEEE 802.11**

opportunistic power save (OPS) STA: A non-AP HE STA that support opportunistic power save mechanism

opportunistic power save (OPS) AP: An AP HE STA that support opportunistic power save mechanism

***Modify section 9.4.2.6 TIM element as follows:***

* TIM element

Modify the following sentence in this subclause:

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 asingle 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 TIM frames or FILS discovery frames at the beginning of a broadcast TWT SP with the TWT flow identifier field set to 3, by an OPS AP: 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 any PPDU 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 (#9842, #7919). Otherwise, bit number *N* in the traffic indication virtual bitmap for the OPS STA is 1.

***Modify the Figure 9-589ck and append the table Table 9-262z in section 9.4.2.218.2 as shown below:***

9.4.2.218.2 HE MAC Capabilities Information field

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | B33 | B34 | B35 | B36 B39 |
|  | QTP Support | A-BQR Support | OPS Support | Reserved |
| Bits: | 1 | 1 | 1 | 4 |

|  |  |  |
| --- | --- | --- |
| **Subfield** | **Definition** | **Encoding** |
|
| OPS Support | * Indicates support for an AP to encode OPS information to TIM element of the FILS Discovery frames or TIM frames as described in 27.14.3.1(AP operation for opportunistic power save);

 Indicates support for a non-AP STA to receive the Opportunistic Power Save encoded TIM elements | If OPS Support is set to 1: The HE STA supports Opportunistic Power Save Functionality. Otherwise set to 0. |

***Modify section 9.6.8.36 FILS Discovery frame format as follows:***

* FILS Discovery frame format

Change Table 9-325a (FILS Discovery frame format) as follows (only modified rows are shown):

|  |
| --- |
| * 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 when dot11HEOptionImplemented is true, otherwise it is not present. (#3046) |

Insert the following at the end of the subclause:

The FILS Discovery frame may include a TIM element, which is defined in 9.4.2.6 (TIM element), for operation as defined in 27.14.3 (Opportunistic power save (#6041)).

***Modify section 27.14.3 Opportunistic power save in congested environment as follows:***

* Opportunistic power save (#6041)

An OPS STA is a non-AP HE STA that sets the OPS Capable subfield set to 1 in HE Capabilities element.

An OPS AP is an AP HE STA that sets the OPS Capable subfield set to 1 in HE Capabilities element.

Opportunistic power save mechanism has the objective to allow OPS STAs to opportunistically go to doze state for a defined period. To achieve this, 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. (#5509)

* AP operation for opportunistic power save

To enable 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 set to 0

At the beginning of these periodic TWT SPs with the TWT flow identifier field set to 3, the AP shall transmit 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 BC TWT SP with the TWT flow identifier field set to 3.

 (#7594, #9959).

* STA operation for opportunistic power save

When an OPS STA with AID N receives a TIM element carried in a TIM frame or a FILS Discovery frame from the associated OPS AP within a broadcast TWT SP with the TWT flow identifier field set to 3, the STA may go to doze state during the TWT SP and until the next TWT SP with the TWT flow identifier field set to 3, if the bit *N* in the traffic indication virtual bitmap field of the current TIM element is set to 0.

Note1 – 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)