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Wireless LANs

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| Clarifications for usage of ATIM frames by PCPsand Awake Windows in DMG networks  |
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Abstract

This document proposes to allow ATIM frame exchange for PCPs, simplifies the meaning of the PCP Active field in Extended Schedule Element, and provides clarifications applicable to Awake Windows in DMG networks. It is submitted as a resolution to CID 3261.

### ****Background****

(1) PCP usage of ATIM signalling

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DMG STAs exchange Announcement Traffic Indication Message (ATIM) frames at the beginning of airtime allocations with multi-access (including for example, the DTI portion of a CBAP-only BI) to communicate with their peers the need to stay ON during the remainder of the allocation.

While it probably has not been the intention of the original text in 802.11ad, the ATIM exchange has been unnecessarily limited to non-PCP/non-AP STAs because of the way (specifically where) the ATIM exchange is defined: Section 10.2.6.2.4 (Power management mode operation of a non-AP **and non-PCP** STA with or without a wakeup schedule).

While AP STAs can arguably be expected to exercise extended listening periods, PCP STAs do not structurally possess any power advantage over non-PCP/non-AP STAs. Applications form PBSSs around DMG STAs, with the PCP role decided based on various metrics that may or may not align with the power available to the PCP STA. As a result, PCPs should be allowed to benefit from the same power saving mechanisms available to non-PCP/non-AP STAs, including ATIM signalling.

The PCP power disadvantage in using ATIM frames is illustrated below.

PCP in Awake or Doze state through the entire CBAP

TBTT

TBTT

Awake Window

Non-PCP/non-AP STAs can use ATIM signaling

This document proposes changes that allow PCP STAs to transmit and receive ATIM frames the same way non-PCP/non-AP STAs transmit and receive these frames. There is no change to DMG AP STAs behaviour; AP STAs do not participate in ATIM exchange. Given the nature of applications leading to formation of PBSS networks, it is envisioned that PCP STAs usage of ATIM frames as a result of this generalization will not show a different pattern compared to non-PCP/non-AP STAs.

(2) Meaning of the PCP Active field in the Extended Schedule Element

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The meaning of “PCP Active = 1” is clarified as PCP being available to transmit and receive frames during the allocation, to allow PCP participation in ATIM frame exchange when applicable, with the additional explanation that PCP can go to Doze state outside the Awake window.

With the ATIM frame exchange extension above, the PCP Active field becomes somewhat irrelevant, and actually a burden to maintain from BI to BI, if used to to reflect the PCP power state during allocations in PCP Doze BIs: A PCP that declares a BI as Doze BI has the practical intention of staying in Doze state for the duration of the BI, which means it will not be active during allocations in a Doze BI; if the PCP indeed intends to operate in one or more allocations during a Doze BI, it should declare the BI as Awake BI instead, and indicate availability for individual CBAPs (and additionally participate in ATIM frame exchange where applicable).

We propose to ignore the PCP Active field during PCP Doze BIs, i.e., make the field not applicable to PCP Doze BIs (note this is technically different from making the field reserved, which would require setting it to 0 during PCP Doze BIs). This relieves the PCP from the burden of maintaining (i.e., constantly refreshing) an Extended Schedule Element often just to toggle the PCP Active fied to reflect the PCP unavailability during allocations in a PCP Doze BI. Instead, PCP uses the field to indicate its availability during Awake BIs, knowig that its unavailability during allocations in PCP Doze BIs is commonly and implicitly understood by all STAs.

(3) Awake window clarification

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Two minor clarifications are made about Awake windows, which are stated to be possibly present only in the first CBAP of a beacon interval: (1) A CBAP-only beacon interval also counts as a CBAP, and can include an Awake window, and (2) an Awake window is limited in duration to the first CBAP only, even if the duration indicated for the Awake window (throught the Awake Window field in the Awake Window element) exceeds the CBAP duration.

For (2), a generalization of Awake window such as what is illustrated below can be envisioned, but it is left out given its added complexity and small practical significance.

Awake Window Length (set by Awake Window element)

TBTT

TBTT

Awake Window

Awake Window

CBAP 2

CBAP 1

**8.4.2.131 Extended Schedule element**

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*[Note to the editor: Modify the following paragraph.]*

For a PCP in Active mode (see 10.2.6 (Power management in a PBSS and DMG infrastructure BSS)), or when applied to a CBAP or SP in a PCP Awake BI, a value of 1 for the PCP Active field indicates that the PCP is available to transmit or receive during the CBAP or SP, and a value of 0 indicates the PCP unavailability to transmit or receive. The PCP Active field is set to 1 at least in the following cases:

 — The PCP transmitting the field is the source or destination of the CBAP or SP,

 — At least one of the Truncatable or Extendable fields is set to 1,

 — The field is transmitted by an AP.

The value of the PCP Active field is ignored when it applies to a CBAP or SP that resides in a PCP Doze BI.

*[Editorial note: Throughout the text, there are inconsistent references to “CBAP allocation” to mean CBAP (i.e., the period itself, and not allocating the period), and similarly to “SP allocation” to mean “SP”; an editorial comment is probably in order to make the CBAP and SP usage consistent.]*

**10.2.6 Power management in a PBSS and DMG infrastructure BSS**

*[Note to the editor: Throughout Section 10.2.6 (including Figure 10-9), replace the few occurences of “power management state” and “power save state” with the more common “power state” for consistency.]*

**10.2.6.1 General**

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*[Note to the editor: Modify Table 10-3 and Table 10-4 as follows.]*

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| Table 10-3—Power management states for an Awake BI (11ad) |
| Portion of the beacon interval | PPS PCP | PS non-AP and non-PCP STA  |
| BTI | Awake | Awake or Doze |
| A-BFT | Awake | Awake or Doze |
| ATI | Awake | Awake |
| DTI | CBAP with the PCP Active field set to 1 in the schedule | Awake or Doze | Awake or Doze |
| CBAP with the PCP Active field set to 0 in the schedule | Doze | Awake or Doze |
| SP with Destination AID set to broadcast AID | Awake | Awake |
| Nontruncatable or nonextensible SP with non-PCP STA as Source AID or Destination AID  | Awake or Doze | Awake or Doze |
| Truncatable SP or extensible SP with non-PCP/non-AP STA (excluding the PS STA) as Source AID or Destination AID | Awake | Awake or Doze |
| SPs allocated to itself  | Awake or Doze | Awake or Doze  |
| All other SPs  | Awake or Doze | Awake or Doze |

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| Table 10-4—Power management states for a Doze BI (11ad) |
| Portion of the beacon interval | PPS PCP | PS non-AP and non-PCP STA  |
| BTI | N/A | Awake or Doze |
| A-BFT | N/A | Awake or Doze |
| ATI | Awake | Awake |
| DTI | CBAP with the PCP Active field set to 1 in the schedule | Doze | Doze |
| CBAP with the PCP Active field set to 0 in the schedule | Doze | Doze |
| SP with Destination AID set to broadcast AID | Doze | Doze |
| SP with individually addressed destination AID | Doze | Awake |
| Nontruncatable or nonextensible SP with non-PCP STA as Source AID or Destination AID  | Doze | Doze |
| Truncatable SP or extensible SP with non-PCP/non-AP STA (excluding the PS STA) as Source AID or Destination AID | Doze | Doze |
| SPs allocated to itself  | Doze | Doze  |
| All other SPs  | Doze | Doze |

**10.2.6.2.4 Power management mode operation of a non-PCP/non-AP STA with or without a wakeup schedule**

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*[Note to the editor: Move the last three paragraphs of this section to the new Section 10.2.6.4; the strikethrough text below comes from an older version of .11mc but the new text in the new Section 10.2.6.4 is from .11mc Draft 3.0.]*

**10.2.6.3 PCP Power management mode**

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*[Note to the editor: Modify the following paragraph and add a NOTE after it.]*

The PCP may enter and remain in the Doze state for any portion of an SP if it is not a source or a destination of the SP. The PCP shall remain in the Awake state for any portion of a truncatable or extendable SP (8.4.2.131 (Extended Schedule element)). The availability of the PCP during a CBAP in the Awake BI shall be announced by setting the PCP Active subfield within the Allocation Control field to 1 for a CBAP allocation made through the Extended Schedule element.

NOTE—A PCP that indicates availability during a CBAP that includes an Awake window can exchange ATIM frames with non-AP and non-PCP STAs during the Awake window and possibly enter the Doze state for the remainder of the CBAP outside the Awake window (see 10.2.6.4 (ATIM frame usage for power management of non-AP STAs)).

*[Note to the editor: Add the new section 10.2.6.4 to describe Awake window and CBAP rules common to non-PCP/non-AP STAs and PCPs.]*

**10.2.6.4 ATIM frame usage for power management of non-AP STAs**

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*[Note to the editor: Move the last three paragraphs of Section 10.2.6.2.4 to this new Section and apply additional edits as follows. I am assuming the title of this section makes it clear that the term “STA” in this section refers to both PCP and non-PCP/non-AP STA - this seems to be the convention for other sections under 10.2.6].*

*[Note to the editor: There are hard to see editorial suggestions in the third paragraph below to change CBAP(s) and BU(s) to CBAPs and BUs respectively].*

broadcast or the CBAP duration, whichever is smaller

NOTE—The entire DTI portion of a beacon interval can form a single CBAP, as indicated by the CBAP Only field in the DMG Parameters field (8.4.1.46 (DMG Parameters field)).

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*[Note to the editor: There are several instances of capitalized “Awake Window” throughout the text that refer to the window itself (what is referred to in the last sentence of the first paragraph above for example), and do not refer to the field or element name – these instances probably need to change to “Awake window” for consistency (or “awake window” under the umbrella of capitalization comment against .11ad).]*