IEEE P802.11  
Wireless LANs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| CR for 6GHz - Discovery | | | | |
| Date: 2019-01-14 | | | | |
| Author(s): | | | | |
| Name | Affiliation | Address | Phone | email |
| Laurent Cariou | Intel |  |  | laurent.cariou@intel.com |
| Po-Kai Huang | Intel |  |  |  |
| Carlos Cordeiro | Intel |  |  |  |
| George Cherian | Qualcomm |  |  |  |
| Thomas Derham | Broadcom |  |  |  |
| Yongho Seok | Mediatek |  |  |  |
| Gabor Bajko | Mediatek |  |  |  |
| James Yee | Mediatek |  |  |  |
| Pooya Monajemi | Cisco |  |  |  |
| Jarkko Kneckt | Apple |  |  |  |
| Ming Gan | Huawei |  |  |  |
| Wook Bong Lee | Samsung |  |  |  |

Abstract

This document provides CR for CIDs 15121, 15825, 15651, 15023

R11: add CID 15023, change may to might in 27.16.1a.1

R12: add forward compatible RNR

R13: edits during presentation

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

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **Clause Number(C)** | **Page** | **Comment** | **Proposed Change** | **Resolution** |
| 15121 | 27.16.1 | 369 | Spec needs to provide rules on how a non-AP STA discovers and associates with a 6GHz BSS. Need details on how 6GHz BSS presence and configuration is advertised in 5/2.4G | As in comment | Revised – agree with the commenter. Apply the changes as proposed in doc 1227r13. |
| 15825 | 27 | 253 | 802.11ax now enables support for 6GHz band. Most devices will soon become tri-band devices. The discovery of APs and corresponding scanning time will increase and impact overhead in the channel and power/time consumption on STAs side. Full discovery of 6GHz APs should be enabled by simply scanning 2.4 and 5GHz bands only as today. This can simply be achieved by defining a multi-band collocated device that has multiple APs in different bands, and by imposing rules so that a discovery message (neighbor report, multiband element) is included in the 2.4 and 5GHz APs to describe the collocated AP at 6GHz | Define a Multiband collocated AP, that is part of a Multiband collocated device. And define rules to enable full discovery at 2.4 and 5GHz of collocated 6GHz APs. | Revised – agree with the commenter. Apply the changes as proposed in doc 1227r13. |
| 15651 |  |  | 6GHz AP Discovery: Add the ability for a STA operating in 2.4/5GHz BSS to discover a 6GHz HE AP. | As in the comment | Revised –  Agree in principle with the comment. Proposed resolution is to include RNR in 2.4/5GHz beacons and probes.  TGax editor to make the changes shown in 11-18/1227r13. |
| 15023 | 9.4.2.37 | 134 | Add a bit to indicate that the reported neighbor is a co-located BSS. This will be useful for discovery of a co-located ER BSS or 6GHz BSS | As in comment | Revised – Agree with the comment. Apply the changes as proposed in 11-18/1227r13. |

1. Discussion

**Objectives of this contribution**

802.11ax voted to extend the scope of the project to operation up to 7.125GHz, in order to enable 802.11ax operation in the 6GHz band, which spans from 5935MHz to 7125MHz.

We expect that all APs operating at 6GHz, except soft APs, will be multi-band colocated devices operating at 6GHz and at 2.4 and/or 5 GHz. Scanning more than 1.2GHz of spectrum is very demanding time-wise and energy-wise. In order to reduce this impact on resource overhead at 6GHz and energy and time consumption on STA side, we propose to ensure that all 6GHz APs (that are collocated with another AP in the lower band) can be discovered by scanning the lower bands (2.4 and 5GHz) only, as it is done today. This is the basic concept that is covered by this document.

In order to achieve this we propose to:

* Mandate that APs collocated in the lower bands (2.4 or 5GHz) include a reduced neighbour report element that provides neighboring information for its respective 6GHz collocated AP(s).

The objective is that a STA that scans 2.4 and 5GHz will have most of the information that it requires to determine if associate with one of the 6GHz APs. Subsequently the STA can behave in one of the following ways:

1. Associate with the 6 GHz AP via the lower band AP using on chanel tunnelling (OCT),
2. Request SSID information, from the AP using ANQP, or
3. Move to the 6 GHz channel to associate with the 6 GHz AP of interest.

This submission describes a discovery mechanism for the APs operating in the 6 GHz band via the lower bands (2.4, and/or 5 GHz) that allows:

* Detection of the operating channels of the BSSs that are available for the association
* Detecting the BSSs that are collocated with the reporting AP, i.e. operating in the same device that has transmitted the discovery information.
  + BSS Transition Management signalling is enhanced to be able to transition to collocated 6 GHz BSSs
* Using OCT to tunnel pre-association frames intended to the 6 GHz AP via the co-located AP operating in the lower bands: Tunneling between the reporting device and the AP in 6 GHz to tunnel probe request/response, association and authentication frames that are transmitted over-the-air to the AP in lower band and tunnelled to the AP at 6GHz.
  + The mechanisms reduce scanning, authentication and association signalling overhead at 6 GHz band, but they do not intend to replace the direct scanning, authentication and association at 6GHz band.
* Using ANQP to query the collocated AP for the SSID of the 6 GHz APs.

2. **Proposed changes**

***11ax Editor: Modify 9.4.2.170 Neighbor AP information field element as follows:***

* Neighbor AP Information field

The Neighbor AP Information field specifies TBTT and other information related to a group of neighbor APs on one channel. See Figure 9-622 (Neighbor AP Information field format).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | TBTT Information Header | Operating Class | Channel Number | TBTT Information Set |
| Octets: | 2 | 1 | 1 | variable |
| * Neighbor AP Information field format | | | | |

The format of TBTT Information Header subfield is defined in Figure 9-623 (TBTT Information Header subfield).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | B0 B1 | B2 | B3 | B4 B7 | B8 B15 |
|  | TBTT  Information Field Type | Filtered  Neighbor AP | Co-Located AP | TBTT  Information Count | TBTT  Information Length |
| Bits: | 2 | 1 | 1 | 4 | 8 |
| * TBTT Information Header subfield | | | | | |

The TBTT Information Field Type subfield is 2 bits in length and identifies, together with the TBTT Information Length subfield, the format of the TBTT Information field. It is set to 0.(#1533)(#1535). (11ai)Values 1, 2, and 3 are reserved.(#1533)

The Filtered Neighbor AP subfield is 1 bit in length. (11ai)When included in a Probe Response frame, it is set to 1 if the SSID corresponding to every AP(#341) in this Neighbor AP Information field matches the SSID in the (11ai)corresponding Probe Request frame. (11ai)When included in a Beacon or FILS Discovery frame transmitted by a non-TVHT AP, it is set to 1 if the SSID corresponding to every AP(#341) in this Neighbor AP Information field matches the SSID of the transmitting AP’s BSS. It is set to 0 otherwise.(11ai)(#1533)

The Co-Located AP subfield is 1 bit in length and is set to 1 if every AP in this Neighbor AP Information field is co-located with the transmitting AP. It is set to 0 otherwise, or if the information is unknown.

(#1533)The TBTT Information Count subfield is 4 bits in length and contains the number of TBTT Information fields included in the TBTT Information Set field of the Neighbor AP Information field, minus one. For example, a value of 0 indicates that one TBTT Information field is included.

(#1533)The TBTT Information Length subfield is 1 octet in length and indicates the length of each TBTT Information field included in the TBTT Information Set field of(#342) the Neighbor AP Information field. When the TBTT Information Field Type subfield is set to 0, the TBTT Information Length subfield:

* contains the length in octets of each TBTT Information field that is included in the TBTT Information Set field of(#342) the Neighbor AP Information field
* is set to 1, 5, 7, 8, 11, or 12; other values are reserved.(11ai)
* indicates the TBTT Information field contents as shown in Table 9-273 (TBTT Information field content(11ai)).

(#1533)A TVHT AP sets the TBTT Information Length subfield to 1.

(11ai)The TBTT Information Length subfield is interpreted as shown in Table 9-283 (TBTT Information field(11ai) contents(#1533)).

|  |  |
| --- | --- |
| * TBTT Information field(11ai) contents(#1533) | |
| TBTT Information Length subfield value | TBTT Information field contents |
| 1 | The Neighbor AP TBTT Offset subfield |
| 5 | The Neighbor AP TBTT Offset subfield and the Short-SSID subfield |
| 7 | The Neighbor AP TBTT Offset subfield and the BSSID subfield |
| 8 | The Neighbor AP TBTT Offset subfield, the BSSID subfield, and the BSS Parameters subfield |
| 11 | The Neighbor AP TBTT Offset subfield, the BSSID subfield and the Short-SSID subfield |
| 12 | The Neighbor AP TBTT Offset subfield, the BSSID subfield, the Short-SSID subfield and the BSS Parameters subfield |
| 0, 2–4, 6, 9–10 | Reserved |
| 13–255 | The first 12 bytes of the field are the same as for TBTT Information Length subfield value equal to 12 and the remaining bytes are reserved |

The Operating Class field is 1 octet in length and indicates a channel starting frequency that, together with the Channel Number field, indicates the primary channel of the BSSs of the APs in this Neighbor AP Information field. Values of Operating Class are shown in Table E-4 (Global operating classes), of which operating classes that, together with the channel number, indicate the primary channel is valid (see 11.49 (Reduced neighbor report(#1533))).

NOTE—The Operating Class field and Channel Number tuple indicate the primary channel in order to assist with passive scanning.

The Channel Number field is 1 octet in length and indicates the last known primary channel of the APs in this Neighbor AP Information field. Channel Number is defined within an Operating Class as shown in Table E-4 (Global operating classes).

The TBTT Information Set field contains one or more TBTT Information fields. The TBTT Information field is defined in Figure 9-624 (TBTT Information field (11ai)format).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Neighbor AP TBTT Offset | BSSID (optional)(#15)(11ai) | Short-SSID (optional)(#15)(11ai) | BSS Parameters |
| Octets: | 1 | 0 or 6 | 0 or 4 | 0 or 1 |
| * TBTT Information field format | | | |  |

 The Neighbor AP TBTT Offset subfield is 1 octet in length and indicates the offset in TUs, rounded down to nearest TU, to:

* the next TBTT of the reported AP from the immediately prior TBTT of the AP that transmits this element. The value 254 indicates an offset of 254 TUs or higher if the reported AP is not part of a Multiple BSSID set or is part of a Multiple BSSID set and is a transmitted BSSID.
* the next TBTT of the transmitted BSSID of the multiple BSSID set of the reported AP from the immediately prior TBTT of the AP that transmits this element if the reported AP is part of a multiple BSSID set and is a nontransmitted BSSID.

The value 255 indicates an unknown offset value.

The BSSID is defined in 9.2.4.3.4 (BSSID field).(11ai)

The Short-SSID subfield is calculated as given in 9.4.2.170.3 (Calculating the Short-SSID(11ai)).(11ai)The format of the BSS Parameters subfield is defined in Figure 9-xxx (BSS Parameters subfield format).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 | B1 | B2 | B3 | B4 | B5 | | B6 B7 |
|  | OCT Recommended | Same SSID | Multiple BSSID | Transmitted BSSID | Member Of Co-located ESS | 20 TU Probe Response Active | Reserved | | |
| Bits | 1 | 1 | 1 | 1 | 1 | 1 | | 2 | |
| Figure 9-xxx BSS Parameters subfield format | | | | | | | | | | |

The OCT Recommended subfield is set to 1 to indicate that OCT is recommended to be used to exchange MMPDUs with the AP indicated in the TBTT Information field (see 11.31.5 (On-channel Tunneling (OCT) operation)), through over-the-air transmissions with the AP sending the Reduced Neighbor Report element. It is set to 0 otherwise.

The Same SSID subfield is set to 1 to indicate that the reported AP has the same SSID as the reporting AP. It is set to 0 otherwise.

The Multiple BSSID subfield is set to 1 to indicate that the reported AP is part of a multiple BSSID set. It is set to 0 otherwise.

The Transmitted BSSID subfield is set to 1 to indicate that the reported AP is a transmitted BSSID. It is set to 0 it the reported AP is a nontransmitted BSSID. It is reserved if the Multiple BSSID subfield is set to 0.

The Member Of Co-located ESS subfield is set to 1 if the reported AP is part of an ESS where all the APs operating in the same band as the reported AP (irrespective of the operating channel within that band) that might be detected by a STA receiving this frame have a corresponding co-located AP operating at 2.4 or 5 GHz. It is set to 0 otherwise or if it does not have that information. It is reserved if the reported AP is operating at 2.4 or 5 GHz.

NOTE 1 – This subfield indicates that the reported AP is part of an ESS that has no 6 GHz-only APs that might be detected by a STA receiving this frame. This means that all APs operating at 6 GHz that are part of that ESS that might be detected by a STA receiving this frame can be discovered at 2.4 and 5 GHz.

NOTE 2 – An AP might be detected by a STA if the STA and the AP are on the same channel and in range.

The 20 TU Probe Response Active subfield is set to 1 if the reported AP is part of an ESS where all the APs that operate in the same channel as the reported AP and that might be detected by a STA receiving this frame are transmitting unsolicited Probe Response frames every 20 TUs (see 27.16.1a.1.1). It is set to 0 otherwise or if it does not have that information.

**TGax Editor: *Insert this subclause as follows:***

**27.16.1a.1 Out of band discovery of 6 GHz BSS***(#15651, 15832, 15023)*

An AP that operates in the 2.4 or 5 GHz band and that is co-located with one or more APs that operate in the 6 GHz band shall include in Beacon and Probe Response frames that it transmits a Reduced Neighbor Report element with the Co-Located AP subfield set to 1 in the TBTT Information Header subfield to provide at least the operating channel(s) and operating class(es) of the co-located AP(s) in the 6 GHz band.

Note – The Reduced Neighbor Report element might contain information on APs that are operating in the 6 GHz band that are not co-located with the transmitting AP, in which case the Co-Located bit is set to 0.

If an AP operating on a 2.4 or 5 GHz channel has one or more co-located APs operating at 6 GHz with the same SSID, then Beacon frames and Probe Response frames transmitted by the AP or by the transmitted BSSID of the same Multiple BSSID set as the AP shall include, at a minimum, for each of these co-located APs, a TBTT Information field in a Reduced Neighbor Report element with the BSSID field set to the BSSID of the co-located AP, and with either the Short SSID field set to the Short SSID of the co-located AP or the Same SSID subfield in the BSS Parameters subfield is set to 1, except if the AP transmits an individually addressed Probe Response frame to a STA that has signalled that it does not support operating in the 6 GHz band (see 9.4.2.53 (Supported Operating Classes element)) or if the AP operating at 6 GHz does not intend to be discovered by STAs.

~~If an AP operating on a 6 GHz channel has one or more co-located APs operating on the 2.4 and/or the 5 GHz band for which none of the co-located APs have the same SSID as the AP operating on the 6 GHz channel, then at least one of the co-located APs operating on the 2.4 and/or 5GHz band shall include, in beacon frames and probe response frames, a TBTT Information field in a Reduced Neighbor Report element with the BSSID field and the Short SSID field set to the BSSID and Short SSID of the co-located AP operating in the 6 GHz band.~~

If an AP operating on a 2.4 or 5 GHz channel has a co-located AP operating at 6 GHz with a different SSID, and no other co-located AP operating on a 2.4 or 5 GHz channel is indicating the 6 GHz AP in a Reduced Neighbor Report of the Beacon and Probe Response frames they transmit, then Beacon and Probe Response frames transmitted by the AP (or by the transmitted BSSID of the same Multiple BSSID set as the AP) shall include a TBTT Information field in a Reduced Neighbor Report element with the BSSID field and the Short SSID field set to the BSSID and Short SSID of the co-located AP, except if the AP transmits an individually addressed Probe Response frame to a STA that has signalled that it does not support operating in the 6 GHz band (see 9.4.2.53 (Supported Operating Classes element)) or if the AP operating at 6 GHz does not intend to be discovered by STAs.

If the 6 GHz AP reported in a TBTT Information field in a Reduced Neighbor Report is not part of a multiple BSSID set, then the BSS Parameters subfield shall be included with the Multiple BSSID subfield set to 0. If the 6 GHz AP reported in a TBTT Information field in a Reduced Neighbor Report is a transmitted BSSID, then the BSS Parameters subfield shall be included with the Multiple BSSID subfield set to 1 and the Transmitted BSSID subfield set to 1. If the 6 GHz AP reported in a TBTT Information field in a Reduced Neighbor Report is a nontransmitted BSSID, then the BSS Parameters subfield shall be included with the Multiple BSSID subfield set to 1 and the Transmitted BSSID subfield set to 0.

A reporting AP should set the OCT Recommended subfield to 1 in the BSS Parameters subfield of a TBTT Information field in a Reduced Neighbor Report element if both the reporting AP and the reported AP support OCT and the Co-Located bit is 1 in the TBTT Information Header subfield of the same Neighbor AP Information field. A reporting AP may set the OCT Recommended subfield to 1 in the BSS Parameters subfield of a TBTT Information field in a Reduced Neighbor Report element if both the reporting AP and the reported AP have the same SSID and support OCT and the Co-Located bit is 0 in the TBTT Information Header subfield of the same Neighbor AP Information field. If the OCT Recommended subfield is set to 1 in the Neighbor AP Information field describing a reported HE AP in the Reduced Neighbor Report element, then a non-AP STA that supports OCT should use the OCT procedure described in 11.31.5 (On-channel Tunneling (OCT) operation) to perform active scanning, authentication and/or association with the reported AP through over-the-air transmissions with the AP that sent the Reduced Neighbor Report element.

An AP that operates in the 2.4 or 5 GHz band and that is co-located with one or more APs operating in the 6 GHz band, shall include the Advertisement Protocol element in Beacon and Probe Response frames that it transmits and shall support responding with a Neighbor Report ANQP element (9.4.5.19 Neighbor Report ANQP element) carrying Neighbor Report element(s) (9.4.2.36 Neighbor Report element) which includes at least the SSID information of all its co-located AP(s) operating in the 6 GHz band.

NOTE 1 –The Neighbor Report ANQP-element can also carry Neighbor Report elements containing information on 6 GHz APs that are not co-located.

NOTE 2 – It is recommended that the AP responds with a GAS Comeback delay of zero.

An AP may set the 20 TU Probe Responses Active subfield to 1 in a Reduced Neighbor Report, or Neighbor Report element it transmits if all 6 GHz APs of the same ESS that operate in the corresponding channel and that might be detected by a STA receiving this frame are transmitting unsolicited Probe Response frames every 20 TUs (see 27.16.1a.1.1 Fast passive scanning).

NOTE – An AP might be detected by a STA if the STA and the AP are on the same channel and in range.

An AP may set the Member Of Co-located ESS subfield to 1 in a Reduced Neighbor Report element, if the reported AP operates at 6 GHz and is part of an ESS where all the APs operating in the same band as the reported AP and that might be detected by a STA receiving this frame (irrespective of the operating channel) have a corresponding co-located AP operating at 2.4 or 5GHz.

**11.32.5 On-Channel Tunneling (OCT) operation:**

**TGax Editor: *Modify this subclause as follows:***

A STA supports the OCT if the OCT Not Supported subfield within the STA's Multi-band element is 0 or if the STA is an AP and the OCT Recommended subfield in a Neighbor AP Information field of the STA's Reduced Neighbor Report element is 1. If a reporting AP sends a frame with a Reduced Neighbor Report element with a TBTT Information field describing a reported AP that has the OCT Recommended subfield equal to 1, then both the reporting AP and the reported AP support the OCT. A STA should not perform OCT with a peer STA that does not support the OCT. A STA that does not support the OCT shall ignore a received OCT MMPDU.

OCT allows:

1. a STA of a multi-band capable device or a STA that has co-located STAs to transmit/forward an MMPDU that was constructed/addressed by/to a different STA of the same device; and
2. an AP to transmit/forward an MMPDU that was constructed/addressed by/to another AP if either one of the APs sends a Reduced Neighbor Report element with a TBTT Information field describing the other AP, and where both APs support OCT.

An MMPDU transmitted this way is referred to as an OCT MMPDU. The MLME of the nontransmitting STA that constructs or is the destination of an OCT MMPDU is referred to as an NT-MLME. The MLME of the STA that transmits or receives an OCT MMPDU over the air is referred to as a TR-MLME. An NT-MLME that constructs an OCT MMPDU destined to a peer NT-MLME does so according to the capabilities of the STA that contains the peer NT-MLME.

[…]

To transmit a tunneled MMPDU, the SME of a STA that supports OCT generates an OCT MLME request primitive that includes the peer Multi-band element and the local Multi-band element. If the OCT MLME request primitive is the MLME-SCAN.request primitive with ScanType parameter set to ACTIVE, the BSSID field within the peer Multi-band element shall be set to the value of the BSSID parameter in the MLME-SCAN.request primitive and the BSSID field within the local Multi-band element shall be set to an individual MAC address.(M70)

***11ax Editor: Modify 9.4.2.36 Neighbor Report element as follows:***

9.4.2.36 Neighbor Report element

Change Figure 9-334 (BSSID Information field) as follows:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 B1 | B2 | B3 | B4 B9 | B10 | B11 | B12 | B13 | B14 | B15 | B16 | B17 | B18 B31 |
|  | AP Reachability | Security | Key Scope | Capabilities | Mobility  Domain | High Throughput | Very High Throughput | FTM | High Efficiency | HE ER BSS(#11986) | Co-located AP | 20 TU Probe Response Active | Reserved |
| Bits: | 2 | 1 | 1 | 6 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | ~~18~~14 |

**Figure 9-334 BSSID Information field**

***TGax Editor: insert the following paragraph immediately after the last paragraph of the subclause starting with “The FTM field”:***

The Co-located AP subfield is set to 1 to indicate that the AP reported in this Neighbor Report element is co-located with the AP sending the Neighbor Report element. (#15023)

The 20 TU Probe Response Active subfield is set to 1 if the reported AP is part of an ESS where all the APs in the coverage area of the STA that operate in the same channel as the reported AP are transmitting unsolicited Probe Response frames every 20 TUs (see 27.16.1a.1.1). It is set to 0 otherwise or if the reporting AP does not have that information.

***TGax Editor: Please insert a new row to Table 9-173 as follows:***

|  |  |  |
| --- | --- | --- |
| Table 9.173 - Optional subelement IDs for Neighbor report | | |
| Subelement ID | Name | Extensible |
| <ANA> | SSID |  |

***TGax Editor: insert the following paragraph immediately before the last paragraph of the subclause:***

The SSID subelement is the same as the SSID element as defined in 9.4.2.2 (SSID element).

**11.50 Reduced neighbor report**

**[…]**

**TGax Editor: *Insert the following paragraph at the end of the subclause 11.50:***

A STA that receives a Neighbor AP Information field with a recognized TBTT Information Field Type subfield but an unrecognized TBTT Information Length subfield has two possible ways of processing the received information: (1) ignore that Neighbor AP Information field and continue to process the subsequent Neighbor AP Information fields or (2) process the first 12 octets of each TBTT Information field of the Neighbor AP Information field as if the TBTT Information Length subfield had value 12, ignore the remaining TBTT Information Length minus 12 octets of each TBTT Information field of the Neighbor AP Information field, and continue to process the subsequent Neighbor AP Information fields. If the unrecognized TBTT Information Length value is less than or equal to 12, the STA shall follow the alternative (1). If the unrecognized TBTT Information Length value is greater than 12, an HE STA shall follow the alternative (2) and a non-HE STA shall follow either the alternative (1) or (2).