IEEE P802.11  
Wireless LANs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Text for Power Management Comments Resolution | | | | |
| Date: 2010-01-20 | | | | |
| Author(s): | | | | |
| Name | Affiliation | Address | Phone | email |
| Jarkko Kneckt | Nokia | Rakentajainrinne 6, 02330 Espoo, Finland |  | Jarkko.Kneckt(at) Nokia.com |
|  |  |  |  |  |

Abstract

The document provides normative resolution text to solve all power management related comments, excluding CID2171 and CID 2725 that were given in LB159.

Note for the editor. The tarck changes option illustrates the changes to draft 4.0.

* Definitions
* **3.s12mesh power mode:**

Representes activity level of a mesh STA per peering. Three mesh power modes are defined; active, light sleep and deep sleep mode.

* Receiver Service Period Initiation (RSPI) subfield

The Receiver Service Period Initiation (RSPI) subfield is one bit in length. The subfield is set to 0 to indicate that the peer service period for the peer trigger frame receiver is not initiated and set to 1 to indicate that the peer service period is initiated. The use of RSPI subfield in the peer trigger frames are described in 11C.13.10.2 (Initiation of a peer service period).

* Power Management field

Change the contents of 7.1.3.1.6 as follows:

* following text is based on the amendment by TGn

The Power Management field is 1 bit in length and is used to indicate the power management mode of a

STA.

In an infrastructure BSS or in an IBSS the following applies: The value of this field remains constant in each frame from a particular STA within a frame exchange sequence (see Annex S).The value indicates the mode in which the station will be after the successful completion of the frame exchange sequence. 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. This field is always set to 0 in frames transmitted by an AP.

In an MBSS the following applies: The value of this field together with Mesh Power Save Level subfield in QoS Control field indicate the mesh power mode in which the mesh STA will be after the completion of the frame exchange sequence. A value of 0 in a group addressed frame indicates that the mesh STA will be in active mode. For non-peer mesh STAs, a value of 1 in a group addressed frame indicates that the mesh STA will be in light or in deep sleep mode. For the peer mesh STAs the link specific mesh power mode rules are determined by the Power Management field in the individually addressed frame exchanged between these peers, as described in 11C.13.4 (Mesh power mode indications and transitions). In an individually addressed frame, a value of 0 indicates that the mesh STA will be in active mode and a value of 1 indicates that the mesh STA will be in light or deep sleep mode after the successful completion of the frame exchange sequence.

* AID field

Change the text in 7.3.1.8 as shown:

~~The~~ In case of infrastructure BSS operation, the AID field is a value assigned by an AP during association that represents the 16-bit ID of a STA. In a mesh BSS operation, the AID field is a value assigned by a mesh STA during mesh peering establishment that represents the 16-bit ID of a neighbor peer mesh STA. The length of the AID field is 2 octets. The AID field is illustrated in Figure 7-26.

* Mesh Power Save Level subfield

The Mesh Power Save Level field and the Power Management field in the Frame Control field indicate the mesh power mode of the mesh STA. The Power Management field set to 1 and the Mesh Power Save Level subfield set to 0 indicate that the mesh STA is operating in light sleep mode (see 11C.13.9.3 (Operation in light sleep mode)). The Power Management field set to 0 and the mesh Power Save Level subfield set to 1 indicate that the mesh STA is operating in deep sleep mode (see 11C.13.9.4 (Operation in deep sleep mode)). The Mesh Power Save Level subfield is reserved, if the Power Management subfield is set to 0. .

* Mesh Capability

The Mesh Capability field comprises a set of values indicating whether a mesh STA is a possible candidate for mesh peering establishment. The details of the Mesh Capability field are shown in Figure s16 (Mesh Capability field).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| B0 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | B8 | B9 B15 |
| Accepting Mesh Peerings | MCCA Supported | MCCA Enabled | Forwarding | Beacon Timing Report Enabled | TBTT Adjustment Enabled | TBTT Adjusting | TSF Adjustment Enabled | Mesh Power Save Level | Reserved |
| Bits: 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 7 |
| * Mesh Capability field | | | | | | | | | |

The Accepting Mesh Peerings subfield is set to 1 if the mesh STA is willing to establish mesh peerings with other mesh STAs and set to 0 otherwise.

The MCCA Supported subfield is set to 1 if the mesh STA implements MCCA services and set to 0 otherwise.

The MCCA Enabled subfield is set to 1 if the mesh STA is using MCCA services and set to 0 otherwise.

The Forwarding subfield is set to the value of the MIB variable dot11MeshForwarding. (#305)

The Beacon Timing Report Enabled subfield is set to 1 if MBCA beacon timing report function (see 11C.12.4.2 (The use of Beacon Timing element)) is enabled on the mesh STA and is set to 0 otherwise.

The TBTT Adjustment Enabled subfield is set to 1 if the TBTT adjusting function is enabled on the mesh STA, and is set to 0 otherwise. (See 11C.12.4.3 (TBTT selection and adjustment))

The TBTT Adjusting subfield is set to 1 while the TBTT adjusting procedure is on going to notify that the mesh STA’s TBTT is shifting intentionally, and is set to 0 otherwise. (See 11C.12.4.3 (TBTT selection and adjustment))

The TSF Adjustment Enabled subfield is set to 1 if the TSF drift compensation function (see 11C.12.2.2.2 (TSF Adjustment)) is enabled on the mesh STA, and is set to 0 otherwise.

The Mesh Power Save Level field and the Power Management field in the Frame Control field indicate the mesh power mode of the mesh STA. The Power Management subfield set to 1and the Mesh Power Save Level field set to 0 indicate that the mesh STA is operating in light sleep mode.The Power Management field set to 0 and the Mesh Power Save Level set to 1 indicate that mesh STA is operating in deep sleep mode. The Mesh Power Save Level field is reserved, if the Power Management subfield is set to 0..

* Mesh peering management
* Overview

The Mesh Peering Management protocol is used to establish, maintain, and close mesh peerings between mesh STAs when security is not required.

Mesh STAs shall not transmit frames other than the ones used for candidate peer mesh STA discovery, mesh peering management, and SAE to a neighboring mesh STA until a mesh peering has been established with the mesh STA.

After discovering a candidate peer mesh STA, the mesh STA may start the Mesh Peering Management protocol to establish a mesh peering with the candidate peer mesh STA. The SME controlling the mesh STA uses the Mesh Peering Instance Controller to manage mesh peering instances. A mesh peering instance is a logical entity that the mesh STA uses to handle a mesh peering or an attempt to establish a mesh peering. Its behavior is governed by a mesh peering management finite state machine defined in 11C.3.3 (Mesh Peering Management Finite State Machine (MPM FSM)). The behavior of the Mesh Peering Instance Controller is defined in 11C.2.2 (Mesh Peering Instance Controller).

Each mesh peering instance is identified by a mesh peering instance identifier. The mesh peering management finite state machine identifier is defined as <localMAC, peerMAC, localLinkID, peerLinkID>. localMAC is the MAC address of the mesh STA that is being used with this mesh peering instance. peerMAC is the MAC address of the peer mesh STA or the candidate peer mesh STA. localLinkID is an integer generated by the mesh STA. peerLinkID is an integer generated by the peer mesh STA or the candidate peer mesh STA. The localLinkID shall be unique among all existing link identifiers used by the mesh STA for its current mesh peering management finite state machines. The mesh STA selects the localLinkID to provide high assurance that the same number has not been used to identify a recent mesh peering management finite state machine. The peerLinkID shall be supplied by the peer mesh STA or candidate peer mesh STA in Mesh Peering Open and Confirm frames. The mesh peering management finite state machine identifiers are transmitted via mesh peering management frames.

A mesh STA shall assign an AID to every peer mesh STA during the mesh peering establishment procedure. Mesh STAs shall assign AID values uniquely to each of the peer mesh STAs. AID is used to encode TIM element in the Beacon frame (see 7.3.2.6). AID 0 (zero) is reserved to indicate the presence of buffered groupcast MSDUs and MMPDUs.

The mesh STA shall maintain information about mesh peering management finite state machine identifier and the respective policy as the states of the mesh peering management finite state machine. The actual method for handling the states is outside the scope of this specification.

The mesh STA shall start the mesh peering management protocol in either of the following two cases. In the first case, the mesh STA passively listen to incoming Mesh Peering Open requests from a candidate peer mesh STA. In the second case, the mesh STA actively creates a mesh peering instance to establish a mesh peering with a candidate peer mesh STA.

A mesh peering instance ends when the mesh peering is closed. The mesh peering close can be caused by the mesh STA due to events outside the scope of this specification. The response to these events is outside the scope of this standard.

The MPM protocol uses mesh peering open frames, mesh peering confirm frames, and mesh peering close frames to establish, manage, and tear down a mesh peering.

A Mesh Peering Open frame requests that a mesh peering instance be established between the Mesh Peering Open sender and the receiver. Mesh Peering Open frames propose mesh parameters for the mesh peering instance. The mesh STA processes the received parameters. If it agrees with the parameters, the mesh STA sends a Mesh Peering Confirm frame in response to the Mesh Peering Open frame. If the mesh STA disagrees on the parameters or there is a failure due to other reasons, the mesh STA closes the mesh peering by sending a Mesh Peering Close frame.

The protocol succeeds in establishing a mesh peering when the following requirements are satisfied: 1) both mesh STAs have sent and received (and correctly processed) a Mesh Peering Open frame regarding this mesh peering; 2) both mesh STAs have sent and received (and correctly processed) a corresponding Mesh Peering Confirm frame regarding this mesh peering.

The mesh peering management protocol uses timers to control the protocol behavior. For each mesh peering instance, there are three timers: retryTimer, confirmTimer, and holdingTimer. The retryTimer controls the maximum time the mesh STA waits for a Mesh Peering Confirm frame responding to any Mesh Peering Open frame the mesh STA has sent for that mesh peering instance. The confirmTimer bounds the time that the mesh STA waits for a Mesh Peering Open frame after receiving a Mesh Peering Confirm frame from the candidate peer mesh STA. The holdingTimer is used to provide a graceful closing period for a mesh peering instance.

The detailed protocol behavior is specified in mesh peering management finite state machine as specified in 11C.3.3 (Mesh Peering Management Finite State Machine (MPM FSM)).\

* Power save in a mesh BSS
* General

A mesh STA shall have the capability to buffer frames and track the mesh power mode of each peer mesh STA. A mesh STA shall use peer service periods for individually addressed frame transmissions to neighboring peer mesh STAs in light or deep sleep mode. A mesh STA transmits a group addressed frame after the DTIM Beacon when any of its peer mesh STAs are in light or deep sleep mode. These capabilities are referred as support for power save.

Operation in light or in deep sleep mode is optional.

NOTE—In this subclause, the frame whose RA field is set to an individually address is referred to as an individually addressed frame. The DA field of the individually addressed frame in this context might not be set to an individual address, if the frame uses 4 address or 6 address format. Similarly, frames whose RA are set to a group address are referred to as group addressed frames, in this subclause.

* Link specific mesh power modes

A mesh STA is in one of two different power states as defined in 11.2.1.1.

The manner in which a mesh STA transitions between power states is determined by the combination of mesh peering specific mesh power modes. A mesh STA shall be in Awake state if any of its mesh peerings require operation in Awake state.

A mesh peering is always associated with two mesh STAs. Both mesh STAs have their own mesh power mode for the mesh peering. A mesh STA defines a mesh power mode in which it operates for the mesh peering and maintains a state about the mesh power mode of the peer mesh STA within the mesh peering. The mesh power modes of mesh peerings are independent and a mesh STA may operate in different mesh power modes for each mesh peering. A mesh STA maintains a mesh power mode for non-peer mesh STAs that is described in 11C.13.3 (Non-peer mesh power modes). An example illustration of the use of mesh power modes is shown in Figure s54 (An example of mesh power mode usage (all mesh STAs have mesh peerings between each other)).

Three mesh power modes are defined: active mode, light sleep mode, and deep sleep mode. The used mesh power mode shall be indicated by the Power Management field and Mesh Power Save Level field. The difference between modes is as follows

* *Active mode:* The mesh STA shall be in Awake state all the time.
* *Light sleep mode:* The mesh STA alternates between Awake and Doze states, as determined by the frame transmission and reception rules. The mesh STA shall listen to all the Beacon frames from its peer mesh STA.
* *Deep sleep mode:* The mesh STA alternates between Awake and Doze states, as determined by the frame transmission and reception rules. The mesh STA may choose not to listen to the Beacons from its peer mesh STA.

A mesh power mode is defined as the combination of the Power Management field indicated in the Frame Control field and the Mesh Power Save Level as shown in the Table s63 (Mesh power mode definition).

|  |  |  |  |
| --- | --- | --- | --- |
| * Mesh power mode definition | | | |
| Activity level | Mesh power mode | Power Management field | Mesh Power Save Level field |
| Highest  Lowest | Active mode | 0 | Reserved |
| Light sleep mode | 1 | 0 |
| Deep sleep mode | 1 | 1 |



* in an MBSS

The TIM element identifies the peer mesh STAs operating in ligth or deep sleep mode for which traffic is pending and buffered in the reporting mesh STA. This information is coded in a partial virtual bitmap using AIDs. In addition, the TIM contains an indication whether group addressed traffic is pending. The mesh STA shall identify those peer mesh STAs for which it is prepared to deliver buffered MSDUs by setting bits in the partial virtual bitmap of the TIM that correspond to the appropriate AIDs.

* Mesh Awake Window

A mesh STA in light or deep sleep mode shall be in Awake state during its own Mesh Awake Window. An Mesh Awake Window is present after the Beacon and Probe Response frames containing an Mesh Awake Window element. A mesh STA shall include a Mesh Awake Window element in its DTIM Beacon frames and may include a Mesh Awake Window in its TIM Beacon and Probe Response frames. Mesh STA in light or deep sleep mode shall include a Mesh Awake Window in its Beacon frame if the Beacon frame indicates buffered traffic for at least one peer mesh STA. The start of the Mesh Awake Window is measured from the end of the Beacon or Probe Response transmission. The duration of the Mesh Awake Window period is defined by the value of the Mesh Awake Window field in the Mesh Awake Window element.

If the owner of the Mesh Awake Window transmits frames destined to group addresses during its Mesh Awake Window, the duration of Mesh Awake Window is extended by an additional PostAwakeDuration. The PostAwakeDuration follows the group address frame, and the owner of the Mesh Awake Window shall stay in awake state until it has transmitted all of its group addressed frames and the PostAwakeDuration has expired. The PostAwakeDuration is equal to duration of the Mesh Awake Window.

The peer mesh STAs may send a trigger frame to the power saving mesh STA during the Mesh Awake Window of the light or deep sleep mode mesh STA in order to initiate a peer service period. A successfully transmitted trigger frame initiates a peer service period as described in 11C.13.10 (Peer service periods).

The first Mesh Data or QoS Null frame that a peer mesh STA transmits during the Mesh Awake Window is a peer trigger frame.

Non-peer mesh STAs may send Probe Request and Mesh Peering Open frames to the light or deep sleep mode mesh STA during its Mesh Awake Window. The light or deep sleep mode mesh STA shall operate in Awake state at least until the completion of the mesh peering management procedure once it is initiated (see 11C.3 and 11C.4), until the completion of the Authentication procedure once it is initiated (see 8.2A), or the transmission of the Probe Response frame upon the reception of Probe Request frame.

* Power Save Support

As described in 11C.13.2 (Link specific mesh power modes) a mesh STA indicates its mesh power mode for each mesh peering and obtains the mesh power modes of its peer mesh STAs.

A mesh STA shall not arbitrarily transmit frames to mesh STAs operating in a light or deep sleep mode, but shall buffer frames and only transmit them at designated times.

As described in 11C.13.5 (TIM transmissions in an MBSS) a mesh STA can indicate the presence of buffered traffic in TIM elements for all peer mesh STAs in light or deep sleep mode. As described in 11C.13.6 (TIM types), a mesh STA transmits its group addressed frames after its DTIM Beacon if any of its peer mesh STA is in light or deep sleep mode.

As described in 11C.13.10 (Peer service periods) peer service periods are used for frame transmissions towards a mesh STA that operates in light or deep sleep mode. Peer service periods are not used in frame exchanges towards active mode mesh STAs.

A mesh STA may initiate a peer service period with a peer mesh STA that operates in deep or light sleep mode by transmitting a peer trigger frame during the Mesh Awake Window of the peer mesh STA.

* Operation in active mode

A mesh STA operating in active mode shall be in Awake state. Peer service periods are not used in frame exchanges toward active mode mesh STAs.

Active mode mesh STA may receive peer trigger frames from a peer mesh STA in light or deep sleep mode at all times when they do not have a peer service period ongoing.

* Conditions for Doze State

A mesh STA may enter Doze state if all following conditions are fulfilled:

* the mesh STA operates in power save mode for all of its mesh peerings, as described in 11C.13.9.3 (Operation in light sleep mode) or 11C.13.9.4 (Operation in deep sleep mode)
* the mesh STA has no peer service period ongoing, as described in 11C.13.10 (Peer service periods)
* the Mesh Awake Window indicated by the mesh STA has expired, as described in 11C.13.7 (Mesh Awake Window)
* the mesh STA has terminated its group addressed frames delivery sequence after its DTIM Beacon
* , as described in 11C.13.6 (TIM types)

Guidance for using the power save in mesh and default parameter values are given in Annex X.4 (Power Save parameters selection).

* Peer service periods
* General

Peer service periods are used for frame exchange in a link in which at least one of the mesh STAs operates in light or deep sleep mode. A peer service period is a contiguous period of time during which one or more individually addressed frames are transmitted between two peer mesh STAs. A peer service period is directional and may contain one or more TXOPs. One mesh STA operates as transmitter in peer service period, transmits frames and initiates the termination of the peer service period. The other mesh STA operates as receiver in peer service period and receives the frames. A mesh STA may have multiple peer service periods ongoing in parallel. At most one peer service period can be set up in each direction with each peer mesh STA. A peer service period is initiated by a peer trigger frame. An example peer service period between two mesh STAs in ligth or deep sleep mode is shown in Figure s56 (Peer service period). The numbering in the left-hand-side describes the phase of the operation. 1 indicates the Initiation phase, 2 indicates the data transmission phase and 3 indicates the termination phase of the peer service period.

|  |
| --- |
|  |
| * Peer service period |

* Initiation of a peer service period

A Mesh Data frame or a QoS Null frame that requires acknowledgement may be used as a peer trigger frame. The RSPI and the EOSP subfields in the QoS Control field control the initiation of a peer service period. Table s64 (Peer service period triggering with RSPI and EOSP field combinations in peer trigger frame) lists how peer service periods shall be initiated with different combinations of RSPI and EOSP field values.

Peer service periods are not used in frame exchange toward active mode mesh STAs.

|  |  |  |
| --- | --- | --- |
| * Peer service period triggering with RSPI and EOSP field combinations in peer trigger frame | | |
| RSPI | EOSP | Peer service period triggering |
| 0 | 0 | One peer service period is initiated. The transmitter of the trigger frame is the transmitter in the peer service period. |
| 0 | 1 | No peer service period is initiated. |
| 1 | 0 | Two peer service periods are initiated. Both mesh STAs are transmitters in a peer service period. |
| 1 | 1 | One peer service period is initiated. The receiver of the trigger frame is the transmitter in the peer service period. |

The peer service period may be initiated in the following cases:

* The mesh STA in light or deep sleep mode receives a peer trigger frame during its Mesh Awake Window as described in 11C.13.7 (Mesh Awake Window)
* The mesh STA in active mode receives a peer trigger frame from the peer mesh STA in light or deep sleep mode as described in 11C.13.9.2 (Operation in active mode)
* The mesh STA receives a peer trigger frame from the peer mesh STA in light sleep mode as described in 11C.13.9.3 (Operation in light sleep mode)

In addition, when a mesh STA enables MCCA while in a power save mode, a scheduled service period begins at the each MCCAOP start time as described in 11C.13.11 (MCCA use by power saving mesh STA). A mesh STA in a light or deep sleep mode shall enter the Awake state prior to the start time of scheduled service period.

* Operation during a peer service period

During the peer service period, the transmitter of the peer service period and peer mesh STA shall operate in Awake state. The peer service period may contain one or more TXOPs.

Reverse Direction Grant (RDG) shall not be used when the receiver of the TXOP operates in light or deep sleep mode and is not a transmitter in service period toward the transmitter in the TXOP.

* Termination of a peer service period

The peer service period is terminated after a successfully acknowledged QoS Null or Mesh Data frame with the EOSP bit set to 1 from the transmitter of the peer service period.

If the mesh STA does not receive an acknowledgement to a frame that requires an acknowledgement and sent with the EOSP subfield set to 1, the mesh STA shall retransmit that frame at least once within the same peer service period — subject to applicable retry or lifetime limit. The maximum number of retransmissions within the same peer service period is the lesser of the Max Retry Limit and the MIB attribute dot11MeshSTAMissingAckRetryLimit.

NOTE—If an Ack to the retransmission of this last frame in the same peer service period is not received, the mesh STA can use the next peer service period to further retransmit that frame subject to the applicable retry or lifetime limit.

* MCCA use by power saving mesh STA

When a mesh STA operates in MCCA enabled mode and is owner of MCCAOPs, the mesh STA shall be in active mode or in light sleep mode toward peer mesh STAs that are owners of MCCAOPs.

A scheduled peer service period begins at the MCCAOP start time, if the MCCAOP responder operates in light or deep sleep mode for the MCCAOP owner. The MCCAOP owner is the transmitter during the scheduled peer service period. The MCCAOP responder is the receiver during the scheduled peer service period. Scheduled peer service periods are not used, if the MCCAOP responder operates in active mode for the MCCAOP owner.

The scheduled peer service period continues until it is successfully terminated by acknowledged QoS Null or Mesh Data frame with set EOSP bit from transmitter to receiver as described in 11C.13.10 (Peer service periods).

* Mesh Protocol Capabilities
* General Mesh Support

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| MP8 | Operation in light or deep sleep mode | 11C.13 (Power save in a mesh BSS) | MP1:O | Yes No N/A  |

**References:**