IEEE P802.11
Wireless LANs

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| Active Scanning Enabling FILS |
| Date: 2011-12-18 |
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Abstract

The submission provides normative text to make active scanning faster, more precise and with less overhead.

The following features are added for the transmitter of the probe request:

* A filter list is added to the Probe Requests frames to enable the requesting STA to more precisely define the APs that respond.
* The transmitter of probe request may cancel the transmission of pending probe response frames. This avoids unnecessary retransmissions of the probe responses if the transmitter of the Probe Request frame switches to scan another channel.

The submission defines probe response collision avoidance mechanism. The mechanism reduces the amount of Probe Response frames, delays in Probe Response transmission and the overheads of the active scanning:

* A Probe Response frame may contain information of other BSSs. If an AP overhears a Probe Response including information of its BSS, the AP may cancel the transmission of its Probe Response frame.
* If an AP receives multiple Probe Request frames, the AP may transmit one Probe Response frame as a response to multiple requests. Similarly a beacon may be used as a probe response. This eliminates duplicate transmission of the same information.

The Probe Response frames may include information of BSSs whose primary channel is other than the scanned channel so that the number of channels to be scanned may be reduced.

**6.3.3 Scan**

**6.3.3.2 MLME-SCAN.request**

**6.3.3.2.2 Semantics of the service primitive**

*Instructions to Editor: Change the clause as shown with track changes:*

The primitive parameters are as follows:

MLME-SCAN.request(

 BSSType,

 BSSID,

 SSID,

 ScanType,

 ProbeDelay,

 ChannelList,

 MinChannelTime,

 MaxChannelTime,

 RequestInformation,

 SSID List,

 ChannelUsage,

 AccessNetworkType,

 HESSID,

 MeshID,

 Filter List,

 VendorSpecificInfo

)

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type** | **Valid range** | **Description** |
| Filter List | As defined in 8.4.2.ai3 | As defined in 8.4.2.ai3 | The list specifies the HESSIDs, Mesh IDs, SSIDs and BSSIDs that ignore the request. |

**6.3.3.3 MLME-SCAN.confirm**

**6.3.3.3.2 Semantics of the service primitive**

*Instructions to Editor: Modify the explanation of the ResultCode parameter of the MLME-SCAN.confirm primitive as follows:*

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type** | **Valid range** | **Description** |
| ResultCode | Enumeration | SUCCESS,INTERMEDIATE\_SCAN\_RESULT,SCAN\_ABORTED,NOT\_SUPPORTED | Indicates the result of the MLME- SCAN.confirm primitive.If SUCCESS, the MLME-SCAN.confirm contains information of all BSSs that has been received during the period from the point when the corresponding MLME-SCAN.request primitive was invoked to the point the scan process was ended.If INTERMEDIATE\_SCAN\_RESULT, the MLME-SCAN.confirm contains a BSS information that has been received. The The scan process is still onging.If SCAN\_ABORTED, the MLME-SCAN.confirm contains all BSS information that has been received during the period from the point when the corresponding MLME-SCAN.request primitive was invoked to the point the scan process was ended.If NOT\_SUPPORTED, the requested active scanning is not allowed in the current regulatory domain. |

**6.3.3.3.3 When generated**

*Instructions to Editor: Change 6.3.3.3.3 as shown below:*

This primitive is generated by the MLME as a result of an MLME-SCAN.request or MLME-SCAN-STOP.request primitive to ascertain the operating environment of the STA.

**6.3.3.3.4 Effect of receipt**

*Instructions to Editor: Change 6.3.3.3.4 as shown below:*

As indicated by the ResultCode, the SME is notified of the intermediate or final results of the scan procedure.

**6.3.3.3ai1 MLME-SCAN-STOP.request**

*Instructions to Editor: Add a new section 6.3.3.3ai as shown below:*

**6.3.3.3ai1.1 Function**

This primitive terminates any ongoing scan or sets new criteria for the ongoing scan process.

**6.3.3.3ai1.2 Semantics of the service primitive**

The primitive parameters are as follows:

MLME-SCAN-STOP.request (

 ScanStopType,

 BSSID,

SSID,

 SSIDList,

 HESSID,

 Mesh ID,

 Filter List,

 VendorSpecificInfo

 )

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type** | **Valid range** | **Description** |
| ScanStopType | Enumeration | STOP\_ALL, SET\_CRITERIA | Determines is the reception of all probe responses cancelled or is new criteria to respond set.  |
| BSSID | MACAddress  | Any valid individual orbroadcast MAC address | Identifies a specific or wildcard BSSID. |
| SSID | Octet string | 0–32 octets | Specifies the desired SSID or the wildcard SSID. |
| SSID List | A set of SSIDElement | As defined in 8.4.2.2. | One or more SSID elements that are optionally present when dot11MgmtOptionSSIDListActivated is true. |
| HESSID | MAC Address | Any valid individualMAC address or thebroadcast MAC address | Specifies the desired specific HESSID network identifier or the wildcard network identifier. This field is present when dot11InterworkingServiceActivated is true. |
| Mesh ID | Octet string | 0–32 octets | Only present if BSSType = MESH orBSSType = ANY\_BSS. Specifies the desiredMesh ID or wildcard Mesh ID. |
| Filter List | As defined in 8.4.2.ai3 | As defined in 8.4.2.ai3 | The list specifies the HESSIDs, Mesh IDs, SSIDs and BSSIDs that are not allowed to respond to the request. |
| VendorSpecificInfo | A set of elements | As defined in 8.4.2.28 | Zero or more elements. |

**6.3.3.3ai1.3 when generated**

This primitive is generated by the SME as for a STA to stop any ongoing scan process.

**6.3.3.3ai1.4 Effect of receipt**

This request terminates any ongoing scan procedures and transmits probe end frame. The confirmation of the scan termination is provided through MLME-SCAN.confirm primitive.

**8.3.3.2 Beacon frame format**

*Instructions to Editor: Add new element to Table 8-20 as shown with track changes*

The frame body of a management frame of subtype Beacon contains the information shown in Table 8-20.

**Table 8-20—Beacon frame body**

|  |  |  |
| --- | --- | --- |
| Order | Information | Notes |
| 56 | FILS Response Parameters | The FILS Response Parameters are present if dot11FILSActivated is true. |
| Last | Vendor Specific | One or more vendor-specific (#1684)elements are optionally present(#29). These (#1684)elements follow all other (#1684)elements(#1221). |

* + - 1. Probe Request frame format

*Instructions to Editor: Add new element to Table 8-26 as shown with track changes.*

The frame body of a management frame of subtype Probe Request contains the information shown in Table 8–26 Probe Request frame body  (#33)

|  |
| --- |
| Table 8–26 Probe Request frame body   |
| Order | Information | Notes |
| 14 | FILS Request Parameters | The FILS Request Parameters are present if dot11FILSActivated is true. |
| 15 | Filter List | The Filter List is optionally present if dot11FILSActivated is true.  |
| Last | Vendor Specific | One or more vendor-specific (#1684)elements are optionally present(#29). These (#1684)elements follow all other (#1684)elements(#1221). |

* + - 1. **Probe Response frame format**

*Instructions to Editor: Add new element to Table 8-27 as shown with track changes.*

The frame body of a management frame of subtype Probe Response contains the information shown in Table 8-27. See additional details and procedures in 9.18.3 and 10.1.4, respectively.

**Table 8-27—Probe Response frame body**

|  |  |  |
| --- | --- | --- |
| Order | **Information** | **Notes** |
| 55 | FILS Response Parameters | The FILS Response Parameters are present if dot11FILSActivated is true. |
| 56 | NeighborList | The NeighborList is optionally present if dot11FILSActivated is true. |
| Last*–1* | Vendor Specific | One or more vendor-specific (#1684)elements are optionally present(#29). These (#1684)elements follow all other (#1684)elements(#1221), except the Requested (#1684)elements. |
| Last–*n* | Requested (#1684)elements | Elements requested by the Request (#1684)element of the Probe Request frame are present(#29) if dot11MultiDomainCapabilityActivated(#1005) is true. See 11.1.3.2.1 (Sending a probe response).(11k) |

**8.3.3.ai1 Probe End frame format**

*Instructions to Editor: Add new frame format after the probe response and renumber the following frame formats accordingly.*

The frame body of a management frame of subtype Probe End contains the information shown in Table 8-ai1. See additional details and procedures in 9.18.3 and 10.1.4, respectively.

|  |  |  |
| --- | --- | --- |
| Order | **Information** | **Notes** |
| 1 | Filter List | The Filter List is optionally present if dot11FILSActivated is true. |
| Last | Vendor Specific | One or more vendor-specific (#1684)elements are optionally present(#29). These (#1684)elements follow all other (#1684)elements(#1221), except the Requested (#1684)elements. |

**8.4.2.ai1 FILS Request Parameters element**

*Instructions to Editor: Add new element type to the element type list.*

**Table 8-ai1—FILS Request Parameters element**

|  |  |  |  |
| --- | --- | --- | --- |
|  | FILS Supported | Comprehensive Response | Reserved |
| Bits:  | 1 | 1 | 6 |

The FILS Supported field is set to 1 to indicate that the requesting STA supports FILS and otherwise the field is set to 0.

The Comprehensive Response field is set to 1 to indicate that the information of other BSSs are requested to be included to the response and otherwise the field is set to 0.

**8.4.2.ai2 FILS Response Parameters element**

*Instructions to Editor: Add new element type to the element type list.*

**Table 8-ai2—FILS Response Parameters element**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Response to Multiple Requests | Comprehensive Response | Beacon Replacing Probe Response  | Reserved |
| Bits:  | 1 | 1 | 1 | 5 |

The Response to Multiple Requests field is set to 1 to indicate that the frame is a response to two or more Probe Request frames and otherwise set to 0.

The Comprehensive Response field is set to 1 to indicate that the frame includes information of other BSSs and otherwise set to 0.

The Beacon Replacing Probe Response field is set to 1 in a Beacon frame to indicate that the Beacon frame replaces the transmission of Probe Response frame and otherwise the field is set to 0. The field is reserved in other than Beacon frames.

**8.4.2.ai3 Filter List element**

*Instructions to Editor: Add new element type to the element type list.*

**Table 8-ai3—Filter List element**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Element Id | Length | BSS Type Parameters | Amount of BSSID or MAC Addr. | Number of HESSIDs | Number Of SSIDs | Number of Mesh IDs | BSSID or MAC Addr1 | ... | BSSID or MAC Addr N |
| Octets: 1 | 1 | 1 | 1 | 1 | 1 | 1 | 6 |  ... | 6 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| HESSID 1 | ... | HESSID M | SSID Length 1 | SSID 1 | ... | SSID Length L | SSID L | Mesh ID Lenght 1 | Mesh ID 1 | ... | Mesh ID Lenght M | Mesh ID M |
| 6 | ...  | 6 | 1 | 0 - 32 |  | 1 | 0 - 32 | 1 | 0 – 32 | ... | 1 | 0 -32 |

The Element Id is equal to the Filter List value in Table 8-ai.

The value of the Length field is the length of the Filter list element (variable) in octets.

The BSS Type Parameters element is one octet in length and it is shown in Table 8-ai3—BSS Type Parameters element. The BSS Type Parameters element is reserved in other than Probe End frames.

**Table 8-ai3—BSS Type Parameters field**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Terminate All Requests | Infrastructure | IBSS | MBSS | Reserved |
| Bits: | 1 | 1 | 1 | 1 | 4 |

The Terminate All Requests field is set to 1 to indicate that transmission of pending Probe Response frames to the transmitter of the element are requested to be cancelled and otherwise set to 0.

The Infrastructure field is set to 1 to indicate that transmission of pending Probe Response frames from infrastructure BSS to the transmitter of the element are requested to be cancelled. The field is reserved, if the Terminate All Requests field is set to 1.

The IBSS field is set to 1 to indicate that transmission of pending Probe Response frames from independent BSS to the transmitter of the element are requested to be cancelled. The field is reserved, if the Terminate All Requests field is set to 1.

The MBSS field is set to 1 to indicate that transmission of pending Probe Response frames from mesh BSS to the transmitter of the element are requested to be cancelled. The field is reserved, if the Terminate All Requests field is set to 1.

The Number of BSSIDs or MAC Addresses field contains an unsigned integer that indicates the amount of BSSID/ MAC Address fields present in the Filter List element.

The Number of HESSIS field contains an unsigned integer that indicates the amount of HESSID fields present in the Filter List element.

The Number of SSIDs field contains an unsigned integer that indicates the amount of SSID elements present in the Filter List element.

The Number of Mesh IDs field contains an unsigned integer that indicates the amount of Mesh ID elements present in the Filter List element.

The BSSIDs or MAC Address field contains a MAC Address of the STA or a BSSID of the BSS that is not allowed to transmit a response to Probe Request frame.

The HESSID field contains a HESSID of the STA that is not allowed to transmit a response to Probe Request frame.

The SSID Length contains the length of the SSID information field and the SSID information field contains the SSID of the STA that is not allowed to transmit a response to Probe Request frame.

The Mesh ID Length contains the length of the Mesh ID information field and the Mesh ID information field contains the Mesh ID of the mesh STA that is not allowed to transmit a response to Probe Request frame.

**10.1.4.3 Active scanning**

**10.1.4.3.1 Introduction**

*Instructions to Editor: Change the text as shown with track changes*

Active scanning involves the generation of Probe Request frames and the subsequent processing of received responses to Probe Request frames. The details of the active scanning procedures are as specified in the following subclauses.

**10.1.4.3.2 Active scanning procedure**

*Instructions to Editor: Delete the current clause 10.1.4.3.2 and move it to clause 10.1.4.3.5. Add the new clause 10.1.4.3.2 and change the text as shown with track changes.*

Upon receipt of the MLME-SCAN.request primitive with ScanType indicating an active scan, a STA shall use the following procedure:

For each channel to be scanned:

a) Wait until the ProbeDelay time has expired or a PHYRxStart.indication primitive has been received.

b) Perform the Basic Access procedure as defined in 9.3.4.2.

c) Send a probe request to the broadcast destination address, with the SSID and BSSID from the MLME-SCAN.request primitive. When the SSID List is present in the MLME-SCAN.request primitive, send one or more Probe Request frames, each with an SSID indicated in the SSID List and the BSSID from the MLME-SCAN.request primitive.

d) Set a ProbeTimer to 0 and start the ProbeTimer.

e) If PHY-CCA.indication (busy) primitive has not been detected before the ProbeTimer reaches MinChannelTime, then set NAV to 0 and scan the next channel, else when ProbeTimer reaches MaxChannelTime, process all received probe responses.

f) Set NAV to 0 and transmit Probe End frame and scan the next channel.

See Figures 10-ai1 and 10-3.



**Figure 10-ai1—Example of active scanning process when Probe Request frame is addressed to individual address.**



**Figure 10-3—Example of active scanning process when Probe Request frame is addressed to broadcast address.**

When all channels in the ChannelList have been scanned, the MLME shall issue an MLME-SCAN.confirm primitive with the BSSDescriptionSet containing all of the information gathered during the scan. If the MLME-SCAN.request primitive was invoked with a ReportingInterval parameter different from zero, the MLME shall additionally issue an MLME-SCAN.confirm primitive once per ReportingInterval with the BSSDescriptionSet containing all of the information gathered during the last ReportingInterval of the scan.

If the MLME receives an MLME-SCAN-STOP.request primitive, the STA shall transmit the Probe End frame with Terminate All Requests field of the FILS Request Parameters set to 1 and stop the ongoing scanning process. The MLME shall issue an MLME-SCAN.confirm primitive with the BSSDescriptionSet containing all of the gathered information and having the ResultCode set to SCAN\_ABORTED.

**10.1.4.3.3 Sending a probe request**

*Instructions to Editor: Add the new Clause 10.1.4.3.3*

STAs may transmit Probe Request frames to a broadcast or to individual addresses.

A Probe Request frame transmitted to an individual address shall be acknowledged by the receiver.

The Probe Request frame addressed to a broadcast address should limit with SSID, SSID List, HESSID and Filter List fields the amount of Probe Response frames that are transmitted as a response to the Probe Request frame.

When the dot11FILSActivated equal true, the FILS Request Parameters element shall be included to Probe Request frame and the FILS Supported field of the FILS Request Parameters shall be set true.

The Comrehensive Response field of the FILS Request Parameters element of the Probe Request frame may be set to 1 to allow the information of other BSSs to be included to the responses.

The SSID List element shall not be included in a Probe Request frame in an IBSS.

**10.1.4.3.4 Selecting the response frame to probe request**

*Instructions to Editor: Add the new Clause 10.1.4.3.4*

STAs receiving Probe Request frames shall respond, if the criteria to response to probe request as described in 10.1.4.3.5(Criteria to respond to probe request), are met.The STA shall response:

* with a Probe Response or a Beacon frame when dot11FILSActivated equal to true. More details on selecting the Probe Response or Beacon frame are described in 10.1.4.3.7(Probe response collision avoidance).
* with Probe Response frame when dot11FILSActivated equal to false

**10.1.4.3.5 Criteria to respond to probe request**

*Instructions to Editor: Add the new Clause 10.1.4.3.5*

Only APs and STAs in an IBSS or in an MBSS respond to probe requests. A result of the procedures defined in this subclause is that in each infrastructure BSS and IBSS there is at least one STA that is awake at any given time to receive and respond to probe requests. In an MBSS, STAs might not be awake at any given time to respond to probe requests. In an infrastructure BSS or in an IBSS, a STA that sent a Beacon frame shall remain in the Awake state and shall respond to probe requests, subject to criteria in the next paragraph, until a Beacon frame with the current BSSID is received. If the STA is contained within an AP, it shall remain in the Awake state and respond to probe requests, subject to criteria in the next paragraphs. There may be more than one STA in an IBSS that responds to any given probe request, particularly in cases where more than one STA transmitted a Beacon frame following the most recent TBTT, either due to not receiving successfully a previous Beacon frame or due to collisions between beacon transmissions.

STAs receiving Probe Request frames shall respond only if the criteria below are met:

a) The Address 1 field in the probe request is the broadcast address or the specific MAC address of the STA, and either item b) or item c) below.

b) The STA is a mesh STA and

1) The Filter List does not include the mesh ID or the specific MAC address of the STA

2) The Mesh ID in the probe request is the wildcard Mesh ID or the specific Mesh ID of the STA.

c) The STA is not a mesh STA and

1) The Filter List does not include the SSID or the specific MAC address of the STA and

2) The SSID in the probe request is the wildcard SSID, the SSID in the probe request is the specific SSID of the STA, or the specific SSID of the STA is included in the SSID List element, and

3) The Address 3 field in the probe request is the wildcard BSSID or the BSSID of the STA.

Additionally, STAs with dot11InterworkingServiceActivated equal to true, receiving Probe Request frames containing an Interworking field in the Extended Capabilities element set to 1 shall examine the Interworking element in the received Probe Request frame and respond with a probe response only if

d) The Filter List does not include the HESSID of hte STA and the HESSID field, if present in the Interworking element, is the wildcard HESSID or the HESSID of the STA, and

e) The Access Network Type field in the Interworking element is the wildcard Access Network Type or the Access Network Type of the STA.

STAs with dot11RadioMeasurementActivated equal to true receiving a probe request frame with a DSSS Parameter Set element containing a Current Channel field value that different from the value of dot11CurrentChannel shall not respond to probe request.

**10.1.4.3.6 Cancelling responses with probe end**

*Instructions to Editor: Add the new Clause 10.1.4.3.6*

The generator of the Probe Request frame may transmit a Probe End frame to a broadcast address or an individual address.

If a STA that has received the Probe End frame has not started transmitting or is transmitting a Probe Response frame to the transmitter of the Probe End frame, a response to Probe Request frame shall be transmitted only if the criteria below are met:

1. The Terminate All Requests field of the BSS Type element in the Filter List of the Probe End frame is set to 0.
2. The STA is an AP STA and the Infrastructure field of the BSS Type element in the Filter List of the Probe End frame is set to 0 or the SSID, the BSSID, or the HESSID of the STA is not included to Filter List of the Probe End frame; or
	1. The BSS of STA is IBSS and the IBSS field of the BSS Type element in the Filter List of the Probe End frame is set to 0 or the SSID or the BSSID of the STA is not included to Filter List of the Probe End frame; or
	2. The STA is a mesh STA and the MBSS field of the BSS Type element in the Filter List of the Probe End frame is set to 0 or the Mesh ID or the MAC Address of the mesh STA is not included to Filter List of the Probe End frame.

If the above criteria is not met, the receiver of Probe End frame may transmit or retransmit a response to Probe Request frame once, but the response shall not be transmitted or retransmitted more than once.

**10.1.4.3.7 Probe response collision avoidance**

*Instructions to Editor: Add the new Clause 10.1.4.3.7*

STAs with dot11FILSActivated equal to true should respond to a Probe Request frame with a Beacon frame if the criteria below are met:

* The requesting STA has received a Probe Response or a Beacon frame containing information of the BSS of the responding AP.
* The next TBTT of the responding STA is within dot11BeaconResponseDuration.
* The responder considers the medium congested. The criterion to consider medium congested is implementation dependent.

When a Beacon frame is transmitted as a response to Probe Request frame, the Beacon Replacing Probe Response field of the FILS Response Parameters element of the Beacon frame shall be set to 1.

If a STA with dot11FILSActivated equal to true receives two or more Probe Request frames that meet the criteria to respond as specified in 10.1.4.3.5(Criteria to respond to probe request), the responding STA may respond by a single Beacon or Probe Response frame with the Response to Multiple Requests field of the FILS Response Parameters element set to 1. The Beacon or the Probe Response frame shall contain all the information requested by the responded Probe Request frames.

When a Probe Response frame contains a response to multiple Probe Request frames, the Probe Response frame shall be transmitted to any transmitter of the multiple Probe Request frames. The selection of the receiver of the Probe Response frame is implementation dependent.

**10.1.4.3.8 Sending a response to probe request**

*Instructions to Editor: Add the new Clause 10.1.4.3.8*

Probe Response frames shall be transmitted as directed frames to the address of the STA that generated the probe request.

Requested Element IDs in the Request element shall be included in the Probe Response frame if the responding STA supports it. In an improperly formed Request element, a STA may ignore the first element requested that is not ordered properly and all subsequent elements requested. In the Probe Response frame, the STA shall return the requested elements in the same order as requested in the Request element.

If dot11RadioMeasurementActivated is true and if the Request element of the Probe Request frame includes the RCPI element ID, the STA shall include in the Probe Response frame an RCPI element containing the measured RCPI value of the received Probe Request frame. If no measurement result is available, the RCPI value shall be set to indicate that a measurement is not available.

If the Comprehensive Response field of the FILS Request Parameters element of the Probe Request or Beacon frame is set to 1, the Probe Response or Beacon frame may include information of other BSSs to Neighbor List element of the Probe Response or Beacon frame, if the criteria as defined in 10.1.4.3.5.(Criteria to respond to probe request) are met for the included BSSs.The BSSs which information is included may have different primary channel as the responding STA. When information of other BSSs is included, the Comprehensive Response field of the FILS Response Parameters element of the Probe Response or Beacon frame shall be set to 1.

**Annex C**

(normative)

*Instructions to Editor: Add new MIB variable as shown below*

dot11FILSActivated OBJECT-TYPE

SYNTAX Boolean

MAX-ACCESS Read-Only

STATUS Current

Description

"This is a capability variable.

Its value is determined by device capabilities.

This attribute, when true, indicates that the station implementation is capable of supporting fast initial link setup. The capability is disabled, otherwise."

DEFVAL { false }

dot11BeaconResponseDuration OBJECT-TYPE

SYNTAX Unsigned32(0..65535)

MAX-ACCESS Read-Only

STATUS Current

Description

"This is a control variable.

It is written by an external management entity.

Changes take effect as soon as practical in the implementation.

This attribute indicates the duration in units of 32 microseconds. If the duration from the reception of the Probe Request frame to the TBTT is less than the value, the STA transmits a Beacon frame as response to the Probe Request frame."

DEFVAL { 100 }