IEEE P802.11
Wireless LANs

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| MLO: Power Save-Listen Interval |
| Date: 2021-01-01 |
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The Listen Interval field in the (Re)Association Request frame sent by a non-AP MLD shall apply to the MLD level, and not to the STA level in R1.

[Motion 135, #SP241, [25] and [183]]

The AP MLD aging function shall not cause the buffered BUs to be discarded after any period that is shorter than that indicated by the non-AP MLD for which the BUs are buffered in the Listen Interval field of its (Re)Association Request frame in R1.

* This is independent of MSDU lifetime, which is also used to discard the frames.
* The exact specification of the aging function is beyond the scope of this standard.

[Motion 135, #SP242, [25] and [183]]

The existing Listen Interval field in the (Re)Association Request frame is reused for the non-AP MLD in R1.

[Motion 135, #SP243, [25] and [183]]

The value of the Listen Interval field sent by the non-AP MLD is in units of the maximum value of beacon intervals corresponding to the links that the non-AP MLD intends to setup in R1.

[Motion 137, #SP247, [3] and [184]]

In R1, an AP MLD may delete buffer for the implementation dependent reasons, including the use of an aging function and availability of buffers where the aging function is based on the listen interval indicated by the non-AP MLD in its (Re)Association Request frame.

[Motion 137, #SP248, [3] and [184]]

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 TGbe 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 TGbe Draft (i.e. they are instructions to the 802.11 editor on how to merge the text with the baseline documents).***

1. **Proposed spec text**

**6.3.7.3 MLME-ASSOCIATE.confirm**

**6.3.7.2.2 Semantics of the service primitive**

***TGbe editor: Modify the row corresponding to ListenInterval as follows***

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid range | Description |
| ListenInterval | Integer | >=0 | Specifies how often the STA awakens and listens for the next Beacon frame, if it enters power save mode when an association is not for a multi-link setup (see 35.3.5.1(Multi-link (re)setup procedure))Specifies how often at least a STA affiliated with the MLD awakens and listens for the next Beacon frame, if all STAs affiliated with the MLD and associated with the multi-link setup enter power save mode when an association is for a multi-link setup (see 35.3.5.1(Multi-link (re)setup procedure)) |

**6.3.7.4 MLME-ASSOCIATE.indication**

**6.3.7.4.2 Semantics of the service primitive**

***TGbe editor: Modify the row corresponding to ListenInterval as follows***

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid range | Description |
| ListenInterval | Integer | >=0 | Specifies how often the STA awakens and listens for the next Beacon frame, if it enters power save mode when an association is not for a multi-link setup (see 35.3.5.1(Multi-link (re)setup procedure)) Specifies how often at least a STA affiliated with the MLD awakens and listens for the next Beacon frame, if all STAs affiliated with the MLD and associated with the multi-link setup enter power save mode when an association is not for a multi-link setup (see 35.3.5.1(Multi-link (re)setup procedure)) |

**6.3.8.2 MLME-REASSOCIATE.request**

**6.3.8.2.2 Semantics of the service primitive**

***TGbe editor: Modify the row corresponding to ListenInterval as follows***

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid range | Description |
| ListenInterval | Integer | >=0 | Specifies how often the STA awakens and listens for the next Beacon frame, if it enters power save mode when a reassociation is not for a multi-link resetup (see 35.3.5.1(Multi-link (re)setup procedure)) Specifies how often at least a STA affiliated with the MLD awakens and listens for the next Beacon frame, if all STAs affiliated with the MLD and associated with the multi-link resetup enter power save mode when a reassociation is not for a multi-link resetup (see 35.3.5.1(Multi-link (re)setup procedure)) |

**6.3.8.4 MLME-REASSOCIATE.indication**

**6.3.8.4.2 Semantics of the service primitive**

***TGbe editor: Modify the row corresponding to ListenInterval as follows***

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid range | Description |
| ListenInterval | Integer | >=0 | Specifies how often the STA awakens and listens for the next Beacon frame, if it enters power save mode when a reassociation is not for a multi-link resetup (see 35.3.5.1(Multi-link (re)setup procedure)) Specifies how often at least a STA affiliated with the MLD awakens and listens for the next Beacon frame, if all STAs affiliated with the MLD and associated with the multi-link resetup enter power save mode when a reassociation is not for a multi-link resetup (see 35.3.5.1(Multi-link (re)setup procedure)) |

***TGbe editor: Modify the row corresponding to 9.4.1.6 Listen Interval field as follows***

**9.4.1.6 Listen Interval field**

When a (re)association is not for a multi-link (re)setup (see 35.3.5.1(Multi-link (re)setup procedure)), the Listen Interval field is used to indicate to the AP how often an S1G STA with dot11NonTIMModeActivated equal to false or a non-S1G STA in power save mode wakes to listen to Beacon frames. It is also used to indicate to an AP the duration during which an S1G STA with dot11NonTIMModeActivated equal to true is required to transmit at least one frame that is addressed to the associated AP. This field is derived from the ListenInterval parameter when present as a parameter of an MLME primitive. The value is in units of beacon interval if dot11ShortBeaconInterval is false and in units of short beacon interval if dot11ShortBeaconInterval is true (see 11.1.3.10.2 (Generation of S1G Beacon frames)).

When a (re)association is for a multi-link (re)setup, the Listen Interval field is used to indicate to the AP MLD how often a**t** least a STA affiliated with a non-AP MLD wakes to listen to Beacon frames if all STAs affiliated with the non-AP MLD and associated with the multi-link (re)setup are in power save mode. This field is derived from the ListenInterval parameter when present as a parameter of an MLME primitive. The value is in units of the maximum value of beacon intervals corresponding to the links that the non-AP MLD intends to setup in the (Re)Association Request frame.

The length of the Listen Interval field is 2 octets. The Listen Interval field is shown in Figure 9-88 (Listen Interval field format carried in a non-S1G PPDU).

NOTE—The value 0 might be used by a STA that is not affiliated with an MLD or all STAs affiliated with an MLD that never enters power save mode.

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When a (re)association is not for a multi-link (re)setup (see 35.3.5.1(Multi-link (re)setup procedure)), an AP uses the listen interval in determining the lifetime of frames that it buffers for a STA.

An AP MLD uses the listen interval in determining the lifetime of frames that it buffers for a non-AP MLD.

***TGbe editor: Please insert this subclause as shown below:***

**35.3.10.6 Operation for MLD listen Interval**

During multi-link (re)setup, the value carried in Listen Interval field in the (Re)Association Request frame sent by a non-AP STA affiliated with a non-AP MLD to an AP affliatated with an AP MLD is requested at the MLD level. The AP affliated AP MLD may reject the multi-link setup because the listen interval requested by the non-AP MLD is too large. After successful multi-link (re)setup, the AP MLD shall use the listen interval in determining the lifetime of frames that it buffers for the non-AP MLD.

The AP MLD may delete buffered BUs for the implementation dependent reasons (subject to 11.2.3.10 (AP and AP MLD aging function)), including the use of an aging function and availability of buffers where the aging function is based on the listen interval indicated by the non-AP MLD in its (Re)Association Request frame or the WNM sleep interval specified by the non-AP MLD in the WNM Sleep Mode Request frame.

If all STAs operating on enabled links and affiliated with the non-AP MLD that is associated with the multi-link (re)setup are in power save mode, at least one of these STAs shall wake up to receive at least one Beacon frame scheduled for transmission within the interval of duration equal to the listen interval indicated by the non-AP MLD in its (Re)Association Request frame, starting from the last TBTT for which another STA or the same STA affiliated with the MLD was awake.

An example of operation for MLD listen interval is shown in Figure 35-x (Example of operation for MLD listen interval)



Figure 35-x—Example of operation for MLD listen interval

In this example, AP MLD has three affiliated APs: AP 1 operates on link 1, AP 2 operates on link 2, and AP 3 operates on link 3. The beacon intervals of link 1, link 2 and link 3 are 300 ms, 200 ms and 70 ms, respectively. Non-AP STA 1 affiliated with the non-AP MLD sends an Association Request frame to AP 1 affiliated with the AP MLD. The non-AP STA 1 requests three links to be setup (link 1 between AP 1 and non-AP STA 1, link 2 between AP 2 and non-AP STA 2, and link 3 between AP 3 and non-AP STA 3) and set the value of Listen Interval field carried in the Association Request frame to 1. Therefore, the listen interval requested by the non-AP MLD is 300ms. AP 1 affiliated with the AP MLD accepts the three links for this multi-link setup (link 1 between AP 1 and non-AP STA 1, link 2 between AP 2 and non-AP STA 2, and link 3 between AP 3 and non-AP STA 3) by sending an Association Response frame to non-AP STA 1 affiliated with the non-AP MLD. After the successful mult-link setup, non-AP STA 1, non-AP STA 2 and non-AP STA 3 enter in power save mode. In this case, the AP MLD shall buffer the DL BUs to the non-AP MLD at least for 300 ms. At T1, the non-AP STA 1 recevies a Beacon frame on link 1, then a non-AP STA affliated the non-AP MLD is required to wake up to receive at least one Beacon frame before T2 where T2=T1+300ms, for example, the non-STA 1 receives the second Beacon frame on link1 (at T1+300ms), or the non-AP STA 2 receives the second Beacon frame on link 2 (at T1+200ms), or the non-AP STA 3 receives the fourth Beacon frame on link 3 (at T1+280ms). The figure was simplified to show the first Beacon frames on all links as aligned. In real deployment, the first TBTTs on all links may not be aligned.

Another example of operation for MLD listen interval is shown in Figure 35-y (Another example of operation for MLD listen interval)



Figure 35-y—Another example of operation for MLD listen interval

In this example, AP MLD has three affiliated APs: AP 1 operates on link 1, AP 2 operates on link 2, and AP 3 operates on link 3. The beacon intervals of link 1, link 2 and link 3 are 300 ms, 200 ms and 70 ms, respectively. Non-AP STA 1 affiliated with the non-AP MLD sends an Association Request frame to AP 1 affiliated with the AP MLD. The non-AP STA 1 requests three links to be setup (link 1 between AP 1 and non-AP STA 1, link 2 between AP 2 and non-AP STA 2, and link 3 between AP 3 and non-AP STA 3) and sets the value of Listen Interval field carried in the Association Request frame to 1. AP 1 affiliated with the AP MLD accepts the two links for this multi-link setup (link 2 between AP 2 and non-AP STA 2, and link 3 between AP 3 and non-AP STA 3) by sending an Association Response frame to non-AP STA 1 affiliated with the non-AP MLD, then listen interval requested by the non-AP MLD is still 300 ms and it is not changed along with the accepted links in the multi-link setup procedure. After the successful mult-link setup, non-AP STA 2 and non-AP STA 3 enter in power save mode. In this case, the AP MLD shall buffer the DL BUs to the non-AP MLD at least for 300 ms. At T1, the non-AP STA 2 recevies a Beacon frame on link 2, then either non-AP STA 2 or non-AP STA 3 is required to wake up to receive at least one Beacon frame before T2 where T2=T1+300ms, for example, the non-AP STA 2 receives the second Beacon frame on link 2 (which occurs at T1+200ms in this example) or the non-AP STA 3 receives the fourth Beacon frame on link 3 (which occurs at T1+280ms). The figure was simplified to show the first Beacon frames on all links as aligned. In real deployment, the first TBTTs on all links may not be aligned.

***TGbe editor: Modify the row corresponding to 11.2.3.6 AP operation as follows***

**11.2.3.6 AP operation**

An AP shall maintain for each currently associated STA a Power Management status that indicates in which power management mode the STA is currently operating. APs that implement and signal their support of APSD shall maintain for each currently associated STA an APSD and an access policy status that indicates whether the STA is presently using APSD and shall maintain the schedule (if any) for the STA. An AP shall, depending on the power management mode of the STA, temporarily buffer BUs destined to the STA. An AP implementing APSD shall, if a STA is using APSD and is in PS mode, temporarily buffer BUs destined to that STA. No BUs addressed directly to STAs operating in the active mode shall be buffered for power management reasons.

The following rules describe the operation:

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k) When a (re)association is not for a multi-link (re)setup (see 35.3.5.1(Multi-link (re)setup procedure)), an AP may delete buffered BUs for implementation dependent reasons (subject to 11.2.3.10 (AP aging function)), including the use of an aging function and availability of buffers. The AP may base the aging function on the listen interval indicated by the STA in its (Re)Association Request frame or the WNM sleep interval specified by the non-AP STA in the WNM Sleep Mode Request frame. In addition, the S1G AP may base the aging function on the listen interval indicated by the AP in the (Re)Association Response frame.

***TGbe editor: Modify the row corresponding to 11.2.3.7 Receive operation for STAs in PS mode as follows***

**11.2.3.7 Receive operation for STAs in PS mode**

A STA in PS mode shall operate as follows to receive a BU from the AP.

The following rules describe operation of a STA in PS mode:

a) When a (re)association is not for a multi-link (re)setup (see 35.3.5.1(Multi-link (re)setup procedure)), the STA with dot11NonTIMModeActivated equal to false shall wake up early enough to be able to receive the first Beacon frame scheduled for transmission at the time corresponding to the last TBTT or TSBTT for which the STA was awake plus the time interval indicated by the ListenInterval parameter of the MLME-ASSOCIATE.request or MLME REASSOCIATE.request primitive. The STA with dot11NonTIMModeActivated equal to true is not required to wake up to receive a Beacon frame and shall transmit at least one PS-Poll or trigger frame that is individually addressed to the associated AP every listen interval starting from the last known transition of the S1G STA in non-TIM mode in doze state unless it follows the TWT or NDP Paging procedure.

NOTE—The STA might wake for a TBTT or TSBTT that is earlier than this deadline. In that case the previous requirement is reset based on a new “last TBTT or TSBTT”.

***TGbe editor: Modify the row corresponding to 11.2.3.10 AP aging function as follows***

**11.2.3.10 AP and AP MLD aging function**

Any AP aging function shall not cause the buffered BU to be discarded after any period that is shorter than that indicated by the STA for which the BUs are buffered, in the Listen Interval field of its (Re)Association Request frame. The exact specification of the aging function is beyond the scope of this standard.

The AP MLD aging function shall not cause the buffered BUs to be discarded after any period that is shorter than that indicated by the non-AP MLD for which the BUs are buffered in the Listen Interval field of its (Re)Association Request frame. The exact specification of the aging function is beyond the scope of this standard.

NOTE—This aging function is independent of (i.e., in addition to) other causes of MSDU discard within the MAC, such as due to the operation of a per-TS MSDU lifetime, or related to dot11QAPEDCATableMSDULifetime.