IEEE P802.11
Wireless LANs

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| Unscheduled Power Save for DMG |
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### ****Abstract****

Despite its significant potential, unscheduled power save in DMG is a poorly defined mechanism, specified through 13 lines of text in Section 10.2.6.2.2 (Power management mod e operation of a non-AP and non-PCP STA with no wakeup schedule). Unscheduled power save brings agility to power save, and in common deployment scenarios (the most common being the entire DTI made of a single CBAP) enables granular (sub-BI) power saving, in contrast with the scheduled power save, which operates at beacon interval granularity.

The existing text leaves many details to imagination. There is brief description of using the Power Management (PM) bit to signal a non-AP and non-PCP STA transition to power save (PS) mode to the AP or PCP of the network, but many questions are left unanswered:

* What kind of frame exchanges can be used for this signaling?
* What is the mechanism to exit unscheduled power save mode?
* How would other non-AP and non-PCP STAs know about a STA transition into or out of PS mode? This is significant since DMG STAs are allowed to directly transmit frames to each other.
* How do unscheduled and scheduled power save mechanisms coexist and complement each other?

This submission addresses the above questions and more. In particular, it enhances the unscheduled power save mechanism robustness and state integrity by drawing elements from power save in infrastructure BSS and IBSS networks. The complete unscheduled power save mechanism defined in this submission coexists with and complements the scheduled power save mechanism. It is centralized in the sense that it makes a non-PCP and non-AP transition into or out of PS mode subject to AP’s or PCP’s acknowledgement, but it also defines elements for faster state synchronization (avoiding the beacon interval latency) by allowing direct (peer to peer) signaling of the Power Management mode.

### ****Revision History****

Rev 0: Initial revision

*[Add a new abbreviation.]*

**3.4 Abbreviations and acronyms**

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PSIM Power Save Indication Map

*[DTIM is undefined in DMG networks.]*

**6.3.2.2.2 Semantics of the service primitive**

The primitive parameters are as follows:

 MLME-POWERMGT.request(

 PowerManagementMode,

 ReceiveDTIMs

 )

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type** | **Valid range** | **Description** |
| PowerManagementMode | Enumeration | ACTIVE,POWER\_SAVE | An enumerated type that describes the requested power management mode of the STA. |
| ReceiveDTIMs | Boolean | true, false | Non-DMG BSS: When true, this parameter causes the STA to awaken to receive all DTIM frames. When false, the STA is not required to awaken for every DTIM Beacon frame.DMG BSS: Not applicable |

*[Clarify the usage of the Power Management field in DMG.]*

**8.2.4.1.7 Power Management field**

The Power Management field is 1 bit in length and is used to indicate the power management mode of a STA. The value of this field is either reserved (as defined below) or remains constant in each frame from a particular STA within a frame exchange sequence (see Annex G). The value indicates the mode of the STA after the successful completion of the frame exchange sequence.

In an infrastructure BSS, the following applies:

— The Power Management field is valid only in frame exchanges as described in 10.2.2.2 (STA Power Management modes), 10.2.6.2.2 (Non-AP and non-PCP STA operation without a wakeup schedule) and 10.2.6.3.2 (PCP operation without a wakeup schedule). In such exchanges, a value of 1 indicates that the STA will be in PS mode. A value of 0 indicates that the STA will be in active mode.

— The Power Management field is reserved in all Management frames transmitted by a STA to an AP or PCP with which it is not associated.

— The Power Management field is reserved in all frames transmitted by the AP.

In an IBSS, the Power Management field is valid only in frame exchanges as described in 10.2.3.4 (STA power state transitions). In such exchanges, a value of 1 indicates that the STA will be in PS mode. A value of 0 indicates that the STA will be in active mode.

In an MBSS, the Power Management field is valid only in frame exchanges as described per the mesh power mode transitions rules in 13.14 (Power save in a mesh BSS).

In a PBSS, the Power Management field is valid only in frame exchanges as described in 10.2.6.2.2 (Non-AP and non-PCP STA operation without a wakeup schedule) and 10.2.6.3.2 (PCP operation without a wakeup schedule).

*[Define a new information element, PSIM (Power Save Indication Map), to communicate the Power Management mode of each STA in a DMG network.]*

**8.4.2.x PSIM element**

The PSIM element is defined as shown in Figure 8-xxx (PSIM element format).

The Element ID and Length fields are defined in 8.4.2.1 (General).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Element ID | Length | Flags | Power Save Indication Bitmap |
| Octets: | 1 | 1 | 1 | 0-32 |

**Figure 8-xxx—PSIM element format**

The Flags field is defined in Figure 8-xxx (PSIM Flags field format).

|  |  |  |  |
| --- | --- | --- | --- |
|  | B0 | B1 | B2 B7 |
|  | PS PCP | PS Non-PCP | Reserved |
| Bits: | 1 | 1 | 6 |

**Figure 8-xxx—Flags field format**

The PS PCP field is set to 1 if the PCP is in PS mode at the time of PSIM element transmission, and is set to 0 otherwise. The PS Non-PCP field is set to 1 if all non-AP and non-PCP STAs are in PS mode at the time of PSIM element transmission, and is set to 0 otherwise. The PS PCP field is set to 0 in in infrastructure BSS.

The power save indication bitmap, carried in the variable-length Power Save Indication Bitmap field, consists of up to 256 bits and is organized into up to 32 octets such that bit number *N* (0 ≤ *N* ≤ 255) in the bitmap corresponds to bit number (*N* mod 8) in octet number ⎣*N* / 8⎦, where the low-order bit of each octet is bit number 0, and the high order bit is bit number 7. Bit *N* in the bitmap is set to 1 if there is an associated DMG STA with AID equal to *N* and the STA is in PS mode at the time of PSIM element transmission, and is set to 0 if there is no associated DMG STA with AID equal to *N* or the STA is not in PS mode at the time of PSIM element transmission. Bit 0, if transmitted, is set to 0 in in infrastructure BSS. Bit 255, if transmitted, is set to 0. Any number of trailing zero octets in the Power Save Indication Bitmap field may be dropped from the element. The Power Save Indication Bitmap field may be dropped from the PSIM element if all non-PCP STAs have the same Power Management mode at the time of PSIM element transmission.

*[NOTE: At some point Section 10.2.6 could see a better reorganization into scheduled and unscheduled power save modes, with non-AP STA behavior defined under each. The current organization, based on non-AP/non-PCP and PCP, results in small sections with similar text.]*

 *[The MLME-POWERMGT primitive behavior is missing details for unscheduled power save.]*

**10.2.6.2 Non-AP and non-PCP STA power management mode**

**10.2.6.2.1 General**

The power management mode of a non-AP and non-PCP STA is selected by the PowerManagementMode parameter of the MLME-POWERMGT.request primitive. Once the STA updates its Power Management mode, the MLME shall issue an MLME-POWERMGT.confirm primitive indicating the result of the operation. When not using a wakeup schedule, a STA that receives an Ack or BlockAck frame from the AP or PCP in response to a Management, Extension or Data frame that carries the desired Power Management mode of the STA as described in 10.2.6.2.2 (Non-AP and non-PCP STA operation without a wakeup schedule) shall update its Power Management mode at the instant the Ack or Block Ack frame is received. When using a wakeup schedule, a STA that acknowledges the reception of a PSC-RSP frame from the AP or PCP with Status Code of SUCCESS shall update the STA’s Power Management mode at the instant indicated by the value of the BI Start Time field of the DMG Wakeup Schedule element in the received PSC-RSP frame.

*[Simplify the section title and add missing behavior related to PM signaling into and out of PS mode.]*

**10.2.6.2.2 Non-AP and non-PCP STA operation without a wakeup schedule**

To change its Power Management mode without a wakeup schedule, a non-AP and non-PCP STA shall inform the AP or PCP through a successful frame exchange as described in Annex G, that is initiated by the STA, and that includes a Management, Extension or Data frame, and that includes an Ack or a BlockAck frame from the AP or PCP. The Power Management subfield(s) in the Frame Control field of the frame(s) sent by the STA in this exchange are all set to the same value and indicate the Power Management mode that the STA shall adopt upon successful completion of the entire frame exchange, except where it is reserved (see 8.2.4.1.7 (Power Management field)). A non-AP and non-PCP STA shall not change its Power Management mode using a frame exchange that does not receive an Ack or BlockAck frame from the AP or PCP, or using a BlockAckReq frame.

As long as there is at least one STA that has entered PS mode, the AP or PCP shall establish an awake window by transmitting an Awake Window element, and shall include a PSIM element in every DMG Beacon or Announce frame it transmits. The AP or PCP may establish an awake window and/or include a PSIM element in a DMG Beacon or Announce frame it transmits even if no STA is in PS mode. The absence of a PSIM element in a DMG Beacon or Announce frame is equivalent to presence of the PSIM element in the frame with all bits of the Power Save Indication Bitmap field in the PSIM element set to 0. The PSIM element in every DMG Beacon or Announce frame transmitted by the AP or PCP shall indicate the Power Management mode of all STAs at the time of frame transmission.

NOTE—A DMG Beacon or Announce frame transmitted by an AP or PCP without a PSIM element indicates that all STAs are in Active mode at the time of frame transmission.

A non-AP and non-PCP STA may also indicate its Power Management mode to another non-AP and non-PCP STA through the Power Management subfield in the Frame Control field of any frame that contains all or part of a BU. The non-AP and non-PCP STA shall indicate its correct Power Management mode in the Frame Control field of any frame it transmits that contains all or part of a BU.

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*[Expand 10.2.6.3 into unscheduled and scheduled subsections to align with 10.2.6.2.]*

**10.2.6.3 PCP power management mode**

**10.2.6.3.1 General**

The Power Management mode of a PCP is selected by the PowerManagementMode parameter of the MLME-POWERMGT.request primitive. Once the PCP updates its Power Management mode, the MLME shall issue an MLME-POWERMGT.confirm primitive indicating the result of the operation. When not using a wakeup schedule, a PCP shall update its Power Management mode at the instant it successfully transmits any frame that contains all or part of a BU with the Power Management subfield in the Frame control field of the frame set to the new Power Management mode of the PCP, or at the instant the PCP transmits a DMG Beacon or Announce frame with the PSIM element in the frame indicating the new Power Management mode of the PCP.

NOTE—A DMG Beacon or Announce frame transmitted by a PCP without a PSIM element indicates that all STAs, including the PCP, are in Active mode at the time of frame transmission.

When using a wakeup schedule, a PCP shall set its Power Management mode to PS mode at the instant indicated by the value of the BI Start Time field of the DMG Wakeup Schedule element that it has successfully delivered to every associated STA, and shall set its Power Management mode to Active mode at the moment it transmits a DMG Beacon or Announce frame without a DMG Wakeup Schedule element.

**10.2.6.3.2 PCP operation without a wakeup schedule**

Similar to non-AP and non-PCP STAs, a PCP may also enter or leave PS mode without a wakeup schedule. Transition into a new Power Management mode occurs at the instant the PCP successfully transmits any frame that contains all or part of a BU with the Power Management subfield in the Frame control field of the frame set to the new Power Management mode of the PCP, or at the instant the PCP transmits a DMG Beacon or Announce frame with the PSIM element in the frame indicating the new Power Management mode of the PCP.

NOTE— The PSIM element in every DMG Beacon or Announce frame transmitted by the PCP indicates the Power Management mode of the PCP at the time of frame transmission. A DMG Beacon or Announce frame transmitted by the PCP without a PSIM element indicates that all STAs, including the PCP, are in Active mode at the time of frame transmission.

A PCP may also indicate its Power Management mode to a non-PCP STA through the Power Management subfield in the Frame Control field of any frame that contains all or part of a BU. The PCP shall present the correct Power Management mode in the Frame Control field of any frame it transmits that contains all or part of a BU.

**10.2.6.3.3 PCP operation with a wakeup schedule**

*[Move all text in the current Section 10.2.6.3 and any revision to this text in the current comment resolution round to this section.]*

*[Editorial – Following the capitalization preference discussion in the 802.11 maintenance group, recommend to change all instances of “Power Management mode” to “power management mode”, for DMG and non-DMG.]*