IEEE P802.11
Wireless LANs

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| CR for 6GHz - Discovery |
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Abstract

This document provides CR for CIDs related to 6GHz discovery.

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.***

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| **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 1227r0. |
| 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 1227r0. |

1. **Proposed changes**

**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.

It is expected that all APs operating at 6GHz, except soft APs, will be multi-band collocated 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 enure 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.

All this can be very simply done by:

* Defining a multi-band collocated device that is made of several collocated APs operating on different bands.
* If this multi-band collocated device include an AP at 6GHz, we can mandate that the collocated APs in the lower bands (2.4 or 5GHz) include a discovery message (neighbour report or multi-band element) describing the 6GHz collocated AP.

The objective is that a STA that scans 2.4 and 5GHz will have all the information it requires to decide if it wants/can associated with one of the 6GHz APs. It should then get as much information as it would get by sending a probe request to the 6GHz AP. When it wants to associate with the 6GHz AP, it only needs to send one frame: association request.

**Allowing probe request in lower band to collect 6GHz info**

The overhead of such discovery message can become quite large, we can then have 2 options:

* Either transmit the complete information describing the 6GHz APs in all beacons, probe responses,,, transmitted in the lower bands
* Or transmit only a partial information and have the ability to receive a probe request in the 2.4/5GHz band from the STA to ask for the complete information regarding the 6GHz AP. On-channel tunnelling procedure currently defined in the 802.11 spec allows this and it is the natural solution here. It allows to tunnel a probe request from a 6GHz STA to a 6GHz AP by using an over-the-air transmission between the STA and AP at 2.4/5GHz… and the same for probe response on the other direction.

**How to design the discovery message**

We need to define a way to:

* 1) Discover a collocated AP at 6GHz when receiving a beacon or a probe response from the collocated 2.4 or 5GHz AP. There is therefore a need for a signalling of co-location
* 2) Discover a multi-band collocated device made of several APs in different bands, when receiving a beacon or other frame from a neighbour AP.

Discussion:

* In 802.11, we use neighbour report and multi-band elements for discovering other APs. Neighbour reports currently does not provide any info whether the AP describe is collocated or not, and can be used for BSS transitions in all cases.
* Multi-band element is specifically used to disover collocated APs.
* Neighbor reports are used throughout the spec for BSS transitions procedures and these procedures must still be functioning at 6GHz, as they are widely used. We therefore need to send neighbour reports from collocated or non-collocated AP describing the 6GHz APs.
* Multi-band element enables also other functionalities, some of them would be very useful, such as On-Channel tunnelling (OCT) and multi-band RSNA. Otherwise, the information provided is often redundant with the one provided in the neighbour report.

Several solutions are possible for 1):

Option 1:

* Just mandating sending a reduced neighbour report in beacons at 2.4/5GHz to collect BSSID, operating band/channel
	+ Based on this information, STA can do active scanning at 6GHz.
* Providing a way for a STA to request more information (all the information it gest by doing active scanning at 6GHz), but through the collocated AP at 2.4/5GHz.
	+ OCT seems the easiest solution, as already defined in the spec

Option 2:

* Mandating sending a neighbor report in beacons at 2.4/5GHz to collect BSSID, operating band/channel, indication of collocation and more information.
* Either the information is complete or the AP provides a way for the STA to request more information (all the information it gets by doing active scanning at 6GHz), but through the collocated AP at 2.4/5GHz.
	+ OCT seems the easiest solution, as already defined in the spec

Option 3:

* Mandating sending a multi-band element in beacons at 2.4/5GHz to collect BSSID, operating band/channel and more information (add an otional subelement to the MBE).
* Either the information is complete or the AP provides a way for the STA to request more information (all the information it gets by doing active scanning at 6GHz), but through the collocated AP at 2.4/5GHz.
	+ OCT seems the easiest solution, as already defined in the spec

For 2)

It seems that the best option is to use neighbor reports. A neighbour report will then be sent for each of the 2/3 collocated APs. We simply need a way to identify that these APs are collocated. The simplest approach is to include a field indicating collocation and to mandate that these neighbour reports are transmitted one after the other.

The following proposed text is based on Multiband element for 1) and neighbour report for 2).

***11ax Editor: Modify 9.4.2.137 Multi-band element as follows:***

* Multi-band element

***11ax Editor: Modify Figure 9.556 Multi-band element format as follows:***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Multi-band Control | Band ID | Operating Class | Channel Number | BSSID | Beacon Interval |
| Octets: | 1 | 1 | 1 | 1 | 1 | 1 | 6 | 2 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | TSF Offset | Multi-band Connection Capability  | FSTSessionTimeout | STA MAC Address (optional) | Pairwise Cipher Suite Count (optional)  | Pairwise Cipher Suite List (optional) | Optional subelements |
| Octets: | 8 | 1 | 1 | 0 or 6 | 0 or 2 | 4 × *m* | Variable |
| * Multi-band element format
 |  |

***11ax Editor: Modify the following section of the subclause 9.4.2.137 Multi-band element:***

The format of the Multi-band Control field is shown in Figure 9-557 (Multi-band Control field format).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | B0 B2 | B3 | B4 | B5 | B6 B7 |
|  | STA Role | STA MAC Address Present | Pairwise Cipher Suite Present  | Complete report | Reserved |
| Bits: | 3 | 1 | 1 | 1 | 2 |
|  | * Multi-band Control field format
 |

***11ax Editor: Include the following in the subclause 9.4.2.137 Multi-band element after the paragraph starting with “The Pairwise Cipher Suite Present”:***

The Complete report subfield indicates if the information carried in the optional subelements of the Multi-band element is complete or if it is only partial. The subfield is set to 1 if the information is complete and set to 0 if the information is only partial.

***11ax Editor: Include the following sentence at the end of the subclause 9.4.2.137 Multi-band element:***

The Optional Subelements field contains zero or more subelements. The subelement format and ordering of subelements are defined in 9.4.3 (Subelements).

***11ax Editor: Modify 9.4.2.37 Neighbor Report element as follows:***

* Neighbor Report element

Change Figure 9-296 (BSSID Information field) as follows:

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 B1 | B2 | B3 | B4 B9 | B10 | B11 | B12 | B13 | B14 | B15 | B16 B18 | B19 B31 |
|  | AP Reachability | Security | Key Scope | Capabilities | Mobility Domain | High Throughput | Very High Throughput | FTM | High Efficiency | HE ER BSS(#11986) | Multi-band collocated AP | Reserved |
| Bits: | 2 | 1 | 1 | 6 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | ~~18~~13 |
|  |  |

The Multi-band collocated AP subfield indicates if the AP represented by this BSSID and the channel number is part of a Multi-band collocated AP. The Multi-band collocated AP subfield is encoded as in Table xxx

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| Table xxx – Multi-band collocated AP subfield  |
| Value | Explanation |
| 0 | Indicates that the AP reported by this neighbor report is not part of a Multi-band collocated AP |
| 1 | Indicates that the AP reported by this neighbor report is part of the same Multi-band collocated AP as the AP transmitting the neighbor report. |
| 2 | Indicates that the AP reported by this neighbor report is part of a Multi-band collocated AP, that multiple neighbor reports are transmitted one after the other to describe all APs of the Multi-band collocated AP, and the AP reported by this neighbor report is the first one being reported. |
| 3 | Indicates that the AP reported by this neighbor report is part of a Multi-band collocated AP, that multiple neighbor reports are transmitted one after the other to describe all APs of the Multi-band collocated AP, and the AP reported by this neighbor report is the last one being reported. |
| 4 | Indicates that the AP reported by this neighbor report is part of a Multi-band collocated AP that multiple neighbor reports are transmitted one after the other to describe all APs of the Multi-band collocated AP, and the AP reported by this neighbor report is neither the first nor the last being reported. |

***11ax Editor: Modify 27.16.1 Basic HE BSS operation as follows***

27.16.1 Basic HE BSS operation

27.16.1.1 Basic HE BSS operation in the 6GHz band

If a device containts an HE AP operating in the 6GHz band and one or more APs operating in the 2.4 and 5GHz bands, the device shall be a multi-band capable device and the APs operating in the 2.4 and 5GHz bands:

* shall include in beacon frames, in probe responses frames, in FILS discovery frames and in (re)association frames a Multi-band element describing the collocated HE AP operating in the 6GHz band. If the APs operating in the 2.4 and 5GHz do not support OCT, the multi-band element shall include all the elements that the HE AP operating at 6GHz includes in the probe response frames it transmits, and shall set the Complete Report subfield in the Multi-band Control subfield in the Multi-band element to 1. If the APs operating in the 2.4 and 5GHz support OCT, the neighbor report may include only a partial number of elements and, in such case, shall set the Complete report subfield in the Multi-band Control subfield in the Multi-band element to 0.

An HE non-AP STA that is part of a multi-band device shall include the Supported Operating Classes element of all the STAs of the device and one or more Multi-band element(s) describing the collocated STA(s) in probe requests frames and (Re-)Association Request frames.

***11ax Editor: Modify 11.22.7.3 BSS transition management request as follows***

* BSS transition management request

[…]

The AP shall include the BSS Transition Candidate List Entries field in the BSS Transition Management Request frame if the AP has information in response to the BSS Transition Management Query frame. The BSS Transition Candidate List Entries field contains zero or more Neighbor Report elements describing the preferences for target BSS candidates. A Preference field value of 0 indicates that the BSS listed is an excluded BSS. The STA should refrain from associating to an AP corresponding to an excluded BSS. The Preference field values are used to establish the relative order of entries within the given list at the given time, and for the given AP. The Neighbor Reports describing the BSSs of a Multi-band device shall be transmitted one after the other in a consecutive way. Among the list of consecutive Neighbor Reports describing BSSs from a Multi-band device, the first Neighbor Report shall have the Multi-band Collocated AP subfield in the BSSID Information field set to 2, the last Neighbor Report shall have the Multi-band Collocated AP subfield in the BSSID Information field set to 4 and the Neighbor Reports in between (if any) shall have the Multi-band Collocated AP subfield in the BSSID Information field set to 3.