###  **IEEE P802.11Wireless LANs**

|  |
| --- |
| AFC fixes |
| Date: 2023-05-16 |
| Author(s): |
| Name | Affiliation | Address | Phone | Email |
| Brian Hart | Cisco Systems |  |  | brianh@cisco.com |
| Jerome Henry | Cisco Systems |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**Abstract**

CIDs 4015, 4016, 4017, 4018, 4019, 4020, 4021, 4022

**Revisions:**

* Rev 0: Initial version of the document.
* Rev 1: Updated CIDs now they are known; moved capabilities from Extended Capabilities to HE MAC Capabilities, and upgraded from 1 bit to 4 bits.
* Rev 2: Added VLP
* Rev 3: Fixed CID#

# Most Urgent and Non-Controversial

**Discussion**

***TGme editor: Please note Baseline is 11me D3.0. Word track changes:***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 4015 | 1) Depending on circumstances, APs might get more power as an Indoor AP (IAP) or as a SP AP (SPAP). Therefore, APs are motivated to be FCC-certified as both SPAPs and IAPs. 2) Although arguably Part 15.407 as written does not prohibit an AP being both at the same time, this was never anticipated and the consistent message from FCC Labs (OET) has been that this is disallowed. Instead FCC Labs expect a SPAP to IAP mode switch (and vice versa) to require an AP reboot or (perhaps) at least the BSS to be brought down and up again. 3) For the AP, if it has to choose between SPAP xor IAP mode, maximizing power is secondary to maximizing client connectivity. 4) Although there is no such thing in Part 15.407 as an indoor client or a SP client, only a client operating under the control of an indoor/SP AP, still some clients in the field can only operate under the control of an indoor access point. 5) Then, in order for an AP to make the IAP/SPAP choice that maximizes client connectivity, it is important for the AP to know each client’s 6 GHz and TX power capabilities and really to know them before before assoc (e.g., else a SPAP never knows if it should be operating as an IAP). | 5529 | E.2.7 | 49 | 1) Add client capability signalling: can the client operate under the control of either of an IAP or SPAP? This can positively indicate that the client is a "modern" client. (The absence of such signaling indicates that the client probably can only operate under the control of an IAP.) Include such signaling in probe req and (re)assoc req, A single bit in the Extended Capabilities element is a reasonable choice. 2) For 6 GHz, require the client to indicate its transmit power support. This could be the Power Capability element, but this has not been refreshed in a long time - so providing a power per bandwidth, and the option of reporting conducted and/or EIRP for the whole bandwidth and/or per MHz (i.e. akin to TPE) may be required. | Revised. See changes in 23/734<motionedRev> under #4015 which substantially align with the commenter’s proposed resolution. |
| 4019 | It is not completely clear if the Regulatory Info subfield expresses *capability* or *operation*. At the same time, the AP’s operational mode is much more important than its capability and this field is carried in the HE \*Operations\* element. | 5529 | E.2.7 | 49 | Try "The Regulatory Info subfield in the Control field of the 6 GHz Operation Information field of the HE Operation element \*expresses the current operational mode of the AP (rather than its capability)\* and is interpreted ...". If AP capability is also of interest, it can be added as a new field in the HE Capabilities element | Revised. See changes in 23/734<motionedRev> under #4019 which substantially align with the commenter’s proposed resolution. |
| 4020 | In regulatory domains without IAPs, SPAPs and VLPs, the guidance is " Some values defined in Table E-12 (Regulatory Info subfield encoding(#600)) might not be valid in all regulatory domains. If a certain Regulatory Info subfield encoding value is not valid in a regulatory domain, then the value is not used when operating in that regulatory domain.(#600)", but this leaves it undefined what value an AP should use if no value in Table E-12 is applicable. | 5529 | E.2.7 | 43 | Allocate a value for this situation: i.e, in Table E-12, define 7 as "None of the above". | Revised. See changes in 23/734<motionedRev> under #4020 which substantially align with the commenter’s proposed resolution. |
| 4022 | Text at P2479L53 and L2480L4 refer to obtaining the units from the TPE in the "most recently received Beacon or Probe Response frame". But, from P696L7, there can be more than one TPE in the Beacon. Which is meant? | 2790 | 11.7.4 | 58 | Define a rule to identify the units if there is more than one TPE element present in the Beacon/Probe Response. If no useful rule can be defined, upgrade/define a new Power Capability element to include units akin to | Revised. See changes in 23/734<motionedRev> under #4022 which substantially align with the commenter’s proposed resolution. |

***Discussion re 4022***

10.22.4 (Operation with the Transmit Power Envelope element) defines reasonable ordering requirements that probably shouldn’t be changed.

|  |
| --- |
| A STA that sends two or more Transmit Power Envelope elements in a frame shall order the elements by increasing values of their(11ax) Maximum Transmit Power Interpretation subfields. (11ax)A STA that is operating in the 6 GHz band that sends two or more Transmit Power Envelope elements in a frame with the same value in the Maximum Transmit Power Interpretation subfield shall order the elements by increasing values of their Maximum Transmit Power Category subfields.NOTE 2—The Maximum Transmit Power Category subfield is reserved, except in the 6 GHz band.(11ax)If a STA that is extended spectrum management capable finds an unknown value in the(11ax) Maximum Transmit Power Interpretation subfield in a Transmit Power Envelope element, then the STA shall ignore that and subsequent Transmit Power Envelope elements.NOTE 3—If a STA receives two Transmit Power Envelope elements, each with a known value in the(11ax) Maximum Transmit Power Interpretation subfield(11ax), then the expected possibilities are as follows:a) The STA complies with either element (shared spectrum),b) The STA complies with both elements (tightened regulations), orc) The STA complies with the second element (changed regulations). |

The Maximum Transmit Power Interpretation subfield is:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 9-316—Maximum Transmit Power Interpretation subfield encoding(11ax)

|  |  |
| --- | --- |
| Value | Interpretation of the Maximum Transmit Power field |
| 0 | Local EIRP |
| 1 | Local EIRP PSD (power spectral density) |
| 2 | Regulatory client EIRP |
| 3 | Regulatory client EIRP PSD |
| 4–7 | Reserved |
| NOTE—This table is expected to be updated only if regulatory domains mandate the use of transmit power control with limits that cannot be converted into one of the currently defined interpretations. |

 |

We currently have the choice between EIRP and EIRP PSD (local vs regulatory doesn’t affect the units). A simple fix for 4022 would be to use the first such element. The pathology would be if the AP really wanted the client’s EIRP PSD but had to transmit Local EIRP. This does not seem to be a grave concern.

***TGme editor: make the following changes under the indicated CIDs***

9.4.2.247.2 HE MAC Capabilities Information field

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| B42 | B43 | B44 | B45 | B46 | B47 | (#4015)B48 B52 |
| HE Subchannel Selective Transmission Support | UL 2×996-tone RU Support | OM Control UL MU Data Disable RX Support | HE Dynamic SM Power Save | Punctured Sounding Support | HT And VHT Trigger Frame RX Support | 6 GHz Regulatory Capabilities Information |

Table 9-367—Subfields of the HE MAC Capabilities Information field(11ax)

|  |  |  |
| --- | --- | --- |
| Subfield | Definition | Encoding |
| … |  |  |
| (#4015)6 GHz Regulatory Capabilities Information | Indicates 6 GHz regulatory-related capabilities  | Present a) optionally if operating in a regulatory domain where 6 GHz Regulatory Capabilities Information applies or b) if there is a field following this field. Encoding is defined in Figure E-xx (6 GHz Regulatory Capabilities Information field format).Otherwise not present, |

11.7.4 Interpretation of transmit power capability

As regards the units of the Minimum Transmit Power Capability and Maximum Transmit Power Capability fields within the Power Capability element sent in a STA’s (Re)Association Request frame to an AP, if all of the following apply:

* The STA is extended spectrum management capable.
* The STA has dot11SpectrumManagementRequired or dot11RadioMeasurementActivated equal to true.
* A Beacon or Probe Response frame has been received from the AP by the STA.
* The Beacon or Probe Response frame includes one or more Transmit Power Envelope elements.

Then

The units shall be interpreted according to the Local Maximum Transmit Power Unit Interpretation subfield in the Transmit Power Information field in the (#4022)first or only Transmit Power Envelope element (see 9.4.2.160 (Transmit Power Envelope element)) sent in the most recently received Beacon or Probe Response frame.

E.2.7 6 GHz band(11ax)(#600)

(#600)When operating in the 6 GHz band, Table E-4 (Global operating classes) is used for the operating classes, so the third octet of the dot11CountryString is 4. For example, when operating in the 6 GHz band in the United States, the Country String field in the Country element is set to (in hexadecimal) 0x55, 0x53, 0x04.

NOTE 1—The first two octets indicate the United States. The third octet indicates that Table E-4 (Global operating classes) is in use (see Annex C).

The Regulatory Info subfield in the Control field of the 6 GHz Operation Information field of the HE Operation element (#4019)expresses the current operational mode of the AP and is interpreted as shown in Table E-12 (Regulatory Info subfield encoding(#600)) when operating in the 6 GHz band. Each regulatory domain might have additional regulations for each Regulatory Info subfield value. Operation in such regulatory domains is subject to the additional regulations. Some values defined in Table E-12 (Regulatory Info subfield encoding(#600)) might not be valid in all regulatory domains. If a certain Regulatory Info subfield encoding value is not valid in a regulatory domain, then the value is not used when operating in that regulatory domain.(#600)

Table E-12—Regulatory Info subfield encoding(#600)

|  |  |
| --- | --- |
| Value | Description |
| 0 | Indoor AP An AP whose operation does not require control from an external system such as an Automated Frequency Coordination (AFC) system but that is subject to additional regulatory requirements intended to prohibit outdoor operation. |
| 1 | Standard power AP An AP whose operation requires control from an external system such as an AFC system. |
| 2 | Very low power AP An AP whose operation does not require control from an external system such as an AFC system, is not subject to additional regulatory requirements intended to prohibit outdoor operation, and is restricted to very low transmit power. |
| 3 | Indoor enabled AP An AP whose operation relies on being able to successfully receive an enabling signal (as defined by the regulatory rules) from an indoor AP or an indoor standard power AP. |
| 4 | Indoor standard power AP An AP whose operation requires control from an external system such as an AFC system and that is subject to additional regulatory requirements intended to prohibit outdoor operation. |
| 5–6 | Reserved |
| (#4020)7 | None of the above |

***TGme editor: please add the following material in section E2.7 immediately before the para beginning “The Maximum Transmit Power Category subfield in the Transmit Power Information field of the Transmit”***

(#4015)The 6 GHz Regulatory Capabilities Information field in the HE MAC Capabilities Information field of the HE Capabilities element is interpreted as shown in Table E-xx (6 GHz Regulatory Capabilities Information field format) when operating in the 6 GHz band. Each regulatory domain might have additional regulations for each subfield of the 6 GHz Regulatory Capabilities Information field. Capability signaling in such regulatory domains is subject to being capable of supporting the additional regulations. Some fields defined in Figure E-xx (6 GHz Regulatory Capabilities Information field format) might not be valid in all regulatory domains. If a certain field is not valid in a regulatory domain, then the value is set to 0 when operating in that regulatory domain.

(#4015)Figure E-xx 6 GHz Regulatory Capabilities Information field format

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | B0 | B1 | B2 | B3 | B4 |
|  | Indoor capable | SP capable | VLP capable | Subordinate capable | Fixed client capable |
| Bits | 1 | 1 | 1 | 1 | 1 |

The subfields of the 6 GHz Regulatory Capabilities Information field are defined in Table E-yy (Subfields of the 6 GHz Regulatory Capabilities Information field)

(#4015)Table E-yy-Subfields of the 6 GHz Regulatory Capabilities Information field

|  |  |  |
| --- | --- | --- |
| Subfield | Definition | Encoding |
| Indoor Capable | An AP that is capable of operating as an Indoor AP or a non-AP STA that is capable of operating under the control of an indoor AP.An indoor AP is defined in Table E-12 (Regulatory Info subfield encoding). | Set to 1 if valid and supported.Set to 0 otherwise. |
| Standard Power capable | An AP that is capable of operating as a Standard Power AP or a non-AP STA that is capable of operating under the control of a Standard Power AP. A Standard Power AP is defined in Table E-12 (Regulatory Info subfield encoding). | Set to 1 if valid and supported.Set to 0 otherwise. |
| Very Low Power capable | An AP that is capable of operating as a Very Low Power AP or a non-AP STA that is capable of operating under the control of a Very Low Power AP. A Very Low Power AP is defined in Table E-12 (Regulatory Info subfield encoding). | Set to 1 if valid and supported.Set to 0 otherwise. |
| Subordinate capable | A non-AP STA that is capable of operating as a Subordinate Device. A Subordinate Device is defined in Table E-13 (Maximum Transmit Power Category subfield encoding)operates in portions of the 6 GHz). | For a non-AP STA:Set to 1 if valid and supported.Set to 0 otherwise.Otherwise:Reserved. |
| Fixed client device capable | A non-AP STA that is capable of operating as a Fixed client device. A Fixed client device is a non-AP that operates only on channels provided by an AFC with additional requirements specified by the regulatory domain inwhich the non-AP STA is operating. | For a non-AP STA:Set to 1 if valid and supported.Set to 0 otherwise.Otherwise:Reserved. |

# Urgent and needs some discussion

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 4018 | 1) Although arguably Part 15.407 as written does not prohibit an AP being both an indoor AP (IAP) and a SP AP (SPAP), at the same time, this was never anticipated and the consistent message from FCC Labs (OET) has been that this is disallowed. Instead FCC Labs expect a SPAP to IAP mode switch (and vice versa) to require an AP reboot or (perhaps) at least the BSS to be brought down and up again. Here an Extended Channel Switch Announcement might be the least disruptive mechanism to switch from IAP to SPAP and vice versa, but suitable regulatory classes are not defined. | 5529 | E.2.7 | 49 | Define regulatory classes for an indoor AP and a SP AP for use by the ECSA. E.g., in the global table, make the existing 6 GHz regulatory classes "No applicable regulation or indoor AP" then introduce new global classes for 6 GHz indicating "6 GHz and SP AP" | Revised. See changes in 23/734<motionedRev> under #4018 which substantially align with the commenter’s proposed resolution. |

Dot11StaOperatesUnderControlOfIndoorAndSpApImplemented

Table D-2—Behavior limits

|  |  |
| --- | --- |
| Behavior Limit | Description |
| (#4018)NoRegOrIndoor | No applicable regulation or AP is indicating that it is an Indoor AP (see E.2.7) |
| SP | AP is indicating that it is a Standard Power AP (see E.2.7) |

Table E-4—Global operating classes

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Operating class | Nonglobal Operating class(es) (see NOTE 3) | Channel starting frequency (GHz) | Channel spacing (MHz) | Channel set | Channel center frequency index | Behavior limits set |
| 131 |  | 5.950 | 20 | 1, 5, 9, 13, 17, 21, 25, 29, 33, 37, 41, 45, 49, 53, 57, 61, 65, 69, 73, 77, 81, 85, 89, 93, 97, 101, 105, 109, 113, 117, 121, 125, 129, 133, 137, 141, 145, 149, 153, 157, 161, 165, 169, 173, 177, 181, 185, 189, 193, 197, 201, 205, 209, 213, 217, 221, 225, 229, 233 | - | (#4018)NoRegOrIndoor |
| 132 |  | 5.950 | 40 | 3, 11, 19, 27, 35, 43, 51, 59, 67, 75, 83, 91, 99, 107, 115, 123, 131, 139, 147, 155, 163, 171, 179, 187, 195, 203, 211, 219, 227 |  | NoRegOrIndoor |
| 133 |  | 5.950 | 80 | 7, 23, 39, 55, 71, 87, 103, 119, 135, 151, 167, 183, 199, 215 |  | NoRegOrIndoor |
| 134 |  | 5.950 | 160 | 15, 47, 79, 111, 143, 175, 207 |  | NoRegOrIndoor |
| 135 |  | 5.950 | 80 | 7, 23, 39, 55, 71, 87, 103, 119, 135, 151, 167, 183, 199, 215 |  | 80+, NoRegOrIndoor |
| 136 |  | 5.925 | 20 | 2 |  | NoRegOrIndoor |
| (#4018)<ANA> |  | 5.950 | 20 | 1, 5, 9, 13, 17, 21, 25, 29, 33, 37, 41, 45, 49, 53, 57, 61, 65, 69, 73, 77, 81, 85, 89, 93, 97, 101, 105, 109, 113, 117, 121, 125, 129, 133, 137, 141, 145, 149, 153, 157, 161, 165, 169, 173, 177, 181, 185, 189, 193, 197, 201, 205, 209, 213, 217, 221, 225, 229, 233 | - | SP |
| <ANA> |  | 5.950 | 40 | 3, 11, 19, 27, 35, 43, 51, 59, 67, 75, 83, 91, 99, 107, 115, 123, 131, 139, 147, 155, 163, 171, 179, 187, 195, 203, 211, 219, 227 |  | SP |
| <ANA> |  | 5.950 | 80 | 7, 23, 39, 55, 71, 87, 103, 119, 135, 151, 167, 183, 199, 215 |  | SP |
| <ANA> |  | 5.950 | 160 | 15, 47, 79, 111, 143, 175, 207 |  | SP |
| <ANA> |  | 5.950 | 80 | 7, 23, 39, 55, 71, 87, 103, 119, 135, 151, 167, 183, 199, 215 |  | 80+, SP |
| <ANA> |  | 5.925 | 20 | 2 |  | SP |
|  |  |  |  |  |  |  |

# Other

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 4016 | 1) There is a regulatory condition for "operating under the control of ..." but this is not met if the controllee is not known to the controller, nor is it met if a std for the regulated spectrum somehow prevents the controller from exercising any control over the controllee. 2) Meanwhile, if an AP is operating as a SPAP, 802.11 requires the AP to advertise the max value it hears from the AFC in the TPE with Maximum Transmit Power Category = Default and Unit interpretation = Regulatory Client EIRP PSD. 3) This signaling has no regulatory purpose and could be misconstrued by a controllee as some kind of controller behavior by the AP.  | 5530 | E.2.7 | 64 | Delete P5530L64-P5531L2. | Revised. The commenter is concerned that controller’s hands are tied by the standard such that it cannot function as a controller. See changes in 23/734<motionedRev> under this CID which substantially address this concern (but in a different part of the text). |
| 4017 | 1) Although arguably Part 15.407 as written does not prohibit an AP being both an indoor AP (IAP) and a SP AP (SPAP), at the same time, this was never anticipated and the consistent message from FCC Labs (OET) has been that this is disallowed. Instead FCC Labs expect a SPAP to IAP mode switch (and vice versa) to require an AP reboot or (perhaps) at least the BSS to be brought down and up again. 2) Then we don't see any regulatory use for values 3 and 4 in Table E-12, and they are misleading in that they imply an option that is not actually available.  | 5530 | E.2.7 | 11 | Delete values 3 and 4. Delete Note 2 at P5530L28. Delete para at P5530L31-35 | DISCUSSION: for value 3, take this path xor the 4021 path.---Accepted (Shown below under #4017.3 for value 3 and the text after note 2, and #4017.4 for value 4 and note 2) |
| 4021 | Part 15 refers to "under the control of an indoor/SP AP" which maps well to association (with VHT/HE/EHT Operaiotn element, TPE, EDCA parameters, etc). As well, for certain use cases (e.g. collaboration + XR) we might have a wireless segment with an infrastructure AP talking to laptop/smartphone that in turn performs rendering for an HMD/glasses. Here the latter link is P2P. It is desirable for the P2P traffic if the AP has available a protocol by which it can provide the requisite control of the P2P link | 5529 | E.2.7 | 49 | Define one or more of the following as the mechanisms by which an AP controls unassociated/P2P traffic in 6 GHz: a) DLS, b) Channel Usage Requst/Response frame, c) some new protocol. | DISCUSSION: take this path xor the 4017.3 path.---Revised. See changes in 23/734<motionedRev> under #4021 which substantially align with the commenter’s proposed resolution, excepting DLS which has been deprecated. |

Table E-12—Regulatory Info subfield encoding(#600)

|  |  |
| --- | --- |
| Value | Description |
| 0 | Indoor AP An AP whose operation does not require control from an external system such as an Automated Frequency Coordination (AFC) system but that is subject to additional regulatory requirements intended to prohibit outdoor operation. |
| 1 | Standard power AP An AP whose operation requires control from an external system such as an AFC system. |
| 2 | Very low power AP An AP whose operation does not require control from an external system such as an AFC system, is not subject to additional regulatory requirements intended to prohibit outdoor operation, and is restricted to very low transmit power. |
| (#4017.3) |  |
| (#4017.4) |  |
| 3–7 | Reserved |
|  |  |

(#600)In Table E-12 (Regulatory Info subfield encoding(#600)), a WLAN STA is not an external system.

(#4017.3)

(#4017.4)

The Maximum Transmit Power Category subfield in the Transmit Power Information field of the Transmit Power Envelope element is interpreted as shown in Table E-13 (Maximum Transmit Power Category subfield encoding(#600)) when operating in the 6 GHz band. Each regulatory domain might have additional regulations for each Maximum Transmit Power Category subfield value. Operation in such regulatory domains is subject to the additional regulations. Some values defined in Table E-13 (Maximum Transmit Power Category subfield encoding(#600)) might not be valid in all regulatory domains. If a certain Maximum Transmit Power Category subfield encoding value is not valid in a regulatory domain, then the value is not used when operating in that regulatory domain.(#600)

(#600)An AP operating in the 6 GHz band shall send at least one Transmit Power Envelope element in Beacon and Probe Response frames as follows:

* Maximum Transmit Power Category subfield = Default; Unit interpretation = (#3452)Regulatory client EIRP PSD

(#600)When operating in the 6 GHz band in a regulatory domain in which a subordinate device (see Table E-13 (Maximum Transmit Power Category subfield encoding(#600))) is supported, an AP that is an indoor AP or indoor standard power AP per regulatory rules shall also send the following Transmit Power Envelope element in Beacon and Probe Response frames:

* Maximum Transmit Power Category subfield = Subordinate device; Unit interpretation =

Regulatory client EIRP PSD

A regulatory client EIRP PSD value advertised by an AP that is a standard power AP or indoor standard power AP shall be set to (#4016)no higher than the highest value that meets the authorized client transmit power limits for the corresponding category obtained from the external system required by the regulatory rules, such as an AFC system, and any other client PSD regulatory rules for the corresponding 20 MHz channel.(#600)

If the regulatory client EIRP PSD values advertised by an AP that is a (#600)standard power AP or indoor standard power AP are insufficient to ensure that regulatory client limits on total EIRP are always met for all transmission bandwidths within the bandwidth of the AP’s BSS, the AP shall also send a Transmit Power Envelope element in Beacon and Probe Response frames as follows:

* Maximum Transmit Power Category subfield = Default; Unit interpretation = Regulatory client

EIRP

NOTE 3—In the case of regulatory rules where the maximum transmit power for client devices is lower than the maximum transmit power for APs(#600), the regulatory client maximum transmit power advertised by the AP for client devices might be lower than the regulatory client maximum transmit power the AP is authorized to use for its own transmissions.

(#4021)A STA is operating under the control of an indoor or SP AP whenever at least one of the following is true:

* the STA is associated with the AP, for transferring PSDUs between the AP and the STA
* the STA is operating in accordance with a recently received Channel Usage Response frame (see 9.6.13.25 (Channel Usage Response frame format) and 11.21.15 (Channel usage procedures)).

If a non-AP STA that is a (#600)subordinate device per regulatory rules receives Transmit Power Envelope elements with Maximum Transmit Power Category subfields indicating (#600)a subordinate device, it may ignore any other received Transmit Power Envelope elements that indicate other values in the Maximum Transmit Power Category subfield.(#600)