IEEE P802.11 Wireless LANs

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| Proposed Clarification Text for Omitting Probe Request Frame | | | | |
| Date:2013-05-03 | | | | |
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Abstract

This submission proposes the 802.11ai specification text for a clarification of omitting probe request frame, as a suggested resolution to a comment submitted for IEEE 802.11 Comment Collection 8 for 802.11ai Draft 0.5[Ref-2].

# Introduction

The following comment has been submitted to IEEE 802.11 Comment Collection 8 for 802.11ai Draft 0.5[Ref-2]:

**Comment: page 61 line 61, Section 10.1.4.3.3**

*There are multiple issues with a STA which is doing active scanning, and does not send its own probe request frame after having received a broadcast probe request frame requesting the same information, e.g.,*

1. *what happens if the STA does not receive any probe responses or beacon frames? Please note that an STA may hear the other STA's probe request, but it may not be able to hear the response from the responder AP.*
2. *how long should the STA wait after it hears the other STA's probe request? Should it just follow the procedure defined in Subsection 10.1.4.3.2 except avoid sending its own probe request?*
3. *how about the AP responds with a unicast probe response frame, to the probe request from another STA?*

**Proposed Change:**

*Provide clarifications to address the identified issues.* *Please see details in the latest revision of Contribution 13/0470.*

This contribution proposes detailed changes in 802.11ai/D0.5 [Ref-2], to address the identified issues.

# Conventions

In this contribution, the proposed 802.11ai Specification Document text will be presented as changes to the current TGai draft specification, 11ai/D0.5 [Ref-2]. The following format conventions are used:

1. The new added text is marked as blue underline text;
2. The deleted text is marked as ~~red strikethrough text~~;
3. The unchanged baseline standard text stays in black text in the context of proposed TGai specification text;
4. The editorial instruction is marked as *italic text highlighted by Yellow*; and
5. Any other text, e.g., discussions, proposed motions, etc., is in black text, but not in the context of proposed TGai specification text.

# Discussions

During 802.11ai (Fast Initial Link Setup) development, it has been identified that the Probe Request and Probe Response frames for active scanning have caused a significant overhead in a busy WirelessLAN system. For example, as reported [Ref-3], for a WirelessLAN in a busy train station during rush hours, the Probe Request/Response frames occupy about 35% in number of observed frames, about 23% in number of bytes, and about 18% in Wireless Media (WM) time.

Technical solutions have been proposed in 802.11ai to reduce the overhead caused by Probe Request/Response frames for active scanning. For example, in Subsection 10.1.4.3.3 in 802.11ai/D0.5 [Ref-2], the following mechanism is specified to reduce the transmissions of Probe Request frames:

*When an MLME receives an MLME-SCAN.request primitive with ScanType indicating an active scan, a STA may not transmit a Probe Request frame to a channel at which the STA has received:*

* *A broadcast addressed Probe Request frame to which 10.1.4.3.5 allows at least the same responses as the information indicated in the received MLME-SCAN.request primitive.*
* *A broadcast addressed Probe Response or a Beacon frame containing at least the same information as indicated in the received MLME-SCAN.request primitive.*

As pointed out by the Comment given in the Introduction section of this contribution, there are multiple issues with the first bullet of above mechanism. The following provides further discussions for each of those identified issues.

1. what happens if the STA does not receive any probe responses or beacon frames? Please note that an STA may hear the other STA's probe request, but it may not be able to hear the response from the responder AP.

**Discussions:**

To illustrate this issue clearly, let’s assume the four stations are physically located in a line in the order of AP-1, STA-a, STA-b, and AP-2, where each station can only hear its direct neighbour or neighbours.

In this case, when STA-a receives an MLME-SCAN.request for an active scan, before it transmits its own Probe Request frame, if it hears a broadcast addressed Probe Request frame (transmitted by STA-b), STA-a may omit its own Probe Request frame transmission, based on the current 802.11ai/D0.5 spec.

However, STA-a won’t be able to receive the Probe Response frame transmitted by AP-2, which causes additional delay for STA-a’s scanning process, as it would have got a response from AP-1 if STA-a had sent out its own Probe Request. In this case, STA-a should not have omitted its own Probe Request frame transmission, i.e., undesired Probe Request omission.

Some mechanisms could be considered to minimize the probability of the undesired Probe Request omissions, e.g., add trigger conditions for probe request omission, e.g., the signal strength of the received Probe Request frame is no less than a pre-defined threshold.

1. how long should the STA wait after it hears the other STA's probe request? Should it just follow the procedure defined in Subsection 10.1.4.3.2 except avoid sending its own probe request?

**Discussions:**

There are two aspects regarding this item: one is that a clarification is needed to complete the procedure’s specification for active scanning without sending Probe Request frame, e.g., following the steps d) to f) as described in Subsection 10.1.4.3.2 in 802.11ai/D0.5 [Ref-2]; the other is how to minimize the delays caused by undesired Probe Request omissions, e.g., timely detect an undesired probe request omission, e.g., STA-a detects an ACK sent by STA-b, but STA-a did not receive Probe Response.

1. how about the AP responds with a unicast probe response frame, to the probe request from another STA?

**Discussions:**

Based on 802.11ai/D0.5 [Ref-2], Probe Response frames shall be transmitted as directed frames to the address of the STA that generated the probe request, or to the broadcast address. Note that, using the same example above, STA-a’s MAC layer may not receive a Probe Response addressed to STA-b, even if STA-a’s RF/PHY receiver can receives the frame. This is another scenario for undesired Probe Request omissions. One way to mitigate could be to encourage AP to send broadcast Probe Response, particularly, when AP is experiencing a high volume of Probe Requests.

# Proposed 802.11ai Specification Text

*Instructions to Editor: make the following changes to the text in line 57 to line 65 on page 61:*

When an MLME receives an MLME-SCAN.request primitive with ScanType indicating an active scan, a STA may not transmit a Probe Request frame to a channel at which the STA has received:

* A broadcast addressed Probe Request frame to which 10.1.4.3.5 allows at least the same responses as the information indicated in the received MLME-SCAN.request primitive, and the signal strength of the received broadcast addressed Probe Request frame is not less than a predefined threshold. In this case, the STA follows the Steps d) to f) as described in Subsection 10.1.4.3.2 to scan the channel, except that the STA may transmit a Probe Request frame to the channel when one of the following conditions is met:
  1. The STA receives an ACK from the same STA that transmitted the broadcast addressed Probe Request frame, but it has not received any Probe Responses; or
  2. When the ProbeTimer reaches MaxChannelTime, and the STA has not received any Probe Responses, Beacons, measurement pilots, or FILS Discovery frames.
* A broadcast addressed Probe Response or a Beacon frame or a measurement pilot frame or an FILS Discovery frame containing at least the same information as indicated in the received MLME-SCAN.request primitive. In this case, the STA follows the sub-steps 1) to 4) of Step e) as described in Subsection 10.1.4.3.2 to process the received frames; and then goes Step f).

*Instructions to Editor: change the paragraph in line 57 page 64 as follows:*

Probe Response frames shall be transmitted as directed frames to the address of the STA that generated the probe request, or to the broadcast address if dot11FILSActivated is true. When an AP have a heavy traffic load of Probe Requests and Responses, e.g., having received multiple Probe Request frames that meet the criteria for responding, it should transmit Probe Response frames to the broadcast address if dot11FILSActivated is true.

# References:

1. IEEE Std 802.11 – 2012
2. IEEE Std 802.11ai/D0.5
3. 11-11-1413-03-00ai-real-air-time-occupation-by-beacon-and-probe