IEEE P802.11
Wireless LANs

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| CR for Power Save of NSTR Mobile AP MLD |
| Date: January 30, 2022 |
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 Abstract

This submission proposes resolutions for following CIDs received for TGbe (CC36):

5064, 6929

***TGbe Editor: Please note, the baseline for this document is REVme D1.0 and TGbe D1.4***

Revisions:

* Rev 0: Initial version
* Rev 1: Editorial modifications.
* Rev 2-3: Add the modifications based on received comments

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 TGbe Draft. This introduction is not part of the adopted material.

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

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **Section** | **Pg/Ln** | **Comment** | **Proposed Change** | **Resolution** |
| 5064 | Gaurang Naik | 35.3.17.1 | 284.24 | An NSTR soft AP is a mobile device and may have considerations similar to a non-AP MLD such as power save. The spec currently does not have a mechanism to signal the unavailability of the non-primary link for a soft AP MLD. | Define a mechanism by which an NSTR soft AP MLD can signal the unavailability of the nonprimary link | RevisedAgree with the commenter in principle. Although the commenter proposed to define a power save mechanism for the NSTR mobile AP MLD, we also need to consider the power save issue for the regular AP MLD.Considering the following cases:* In some use case, the non-AP MLD wants to enhance its throughput or improve the delay by using the multi-link for delivery. Hence, we should allow the non-AP MLD to wake up the AP in the doze state in some case.
* In some use case, e.g. the AP maintenance, regulatory reasons or the NSTR mobile AP MLD being in a low-power level, the affiliated AP in the doze state doesn’t allow the non-AP MLD to wake up it.

Hence, the proposed resolution needs to address the above different use cases. TGbe editor, please make changes as shown in doc 11-21/0356r3 tagged 5064 |
| 6929 | Ryuichi Hirata | 35.3.17.1 | 284.20 | Soft AP MLD is typically battery powered, therefore power save mechanism for soft AP MLD should be defined. | Define power save mechanism for soft AP MLD. | RevisedTGbe editor, please make changes as shown in doc 11-21/0356r3 tagged 5064 |

Discussion:

The signaling related to the power save of the AP MLD is only known to the non-AP MLD. But for the non-AP MLD, it may still want to use the multi-link for delivery at some time. And the AP MLD has no way to predict this time point. Hence, when the AP affiliated with an AP MLD is operating in the power save mode, a wake up mechanism is proposed to balance the power save of the AP MLD and the instant throughput needs of the non-AP MLD. Thus, the proposed resolution will not degrade the transmission performance of the associated non-AP MLDs while reducing the power consumption of the AP MLD as much as possible.

When an affiliated AP is operating in the power save mode, the interaction procedure is illustrated as the below figure.



*TGbe editor: Change the following subclause as follows: (#5064)*

**9.4.2.170 Reduced Neighbor Report element**

**9.4.2.170.2 Neighbor AP Information field**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | B0 B7 | B8 B11 | B12 B19 | B20 B21 | B22 B23 |
|  | MLD ID | Link ID | BSS Parameters Change Count | Power Management Mode | Reserved |
| Bits: | 8 | 8 | 4 | 2 | 2 |

The Power Management Mode subfield indicates the power management mode of the corresponding reported AP that is affiliated with an AP MLD and its encoding is defined in Table 9-xxx (Power Management Mode subfield values).

**Table 9-xxx—Power Management Mode subfield values**

|  |  |  |
| --- | --- | --- |
| Values | Meaning | Description |
| 00 | Active mode | In this mode, the corresponding AP is always in the awake state. |
| 01 | Reserved |  |
| 10 | Power save mode | In this mode, the AP is allowed to transition between the awake state and the doze state. The AP operates in the doze state by default unless it receives a wakeup request and enters the awake state. |
| 11 | Sleep mode | In this mode, the corresponding AP is always in the doze state. And The non-AP MLD cannot send a wakeup request to this AP through its affiliated STA.  |

*TGbe editor: Change the following subclause as follows: (#5064)*

**9.2.4.7.10 AAR Control**

The Control Information subfield in an AAR Control subfield contains information related to the procedure that allows an AP affiliated with an AP MLD to assist a non-AP STA affiliated with a non-AP MLD that belongs (#7555)an NSTR link pair to recover its medium synchronization (35.3.16.8.2 (AP assisted medium synchronization recovery procedure)).

It also can be used to wake up the corresponding AP affiliated with an AP MLD and that is operating in the power save mode (35.3.13 Power save for AP MLD).

The format of this subfield is shown in Figure 9-33c (Control Information subfield format in an AAR Con- trol subfield).

|  |  |  |  |
| --- | --- | --- | --- |
|  | B0 B7 | B8 | B9 B11 |
|  | Assisted Link ID Bitmap | Type | Reserved |
| Bits: | 16 | 1 | 3 |
| **Figure 9-33c Control Information subfield format in an AAR Control subfield** |

If the Type subfield is set to 0, the Assisted AP Link ID Bitmap subfield indicates the link identifier(s) of an AP affiliated with an AP MLD that is solicited to transmit a Trigger frame to a non-AP STA affiliated with a non-AP MLD that belongs to (#7555)an NSTR link pair after a frame that contains AAR Control subfield sent by another non- AP STA affiliated with the same non-AP MLD to its associated AP affiliated with the same AP MLD. If the Type subfield is set to 1, the Assisted AP Link ID bitmap subfield indicates the link identifier(s) of an AP affiliated with an AP MLD that operating in the power save mode is requested to wake up after a frame that contains AAR Control subfield sent by another non-AP STA affiliated with the same non-AP MLD to its associated AP affiliated with the same AP MLD. A value of 1 in bit position i of the Assisted AP Link ID Bitmap subfield means that the link ID i is the link identifier of the solicited AP affiliated with the AP MLD. A value of 0 in bit position i of the Assisted AP Link ID Bitmap subfield means that the link ID i is not the link identifier of the solicited AP affiliated with the AP MLD.

The Type subfield specifies the function of the AAR Control subfield. The Type subfield is set to 0 if the AAR Control subfield is used to solicit to transmit a Trigger frame and set to 1 if the AAR Control subfield is used to wake up the corresponding APs for the frame exchange.

*TGbe editor: Change the following subclause as follows: (#5064)*

**9.4.2.312.2.2 Multi-link Control field of the Basic Multi-Link element**

**…**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 B3 | B4 | B5 B6 | B7 B11 | B12 | B13 | B14 B15 |
|  | Maximum Number Of Simultaneous Links | SRSSupport | TID-To-Link Mapping Negotiation Supported | Frequency Separation For STR | AAR Support | Power Save Operation Support | Wakeup Delay |
| Bits: | 4 | 1 | 2 | 5 | 1 | 1 | 2 |
| **Figure 9-1002i MLD Capabilities subfield format** |

The Power Save Operation Support subfield is set to 1 if the AP MLD supports the power save operation and set to 0 otherwise.

The Wakeup Delay subfield indicates the transition delay time needed by an AP that is affiliated with an AP MLD to switch from the doze state to the awake state. The Wakeup Delay subfield includes 2 bits and is set as define in Table 9-xxx (Encoding of the Wakeup Delay subfield).

Table 9-xxx Encoding of the Wakeup Delay subfield

|  |  |
| --- | --- |
| Wakeup Delay subfield value | Wakeup delay |
| 0 | 0 us |
| 1 | 32 us |
| 2 | 64 us |
| 3 | 128 us |

*TGbe editor: Add the following paragraph in the following subclause as follows: (#5064)*

**35.3.4 Discovery of an AP MLD**

**35.3.4.1 AP Behavior**

If an AP affiliated with an AP MLD is operating in the power save mode or the sleep mode, the TBTT Information Field Type subfield and the TBTT Information Length subfield of the TBTT Information field corresponding to this AP to 1 and 3, respectively.

*TGbe editor: Add the following subclause as follows: (#5064)*

**35.3.13 Power save for AP MLD(#5064)**

An AP affiliated with an AP MLD shall advertise the power management mode of the AP affiliated with the same AP MLD by using the corresponding Power Management Mode subfield of the MLD Parameters field of the TBTT Information field corresponding to this affiliated AP in the Reduced Neighbor Report element.

NOTE: The AP MLD may prohibit the non-MLD STAs to associate with the specified affiliated AP by advertising a new BSS membership selector or use the BTM in advance before the affiliated AP enters the power save mode or the sleep mode.

An AP affiliated with an AP MLD may enter the active mode by setting the Power Management Mode subfield of the MLD Parameters field to 00 in the TBTT Information field corresponding to this affiliated AP in the Reduced Neighbor Report element carried in the Beacon and Probe response frames. If the AP affiliated with an AP MLD is operating in the active mode, it always remains in the awake state.

An AP affiliated with an AP MLD may enter the power save mode by setting the Power Management Mode subfield of the MLD Parameters field to 10 in the TBTT Information field corresponding to this affiliated AP in the Reduced Neighbor Report element carried in the Beacon and Probe response frames.

When an AP affiliated with an AP MLD is operating in the power save mode, it shall advertise the corresponding Wakeup delay through the Wakeup Delay subfield of the Multi-link element carried in the Beacon and Probe response frames.

When an affiliated AP is advertised in the power save mode, if a non-AP MLD want to use the corresponding link for delivery, it shall send a PPDU carrying an AAR Control subfield with the Type subfield equal to 1 to wake up this AP through an affiliated STA and corresponding affiliated AP, respectively. Simultaneously, the corresponding STA shall operate in the awake state and is allowed to initiate the channel access after the wakeup delay.

The AP that is affiliated with an AP MLD and operating in the doze state is not able to transmit or receive PPDUs.

When an AP affiliated with an AP MLD transitions from the doze state to the awake state, it shall regard that all associated STAs who didn’t sent a PPDU carrying an AAR Control subfield with the Type subfield equal to 1 to wake up this AP are operating in the power save mode with the doze state. And it shall regard that all associated STAs who had sent a PPDU carrying an AAR Control subfield with the Type subfield equal to 1 to wake up this AP are operating in the power save mode with the awake state or in the active mode.

An affiliated AP that is operating in the power save mode shall enter the awake state within the wakeup delay after successfully receiving a PPDU carrying an AAR Control subfield with the Type subfield equal to 1.

After an affiliated AP which is advertised to operation in the power save mode is waked up, it may switch back to the doze state if one of the following conditions is met:

* The channel has been idle for a given time period.
* Each non-AP MLD who previously sent a PPDU carrying an AAR Control subfield with the Type subfield equal to 1 to wake up this AP had already set the More Data subfield of the last PPDU to 0.

An AP affiliated with an AP MLD may enter the sleep mode by setting the Power Management Mode subfield of the MLD Parameters field to 11 in the TBTT Information field corresponding to this affiliated AP in the Reduced Neighbor Report element carried in the Beacon and Probe response frames. If an AP affiliated with an AP MLD is operating in the sleep mode, it always remains in the doze state.

*TGbe editor: Change the following subclause as follows: (#5064)*

* More Data subfield

The More Data subfield is used differently by a DMG, an S1G STA, and a non-DMG non-S1G STA(#464).

A non-DMG and non-S1G STA uses the More Data subfield to indicate to a STA in PS mode that more BUs are buffered for that STA at the AP. The More Data subfield is valid in individually addressed Data or Management frames transmitted by an AP to a STA in PS mode. The More Data subfield is set to 1 to indicate that at least one additional buffered BU is present for the same STA.

A STA affiliated with a non-AP MLD uses the More Data subfield to indicate to an AP that is affiliated with an AP MLD and operating in the power save mode that more BUs are buffered for that AP at that STA. The More Data subfield is valid only in individually addressed Data or Management frames transmitted by a STA affiliated with a non-AP MLD to an AP that is affiliated with an AP MLD and operating in the power save mode. The More Data subfield is set to 1 to indicate that at least one additional buffered BU is present for the AP that is affiliated with the AP MLD and operating in the power save mode.

(11ax)An AP optionally sets the More Data subfield to 1 in Ack frames sent to a non-DMG non-S1G non-HE STA and in Ack, BlockAck, and Multi-STA BlockAck frames sent to an HE STA. An HE AP indicates that it supports setting the More Data subfield to 1 in these control response frames by setting the More Data Ack subfield to 1 in the QoS Info field of elements it includes in frames transmitted to the STA.

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