IEEE P802.11  
Wireless LANs

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| |  |  |  |  |  | | --- | --- | --- | --- | --- | | LPI with Puncturing | | | | | | Date: 2025-09-17 | | | | | | Author(s): | | | | | | Name | Affiliation | Address | Phone | email | | Pelin Salem | Cisco Systems | San Jose, CA |  | [pmohamed@cisco.com](mailto:pmohamed@cisco.com) | | Brian Hart | Cisco Systems | San Jose, CA |  | [brianh@cisco.com](mailto:brianh@cisco.com) | |  |  |  |  |  | |  |  |  |  |  | |  |  |  |  |  | |  |  |  |  |  | |

Abstract

This submission proposes text update to implement 6GHz low power indoor PPDU puncturing AP signaling:

NOTE – Set the Track Changes Viewing Option in the MS Word to “All Markup” to clearly see the proposed text edits.

**Revision History:**

R0: Initial version.

R1: Adding proposed “punctured transition band” and “punctured passband” definitions to "3.2 Definitions specific to IEEE Std 802.11"

R2: Changed definition, identified Word track changes, editorial items

R3: Updates in response to F2F discussion at May meeting and also considering that the frequency response is piecewise linear rather than sampled.

R4: Added CID

R5: Added CID

R6: Added regulatory references for composite operation

## Comment

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 22 | Brian Hart | E.2.7 | 6665.44 | 44 | There are certain regulatory complications with puncturing when an indoor standard power AP sees better power from LPI mode, but there are ways to substantially workaround these complications in a manner that achieves regulatory goals. | See proposed changes in 25/288, which can be used to help educate regulators and give them comfort that this is a considered/vetted direction | Revised, see changes under 25/288<motionedRev> that substantially align with the commenter’s proposal. |
| 66 | Nedime Pelin Mohamed Hassan Salem | E.2.7 | 6665.44 | 44 | An indoor standard power AP (or simultaneous composite AP) may see the LPI operation more advantageous based on the channel response received from AFC for SP operation.  Regulatory challenges that won't allow indoor puncturing could be remedied by the right approach satisfying regulatory goals while enabling LPI puncturing. | Please view the proposed changes in 25/288.  These changes can be used to persuade the regulators that the proposed approach is thoroughly vetted by the standards/industry experts to protect incumbents hence void any regulatory concerns against enabling LPI puncturing. | Revised, see changes under 25/288<motionedRev> that substantially align with the commenter’s proposal. |

## Background

The Simultaneous Composite AP is expected to support all client classes and enable the full suite of 802.11 features, including PPDU puncturing. Under current FCC regulations, PPDU puncturing is not permitted in LPI BSSs as a mechanism to protect incumbent users. Consequently, when an incumbent occupies the upper or lower half of an 80 MHz or 160 MHz channel, the available LPI BSS bandwidth is reduced to 40 MHz or 80 MHz, respectively. There is, however, strong potential for the FCC to allow PPDU puncturing in LPI BSSs of Simultaneous Composite APs, provided the AFC response for the punctured channel(s) supports power levels above those used by LPI APs and clients. This enhancement would not require protocol changes—only updates to AP behavior and the contents of the TPE element.

Reference:

1. <https://mentor.ieee.org/802.11/dcn/24/11-24-1071-04-00bn-lpi-ppdu-puncturing-follow-up.pptx>

Figures referenced in the text

A graph of a transmission mask

AI-generated content may be incorrect.

**A diagram of a mask

AI-generated content may be incorrect.**

**Example snippet of AFC frequency response showing that it is piecewise linear:**

|  |
| --- |
| {                      "frequencyRange": {                          "highFrequency": 6248,                          "lowFrequency": 6247                      },                      "maxPsd": 6.296594891289516                  },                  {                      "frequencyRange": {                          "highFrequency": 6249,                          "lowFrequency": 6248                      },                      "maxPsd": 6.299208933587977                  },                  {                      "frequencyRange": {                          "highFrequency": 6250,                          "lowFrequency": 6249                      },                      "maxPsd": 6.301822517127107                  }, |

**Example regulations**

Canada ISED

[ICES-Gen Issue 2 (General Requirements for Compliance of Interference Causing Equipment)](https://ised-isde.canada.ca/site/spectrum-management-telecommunications/sites/default/files/documents/ices-gen_issue2.pdf):

“Composite equipment: Equipment that incorporates two or more units of other equipment, either in the same enclosure or in separate interconnected enclosures, some or all of which are already on the Canadian market and in compliance with the applicable ISED standard(s). Components (i.e. unfinished products) are not “units of equipment” in the sense used in this definition.”

USA FCC

[Part 2, Section 947, bullet(f)](https://www.ecfr.gov/current/title-47/chapter-I/subchapter-A/part-2/subpart-J/subject-group-ECFRd5ad3b739dbf27a/section-2.947):

“A composite system is a system that incorporates different devices contained either in a single enclosure or in separate enclosures connected by wire or cable. If the individual devices in a composite system are subject to different technical standards, each such device must comply with its specific standards. In no event may the measured emissions of the composite system exceed the highest level permitted for an individual component. Testing for compliance with the different standards shall be performed with all of the devices in the system functioning. If the composite system incorporates more than one antenna or other radiating source and these radiating sources are designed to emit at the same time, measurements of conducted and radiated emissions shall be performed with all radiating sources that are to be employed emitting.”

## Proposed Text Update under CID 22

*Instruction to TGmf Editor: Edit the TGmf draft as shown below.*

**3.2 Definitions specific to IEEE Std 802.11**

(normative)

*TGmf editor: Please insert the following text to this section (on page 242, starting at line 17):*

**punctured passband:** For a set of contiguous punctured 20 MHz subchannels, the portion of the bandwidth that has minimum power spectral density.

NOTE – For a first example, illustrated in Figure 27-61, a punctured passband at -20dBr starts at -(N×10)+0.5 and ends at N×10-0.5 for N contiguous 20 MHz preamble punctured channels with unpunctured subchannels above and below. For a second example, for an 80 MHz HE PPDU with the highest 20 MHz subchannel punctured as shown in Figure 27-62, the punctured passband is between 20.5 and 40 MHz**.**

**punctured transition band:** For a set of contiguous punctured 20 MHz subchannels, a contiguous portion of the bandwidth after excluding the punctured passband.

NOTE – For a first example, illustrated in Figure 27-61, a punctured transition band is the band that starts at -(N×10) and ends at -(N×10)+0.5. Another punctured transition band is the band that starts at N×10-0.5 and ends at N×10 for N contiguous 20 MHz preamble punctured channels with unpunctured subchannels above and below. For a second example, for an 80 MHz HE PPDU with the highest 20 MHz subchannel punctured as shown in Figure 27-62, there is one punctured transition band which is between 20 and 20.5 MHz.

**Annex D**

(normative)

**Regulatory references**

**D.1 External regulatory references**

The documents listed in Table D-1 (Regulatory requirement list) specify current regulatory requirements for various frequency bands and geographic areas at the time this standard was developed. They are provided for information only and are subject to change or revision at any time.

Table D-1—Regulatory requirement list

|  |  |  |  |
| --- | --- | --- | --- |
| Geographic area | Approval standards | Documents | Approval authority |
| Canada | Minister of Industry | RSS-210 - License-exempt Radio Apparatus (All Frequency Bands): Category I Equipment;  ICES-Gen Issue 2 (General Requirements for Compliance of Interference Causing Equipment), Section 2 | Industry Canada |
| United States and its territories | Federal Communications Commission (FCC) | 47 CFR [B6], Part 2, Section 947; Part 15, Sections 15.205, 15.209, 15.247 and 15.255; and Subpart E, Sections 15.401-15.407, and Subpart H, Sections 15.701-15.716, Section 90.210, Sections 90.371-383, Sections 90.1201-90.1217, Sections 90.1301-90.1337, Section 95.639, Sections 95.1501-1511 First Report and Order, 35 FCC Rcd. 13440 (15)† | FCC |

**Annex E**

(normative)

**E.2 Band-specific operating requirements**

**E.2.7.1 General**

*TGmf editor: please move all content from E.2.7 to this section, then apply the following edits marked by Word track changes:*

(#6076) A regulatory client EIRP PSD value advertised by an AP that is an indoor standard power AP shall be set to the higher of the following two values:

* The highest value that meets the authorized client transmit power limits for the corresponding cate-

gory 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.

* The highest value that meets the LPI only client transmit power limits authorized by the regulatory

rules for the corresponding category for the corresponding 20 MHz channel if LPI operation is permitted, and otherwise negative infinity.

NOTE <TGmf editor to assign a NOTE number (e.g., 4) and renumber subsequent notes in this clause accordingly> – An example of where LPI operation might be restricted is when the channel is punctured and regulatory requirements such as for channel access are not met. See also E.2.7.2.

*Instruction to TGmf Editor: Add the following new subclause*

**E.2.7.2 Puncturing with Low Power Indoor APs**

This subclause is informative and does not contain mandatory requirements.

In the following, an optional procedure is described for certain regulatory domains that:

* define indoor APs, standard power APs, and composite device operation (see Table D.1 (Regulatory requirement list), and
* restrict indoor APs (and their associated STAs) from using preamble puncturing to avoid incumbents, and
* permit standard power APs, under external system control, to utilize preamble puncturing.

In such domains, an indoor standard power AP can be a composite device with separate certifications as an indoor AP and as a standard power AP. The indoor standard power AP can operate as a standard power AP while conditions are more favourable for this mode, and can operate as an indoor AP while conditions are more favourable for this mode.

The following procedure enables use of preamble puncturing regardless of the AP’s operating mode.

The external system control imposes power spectral density conditions. The maximum power spectral density permitted for non-AP STAs not certified for standard power operation is defined as *P* dBm per MHz. For the punctured transmit spectral masks defined in this standard, the minimum power spectral density reduction within the punctured 20 MHz channels, except for any punctured transition bands next to a punctured passband, is defined as *D* dB. In 27.3.21.1 (Transmit spectral mask) and 36.3.20.1.2 (Additional restrictions for puncturing in EHT PPDU), *D* is equal to 20 dB.

Certain regulatory domains might permit the AP to enable preamble puncturing on candidate punctured channels when the following conditions are met:

* the transmit power spectral density allowed by the external system equals or exceeds *P* over the candidate unpunctured bandwidth and punctured transition bands up to and including the 20 MHz boundaries of the candidate punctured channels, and
* the transmit power spectral density allowed by the external system exceeds *P*-*D* throughout the candidate punctured passbands, and
* the regulatory client EIRP PSD value(s) for the punctured channel(s) advertised by the AP are set to 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.

For example, the PPDU bandwidth is 80 MHz bandwidth and comprises a lower 40 MHz, an upper 20 MHz and an uppermost 20 MHz, *P* is -1 dBm/MHz, the external system uses a resolution of 1 MHz, the external system’s response permits no more than 6 dBm/MHz over the lower 49 MHz and the uppermost 21 MHz, and permits no more than -20 dBm/MHz for the central 10 MHz of the upper 20 MHz channel. A candidate puncturing is to puncture the upper 20 MHz channel, with *D* equal to 20 dB. This candidate puncturing is permitted as seen in Figure E.2.7.2xx since:

* 6 dBm/MHz exceeds -1 dBm/MHz over the 60 MHz of unpunctured bandwidth and, related to the punctured upper 20 MHz channel, the two 0.5 MHz-wide punctured transition bands
* For the punctured passband of the punctured 20 MHz subchannel, *P*-*D* = -1-20 = -21 dBm/MHz which falls below the worst case -20 dBm/MHz permitted by the external system.
* The AP advertises a regulatory client EIRP PSD value of -20 + 10×log10(20/1) = -7 dBm for the upper 20 MHz channel



Figure E.2.7.2xx: Example of the transmit spectral mask of a candidate punctured PPDU falling under the frequency response from an external system.

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