IEEE P802.11  
Wireless LANs

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| |  |  |  |  |  | | --- | --- | --- | --- | --- | | Disallowed Sub channels | | | | | | Date: 2018-04-16 | | | | | | Author(s): | | | | | | Name | Affiliation | Address | Phone | email | | Matthew Fischer | Broadcom |  |  | [Matthew.fischer@broadcom.com](mailto:Matthew.fischer@broadcom.com) | | Yongho Seok | MediaTek |  |  | [yongho.seok@mediatek.com](mailto:yongho.seok@mediatek.com) | | Lochan Verma | Qualcomm |  |  |  | | Jianhan Liu | Mediatek |  |  |  | | Hongyuan Zhang | Marvell |  |  |  | | Youhan Kim | Qualcomm |  |  |  | | Zhou Lan | Broadcom |  |  |  | |

Abstract

Proposed language to address the issue of disallowed subchannels.

**NOTE that as of r7, this document includes the material that had been present in 11-18-1258r0**

The proposed change is to add a new field to the end of the HE Operation IE called Operational Subchannel Information field.

One additional bit called Punctured Operation is added inside of the HE Operation Information field to signal the presence/absence of the new field

The new field is a combination of a length and a bit map, where the length is a 3 bit value and the bit map is the length of octets indicated in the length field. Each bit of the bitmap corresponds to a subchannel of resolution 242-tones. The lowest numbered bit corresponds to the subchannel with the lowest frequency of the BSS operating channel, etc.

A bit set to 1 indicates transmissions are allowed on that subchannel.

A bit set to 0 indicates transmission is not allowed on that subchannel.

The absence of the field indicates no puncturing, i.e. transmission is allowed on all subchannels of the BSS channel width.

Corresponding behavioral language is added to subclause 27.

A change to the HE NDP Announcement is included to signal the puncturing of the sounding sequence by adding a disallowed subchannel bitmap field which is present when the AID11 value is 2047 and the Disambiguation subfield value is 1, instead of a normal STA Info field.

Also included are proposed HE MIMO Control field changes to indicate a punctured set of feedback information, basically, adding the same disallowed subchannels bitmap to the HE MIMO Control field.

The proposed changes on this document are based on TGax Draft 2.3.

**REVISION NOTES:**

**R0**:

initial

**R1**:

Removed resolution field

Updated document revision number references

**R2**:

The supported channel width indicated in the HT and VHT Capabilities elements is not the same as the value represented in the HE Capabilities element when some subchannels are disallowed.

**R3**:

Added a modified STA Info subfield in the 9.3.1.20 VHT/HE NDP Announcement frame format subclause to carry Subchannel Punctured information using a newly reserved AID11 value.

Added punctured operation behavioural description within 27.6.2 Sounding sequences and support, where the bandwidth of the HE feedback is determined, first by applying the tone index values and then by applying the disallowed subchannel indication within the HE NDP Announcement frame. Similar language added to 27.6.3 Rules for HE sounding protocol sequences where the bandwidth of the HE NDP Announcement frame is determined.

Change resolution of Operational Subchannel Information in the HE Op IE from 20 MHz to 242-tone.

Added Disallowed Subchannel Bitmap subfield to the HE MIMO Control field in 9.4.1.62 and some behavioural language to 27.6.2 and 27.6.3 to describe its use.

Changed MIB variable name (shortened it)

**R4**:

Add a rule that when a STA Info field in the HE NDPA frame has the AID11 field value of 2047, then that STA Info field shall be the first in the frame.

In 9.4.1.62 HE MIMO Control field changes, modified the disallowed subchannel bitmap length to be 0 or 8 and add a reserved field of 0 or 8. The intent was to add 16 bits to allow word alignment of the remainder of the frame contents and the disallowed subchannel bitmap is only 8 bits in length, not 16, so a reserved field is needed to reach a total of 16 bits

**R5**:

Update text to D3.0

Update CID – remove LB230 CID, replace with LB233 CID

Add Disambiguation field to STA Info subfield of HE NDPA frame when AID11 == 2047

27.6.3 – redefined MU sounding vs SU sounding (i.e. based on number of STA Info fields present in the NDPA frame, i.e. now excluding AID11==2047 from the count)

27.16.1 – BSS BW indication and interpretation – added sentences to describe how a puncturing capable AP sets BW and bitmap values (BW set to the set of contiguous subchannels indicated in the operational subchannel bitmap that includes the primary channel) and how a non-AP STA combines the two fields to determine the actual available punctured set of subchannels/tones for transmission

**R6**:

Change the punctured sounding allowance to reference SU TXBFer/ee instead of MU

Make the condition for modified STA Info field in NDPA as AID11==2047 and Disambiguation == 1

27.16.1 – slight modification to the wording because the VHT Cap is not indicating support for 80+80 or 160 MHz operation, but the STA wants to support that mode, so cannot say that it indicated support, because it did not indicate it

**R7**:

**MERGED with 11-18-1258, i.e. brought that material into this doc.**

3.2 definitions 802.11 – added subchannel punctured PPDU

3.4 abbreviations and acronyms – added SCP - subchannel punctured

9.4.1.63 – HE compressed BF Report field – note that AvgSNRi does not include punctured tone information

9.4.2.238 HE Operation element – modified the definition of the operational subchannel information field – specifically changing terms to make the meaning more generic and leaving the specific definition of a subchannel to the behavioural subclauses

10.6.6.6 Channel width selection for control frames – added this subclause reference to make changes surrounding punctured exchanges and the effect on control responses

10.65a Subchannel Punctured operation – new subclause that describes behaviour for AP and STA that are HE SCP STA and that provides requirements for setting various TXVECTOR parameters for SCP PPDU transmissions, including correspondence between values of ACTIVE\_SUBCHANNELS and FORMAT and CH\_BANDWIDTH, includes settings for NDP and HE\_MU and NON\_HT\_DUP cases, mesh STA prohibited

27.6.3 – slight modification to wording to make it clearer

27.11 – new subclause for setting the ACTIVE\_SUBCHANNELS parameter, needed to cover the non-SCP PPDU case, refers to 10.65a for the SCP PPDU case

27.16.1 – HT, VHT, HE Capabilities and Operation elements text – changed one instance of HT Capabilities to HT Operation

27.16.1 – HT, VHT, HE Capabilities and Operation elements text – changed conditions to be more accurate, added text for setting the VHT Operation IE

27.16.1 – channelization determination protocol for HE SCP STA added

27.16.1 – deleted an occurrence of HE Capabilities element Channel Width Set subfield that should have referred to the VHT Operation element’s Channel Width subfield because this sentence was redundant to the requirements specified earlier in the subclause for setting the VHT Op IE Channel Width subfield

27.16.1 – deleted a portion of a sentence allowing HE SCP STA to transmit on any subchannel in the allowed bitmap because this was made redundant by the addition of the dot11CurrentChannelWidth for HE SCP STA determination language

28.1.1 – optional feature lists, added Subchannel Punctured Operation

28.2.2 – add ACTIVE\_SUBCHANNELS to TXVECTOR, RXVECTOR parameter table (taken from 11-18-1258 and modified to define the width of a subchannel represented by the bitmap depending on format and modified to account for comments from Robert)

28.3.13 – non-HT Duplicate transmission – define the PHY implications of puncturing of non-HT duplicates based on the ACTIVE\_SUBCHANNELS parameter

10.6.6.6 – added a few text changes to point to 10.65a for control response frames that are SCP PPDU for setting of TXVECTOR parameters

Updated author list

**END OF REVISION NOTES**

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. This introduction is 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.***

**CIDs**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 16723 | Ron Porat | 28.3.16 | 547.53 | preamble puncturing as currently defined in D3.0 is lacking several features needed to make it useful especially in Radar channels when some subchannels are blocked for very long durations | Please consider adding the following enhancements: 1. Broadcast message to declare Subchannel Punctureds 2. Punctured NDP to enable BF and DL MU-MIMO 3. NDPA signaling of punctured subbands in the NDP 4. Punctured Non-HT Dup to carry NDPA 5. New PHY modes to enable single user transmission across the entire available punctured BW with at least 60MHz support and one mode for >80MHz (e.g. 120MHz) | Revise - TGax editor to make changes as shown in 11-18/0496r7 that are marked with CID 16723 |

**Discussion:**

Operation within some bands in some regulatory jurisdictions requires monitoring and/or other means of determining whether a primary operator is using channels in the band (e.g. database information). If primary devices are detected or otherwise indicated as operating within a channel, then regulations might require that secondary users, e.g. WLAN devices, are required to cease transmissions in the channel. Because some regulations allow operation on an aggregation of multiple disjoint channels in some of these “shared” bands, and might add additional similar regulations for various bands in the future, and provided that it is in the interest of 802.11 devices to be able to take advantage of disjoint aggregation, then it is necessary to include signalling for 802.11 devices to communicate which disjoint channel combinations are allowed to be used at any given time.

Within various existing regulations, the concept exists, wherein, a device operating as a non-primary user in the band may be a master device which determines which channels are available and which are not available and through some means communicates this information, often implicitly, to non-master devices (aka dependent devices). Existing 802.11 TGax signalling to support the master device concept is both implicit and positive and therefore does not adequately address the case of discontiguous channel aggregation.

For example, a master device acting as an AP might determine that a primary user has begun operating in a channel N that is currently being used by the master device and the master device may then choose to inform any non-master device of its intent to change to a new channel without explicitly indicating the reason for doing so. E.g. the Channel Switch Announcement element can be used.

Non-master devices wishing to operate on a specific channel must first identify the presence of a master device operating on the channel and the presence of such a master device transmitting on the channel is an implicit indication of the availability of the channel for use by the non-primary user. That is, the presence or absence of a master device transmission on a channel is an implicit indication of the availability of the channel for use by non-primary devices. This is implicit signalling as there is no specific field in for example, a beacon that indicates that the channel is available for use.

For discontiguous operation, a master device could operate on an aggregation of channels while intentionally avoiding transmissions on an interior channel based on its knowledge of primary user use of that interior channel. A non-master device currently has no way to determine whether some portion of an aggregated set of channels is not actually available for use by non-primary devices. For example, an 802.11 TGax AP could indicate operation on an 80 MHz channel as a non-primary user, but then discover that a primary user is operating on one of the 20 MHz channels within the 80 MHz. The AP can avoid transmitting on the protected sub-channel, but there is no signalling to indicate to other devices, e.g. non-AP STAs, that that sub-channel is not available. The text in this document offers a proposal for communicating this explicit information.

Summary of the proposed change:

The proposed change is to add a new field to the end of the HE Operation IE called Operational Subchannel Information field.

One additional bit called Punctured Operation is added inside of the HE Operation Information field to signal the presence/absence of the new field

The new field is a combination of a length and a bit map, where the length is a 3 bit value and the bit map is the length of octets indicated in the length field. Each bit of the bitmap corresponds to a specific subchannel. The lowest numbered bit corresponds to the subchannel with the lowest frequency of the BSS operating channel, etc. Note that a length field is needed in order to maintain extensibility of the HE Operation element.

A bit set to 1 indicates transmissions are allowed on that subchannel.

A bit set to 0 indicates transmission is not allowed on that subchannel.

The absence of the field indicates no puncturing, i.e. transmission is allowed on all subchannels of the BSS channel width.

Corresponding behavioral language is added to subclause 27.

One might argue for changes to the equation describing the construction of an HE PPDU – i.e. the per-tone equation.

Similarly, one might argue for changes to the 40 MHz non-HT DUP Equation 19-61 to account for missing subchannels. E.g. see the term at the front which is the scaling factor and the summation that spans 0 to (N20MHz – 1). The equation would need to mention TXVECTOR parameter ACTIVE\_SUBCHANNELS. And for 80 MHz non-HT DUP, similar changes for Equation 21-100.

Note that the proposed language here takes a different approach, see modified clause 28 subclauses.

**Proposed Changes to Draft Text of TGax D3.0:**

**3.2 Definitions specific to IEEE 802.11**

***TGax editor: add a new definition as shown, in the appropriate location:***

**Subchannel punctured (SCP) physical layer (PHY) protocol data unit (PPDU):** a PPDU transmitted using OFDM and with one or more sets of carriers nulled out**(#16723)**

**3.4 Abbreviations and acronymns**

***TGax editor: add a new abbreviation as shown, in the appropriate location:***

**SCP Subchannel punctured(#16723)**

**9.3.1.20 VHT/HE NDP Announcement frame format**

***TGax editor: change the caption of Figure 9-51b – STA Info subfield format in an HE NDP Announcement frame to “STA Info subfield format in an HE NDP Announcement frame when the value in the AID11 subfield is not equal to 2047 or the Disambiguation subfield is equal to 0”***

***TGax editor: add a new figure with the caption “Figure 9-51bx – STA Info subfield format in an HE NDP Announcement frame when the value in the AID11 subfield is equal to 2047 and the Disambiguation subfield is equal to 1” with the figure appearing as shown:***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | B0 B10 | B11 B18 | B19 B26 | B27 | B28 B31 |
|  | AID11 | Disallowed Subchannel Bitmap | Reserved | Disambiguation | Reserved |
| Bits: | 11 | 8 | 8 | 1 | 4 |

**Figure 9-51bx – STA Info subfield format in an HE NDP Announcement frame when the value in the AID11 subfield is equal to 2047 and the Disambiguation subfield is equal to 1**

***TGax editor: modify the text as shown:***

The AID11 subfield contains the 11 least significant bits of the AID of a STA expected to process the following HE NDP and prepare sounding feedback, except that if the AID11 field contains the value 2047 and the Disambiguation subfield contains the value 1, then the remaining bits of the STA Info subfield have the meaning indicated in Figure 9-51bx – STA Info subfield format in an HE NDP Announcement frame when the value in the AID11 subfield is equal to 2047 and the Disambiguation subfield is equal to 1. **(#16723)**

The Disallowed Subchannel Bitmap subfield indicates which 242-tone groups are disallowed for operation and which 242-tone groups are to be included in the requested feedback. The lowest numbered bit of the Disallowed Subchannel Bitmap subfield corresponds to the 242-tone group that lies within the BSS width and that has the lowest frequency of the set of all 242-tone groups within the BSS width. Each successive bit in the bitmap corresponds to the next higher frequency 242-tone group. A bit in the bitmap is set to 1 to indicate that for the corresponding punctured 242-tone group, no energy is present in the NDP frames associated with this NDP Announcement frame and STAs addressed by the NDP Announcement frame do not include the group when determining the average SNR of space time streams 1 to Nc when generating the requested feedback. Otherwise, the bit is set to 0. **(#16723)**

If the HE NDP Announcement frame has more than one STA Info field that has a value in the AID11 field other than 2047 or a value of 0 in the Disambiguation subfield then the Nc field indicates the num-ber of columns Nc, in the Compressed Beamforming Feedback Matrix subfield minus 1. Set to 0 to request *Nc* = 1, set to 1 to request *Nc* = 2, ..., set to 7 to request *Nc* = 8. If the HE NDP Announcement frame has only one STA Info field that has a value in the AID11 field of 2047 and a value of 1 in the Disambiguation subfield then the Nc field is reserved.

**9.4.1.62 HE MIMO Control field**

***TGax editor: change one of the reserved bits of the HE MIMO Control field to be “Disallowed Subchannel Bitmap Present” in Figure 9-121d – HE MIMO Control field and add two new fields called “Disallowed Subchannel Bitmap” with a number of bits indicated as “0 or 8” and a reserved field with a number of bits indicated as “0 or 8” and add the following descriptive text:***

The Disallowed Subchannel Bitmap Present subfield indicates whether a Disallowed Subchannel Bitmap subfield and a reserved field of 8 bits are present in the HE MIMO Control field. These subfields are present if the Disallowed Subchannel Bitmap Present subfield is equal to 1. These subfields are not present if the Disallowed Subchannel Bitmap Present subfield is equal to 0.

The Disallowed Subchannel Bitmap subfield is defined in 9.3.1.20 (VHT/HE NDP Announcement frame format).

**9.4.1.63 HE Compressed Beamforming Report field**

***TGax editor: insert the following new text at the very end of the subclause:***

The computation of the *AvgSNR*i values does not include channel information from tones that lie within 242-tone RUs that are indicated as punctured in the Disallowed Subchannel Bitmap subfield, if present, of the HE NDP Announcement frame that solicited the feedback.

**9.4.2.237.2 HE MAC Capabilities Information field**

***TGax editor: change one of the reserved bits of the HE Capability element MAC Capabilities subfield to be “Punctured Operation Support” and add the following row to Table 9-262z – Subfields of the HE MAC Capabilities Information field, noting that the column headings are shown for editing convenience:***

|  |  |  |
| --- | --- | --- |
| **Subfield** | **Definition** | **Encoding** |
| Punctured Operation Support | Indicates support for punctured operation as described in 27.6 (HE Sounding protocol)). | Set to 1 if dot11PuncturedOperationActivated is true (see 27.6 (HE Sounding protocol)).  Set to 0 otherwise. |

**9.4.2.238 HE Operation element**

***TGax editor: change one of the reserved bits of the HE Operation Parameters field to be a new one-bit subfield called “Punctured Operation” and add the following paragraph as a description of the new subfield:***

The Punctured Operation subfield indicates whether the BSS channel width includes disallowed subchannels. The Punctured Operation subfield is set to 1 if dot11PuncturedOperationActivated is true to indicate that the BSS channel width includes disallowed subchannels and is set to 0 otherwise. The Punctured Operation subfield is set to 0 when transmitted by a STA operating in the 2.4 GHz band. **(#16723)**

***TGax editor: add one new subfield called “Operational Subchannel Information” to the MSbit side of Figure 9-589cq – HE operation element format, label the width of the new subfield as “variable” and add the following paragraphs and figures as descriptions of the new subfield and its sub-subfields:***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Element ID Extension | HE Operation Parameters | Basic HE MCS And NSS Set | VHT Operation Information | MaxBSSID Indicator | Operational Subchannel Information |
| Bits: | 1 | 1 | 1 | 4 | 3 | 0 or 3 | 0 or 1 | variable**(#16723)** |

**Figure 9-589cq – HE Operation element format**

The Operational Subchannel Information subfield indicates on which subchannels of the BSS width, transmission is allowed and on which subchannels, transmission is disallowed. The Operational Subchannel Information subfield contains three subfields as shown in Figure 9-589xx Operational Subchannel Information subfield format. The Operational Subchannel Information field is present if the Punctured Operation subfield is equal to 1 and is not present otherwise. **(#16723)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Reserved | Operational Subchannel Bitmap Length | Operational Subchannel Bitmap |
| Bits: | 5 | 3 | variable |

**Figure 9-589xx – Operational Subchannel Information subfield format(#16723)**

The Operational Subchannel Bitmap Length subfield is 3 bits in length and contains an unsigned integer which indicates the length of the Operational Subchannel Bitmap subfield. The length of the Operational Subchannel Bitmap subfield is equal to one plus the numerical value of the Operation Subchannel Bitmap Length subfield octets. Operational Subchannel Bitmap Length subfield values greater than 1 are reserved.  **(#16723)**

The Operational Subchannel Bitmap subfield indicates the Reference 20 MHz subchannels of the BSS width on which transmissions are allowed when transmitting PPDUs using Subchannel Punctured operation. The encoding of the subfield for 20 MHz subchannel based puncturing is indicated in Table 9-589yy – Operational Subchannel Bitmap subfield encoding. A bit in the bitmap is set to 1 to indicate that transmission is allowed on the corresponding subchannel and is set to 0 to indicate that transmission is disallowed on the corresponding subchannel. The number of subchannels in the BSS width might not be a multiple of eight. Bits of the bitmap corresponding to subchannels that are not contained within the BSS width are reserved. If the Operational Subchannel Bitmap subfield is not present, then transmission is allowed on all subchannels of the BSS channel width. The definition of a subchannel for Subchannel Punctured operation is defined in 10.65a (Subchannel Punctured operation). **(#16723)**

**Table 9-589yy - Operational Subchannel Bitmap subfield encoding**

|  |  |
| --- | --- |
| **Operational Subchannel Bitmap subfield bit position** | **Reference 20 MHz subchannel** |
| 0 | Primary 20 MHz channel |
| 1 | Secondary 20 MHz channel |
| 2 | The 20 MHz channel of the secondary 40 MHz channel that has the lowest frequency |
| 3 | The 20 MHz channel of the secondary 40 MHz channel that has the highest frequency |
| 4 | The 20 MHz channel of the secondary 80 MHz channel that has the lowest frequency |
| 5 | The 20 MHz channel of the secondary 80 MHz channel that has the second lowest frequency |
| 6 | The 20 MHz channel of the secondary 80 MHz channel that has the third lowest frequency |
| 7 | The 20 MHz channel of the secondary 80 MHz channel that has the highest frequency |

***TGax editor: insert the header and editing instruction and text modifications as shown:***

**10.6.6.6 Channel Width selection for Control frames**

***Change the paragraphs shown as follows:***

A STA that sends a Control frame in response to a frame carried in an HT PPDU or a VHT PPDU shall set the TXVECTOR parameter CH\_BANDWIDTH to indicate a channel width that is the same as the channel width indicated by the RXVECTOR parameter CH\_BANDWIDTH of the frame eliciting the response.

A STA that sends a Control frame in response to a frame carried in a non-HT or non-HT duplicate PPDU

with a nonbandwidth signaling TA

— Should set the TXVECTOR parameter CH\_BANDWIDTH to the same value as the RXVECTOR parameter CH\_BANDWIDTH for the frame eliciting the response.

— Shall not set the TXVECTOR parameter CH\_BANDWIDTH to a value greater than the RXVECTOR parameter CH\_BANDWIDTH for the frame eliciting the response.

NOTE—According to this rule, a STA can respond with a 20 MHz PPDU if it receives a non-HT duplicate frame but is

not able to detect the channel width occupied by the frame (whether by design or because the frame was received over a

channel that is narrower than the channel on which it was transmitted).

A VHT STA that sends a Control frame that is in response to a non-HT or non-HT duplicate format frame with a bandwidth signaling TA and that is not a CTS shall set the channel width indicated by the TXVECTOR parameter CH\_BANDWIDTH to the same value as the channel width indicated by the RXVECTOR parameter CH\_BANDWIDTH\_IN\_NON\_HT for the frame eliciting the response, unless the Control frame is an SCP PPDU, in which case, the CH\_BANDWIDTH parameter shall be set according to the rules indicated in 10.65a (Subchannel Punctured operation). The RA field of a Control frame that is not a CF-End frame and that is sent in response to a Control frame with a bandwidth signaling TA shall be set to a nonbandwidth signaling TA obtained from the TA field of the immediately previous Control frame. For the channel width selection rules for CTS sent in response to an RTS with a bandwidth signaling TA, see 10.3.2.9 (CTS and DMG CTS procedure).

A frame that is intended to provide protection is transmitted using a channel width selected by the rules defined in 10.28 (Protection mechanisms).

An HT STA that uses a non-HT duplicate frame to establish protection of its TXOP shall send any CF-End frame using a non-HT duplicate frame.

The TXOP holder should set the TXVECTOR parameter CH\_BANDWIDTH of a CF-End frame to the maximum bandwidth allowed by the rules in 10.24.2.8 (Multiple frame transmission in an EDCA TXOP).

NOTE—A CF-End frame transmitted by an AP a SIFS duration after receiving a CF-End frame is considered a control response frame.

An SCP STA that transmits a Control frame that is an SCP PPDU shall follow additional rules for seting the TXVECTOR parameters FORMAT, NON\_HT\_MODULATION, CH\_BANDWIDTH and ACTIVE\_SUBCHANNELS as described in 10.65a (Subchannel Punctured operation).

***TGax editor: insert the header and editing instruction and text modifications as shown:***

***Insert the following new subclause:***

**10.65a Subchannel Punctured operation(#16723)**

The transmission of a PPDU using OFDM with one or more specifically defined sets of carriers nulled out is called Subchannel Punctured operation and a PPDU transmitted in this manner is called a Subchannel Punctured PPDU (SCP PPDU). HE STAs may optionally support Subchannel Punctured operation. An HE STA with dot11PuncturedOperationActivated equal to true supports Subchannel Punctured operation and is called an HE SCP STA. The rules in this subclause describe Subchannel Punctured operation for HE SCP STAs.

An HE SCP STA that is not a mesh STA shall set the Punctured Operation Support subfield to 1 in frames that it transmits that contain the HE Capabilities element.

A mesh STA shall set the Punctured Operation Support subfield to 0 in frames that it transmits that contain the HE Capabilities element.

An HE SCP STA that is an AP dynamically determines which subchannels can be used and which cannot be used in PPDUs transmitted by STAs that are associated with the AP. The method for determination of which subchannels can be used for PPDU transmissions is beyond the scope of this standard. The AP indicates to associated HE STAs which subchannels can be used for transmissions of PPDUs that are not SCP PPDUs through the indication of the BSS channel width as described in 21.3.14 (Channelization). An AP that is an HE SCP STA shall indicate which additional subchannels may be used by associated HE SCP STAs for SCP PPDU transmissions by including the Operational Subchannel Bitmap subfield within HE Operation elements that it transmits. The AP sets each bit of the Operational Subchannel Bitmap to 1 to indicate that the corresponding subchannel may be used for the transmission of SCP PPDUs, otherwise, the bit is set to 0.

An HE STA associated with an HE AP determines the BSS channel width as described in 27.16.1 (Basic HE BSS functionality). An HE SCP STA associated with an AP that is an HE SCP STA determines which subchannels may additionally be used for SCP PPDU transmissions as described in 27.16.1 (Basic HE BSS functionality).

The nulling of carriers within an SCP PPDU is specified with a granularity of a subchannel. For an SCP PPDU that has a TXVECTOR parameter FORMAT value of HE MU PPDU or that has a FORMAT value of HE\_SU and an APEP\_LENGTH value of 0, a subchannel is a 20 MHz channel as defined in clause 17 (Orthogonal frequency division multiplexing (OFDM) PHY specification) for the portions of the PPDU that use a tone plan as specified in clause 17 (Orthogonal frequency division multiplexing (OFDM) PHY specification) and a subchannel is a 242-tone RU as defined in 28.3.2 (Subcarrier and resource allocation) for the portions of the PPDU that use a tone plan as specified in clause 28 (High Efficiency (HE) PHY specification). For an SCP PPDU that has a TXVECTOR parameter NON\_HT\_MODULATION value of NON\_HT\_DUP\_OFDM a subchannel is a 20 MHz channel as defined in clause 17 (Orthogonal frequency division multiplexing (OFDM) PHY specification).

The indication of which subchannels are punctured for an SCP PPDU is conveyed from the MAC to the PHY through the TXVECTOR parameter ACTIVE\_SUBCHANNELS which is a bitmap with an encoding that is the same as the encoding for the Operational Subchannel Bitmap subfield shown in Table 9-589yy - Operational Subchannel Bitmap subfield encoding. Each bit in the ACTIVE\_SUBCHANNELS bitmap corresponds to a 20 MHz subchannel as defined in clause 17 (Orthogonal frequency division multiplexing (OFDM) PHY specification) and to the 242-tone RU that is most closely aligned with the 20 MHz subchannel, where a 242-tone RU is as defined in 28.3.2 (Subcarrier and resource allocation). A bit in the ACTIVE\_SUBCHANNELS bitmap is set to 0 to indicate that no energy is transmitted on the corresponding subchannel for the corresponding PPDU.

An HE SCP STA associated with an AP that is an HE SCP STA may transmit an SCP PPDU if the Punctured Operation subfield of the most recently received HE Operation element from the AP is set to 1.

An HE SCP STA that transmits an SCP PPDU shall set the TXVECTOR parameter FORMAT to HE\_MU, HE\_SU or NON\_HT.

An HE SCP STA that is not an AP may transmit a PPDU with TXVECTOR parameter FORMAT equal to HE\_MU if the PPDU is an SCP PPDU.

If an HE SCP STA transmits an SCP PPDU that does not contain sounding feedback and that has the TXVECTOR parameter FORMAT equal to HE\_MU, then any bit in the ACTIVE\_SUBCHANNELS value may be set to 1, provided that the corresponding bit of the Operational Subchannel Bitmap subfield is equal to 1 and provided that the value of ACTIVE\_SUBCHANNELS is equal to one of the values listed in Table 10-10abc - Setting of the ACTIVE\_SUBCHANNELS and CH\_BANDWIDTH parameters of the TXVECTOR for SCP PPDU transmissions with the FORMAT parameter equal to HE\_MU or HE\_SU.

If an HE SCP STA transmits an SCP PPDU that does contain sounding feedback and that has the TXVECTOR parameter FORMAT equal to HE\_MU, then any bit in the ACTIVE\_SUBCHANNELS value maybe set to 1, provided that the corresponding bit of the Disallowed Subchannel Bitmap subfield of the HE NDP Announcement that solicited the feedback is equal to 1 and provided that the value of the ACTIVE\_SUBCHANNELS parameter is equal to one of the values listed in Table 10-10abc - Setting of the ACTIVE\_SUBCHANNELS and CH\_BANDWIDTH parameters of the TXVECTOR for SCP PPDU transmissions with the FORMAT parameter equal to HE\_MU or HE\_SU.

If an HE SCP STA transmits an SCP PPDU with the TXVECTOR parameter FORMAT equal to HE\_MU, then the CH\_BANDWIDTH and ACTIVE\_SUBCHANNELS parameters shall be set as as indicated in Table 10-10abc - Setting of the ACTIVE\_SUBCHANNELS and CH\_BANDWIDTH parameters of the TXVECTOR for SCP PPDU transmissions with the FORMAT parameter equal to HE\_MU.

**Table 10-10abc - Setting of the ACTIVE\_SUBCHANNELS and CH\_BANDWIDTH parameters of the TXVECTOR for SCP PPDU transmissions with the FORMAT parameter equal to HE\_MU**

|  |  |  |
| --- | --- | --- |
| **ACTIVE\_SUBCHANNELS value, bit 0 is on the right** | **CH\_BANDWIDTH value** | **Explanation** |
| B00001101 | HE-CBW-PUNC80-PRI |  |
| B00001011 | HE-CBW-PUNC80-SEC |  |
| B00000111 | HE-CBW-PUNC80-SEC |  |
| By3y2y1y01101 | HE-CBW-PUNC160-PRI20 | y3, y2, y1, y0 each have a value of either 0 or 1, except that the case of all 0 is disallowed |
| Bz5z4z3z2z1z011 | HE-CBW-PUNC160-SEC40 | z5, z4, z3, z2, z1, z0 each have a value of either 0 or 1, except that the cases of z5, z4, z3, z2 all 0 and z5, z4, z3, z2, z1, z0 all 0 are disallowed |

Any value of ACTIVE\_SUBCHANNELS not listed in Table 10-10abc Setting of the ACTIVE\_SUBCHANNELS and CH\_BANDWIDTH parameters of the TXVECTOR for SCP PPDU transmissions with the FORMAT parameter equal to HE\_MU is not allowed for the transmission of any PPDU.

The value of the Disallowed Subchannel Bitmap subfield of the STA Info field of an HE NDP Announcement frame that includes the value of 2047 in the AID11 subfield and a value of 1 in the Disambiguation subfield of at least one STA Info subfield shall be equal to one of the values indicated in the ACTIVE\_SUBCHANNELS value column of Table 10-10abc - Setting of the ACTIVE\_SUBCHANNELS and CH\_BANDWIDTH parameters of the TXVECTOR for SCP PPDU transmissions with the FORMAT parameter equal to HE\_MU.

If an HE SCP STA transmits an SCP PPDU that has the TXVECTOR parameter FORMAT equal to HE\_SU, then the APEP\_LENGTH parameter shall be equal to 0 and the ACTIVE\_SUBCHANNELS value shall be set to the same value as the Disallowed Subchannel Bitmap subfield of the STA Info field of the HE NDP Announcement frame that includes the value of 2047 in the AID11 subfield and a value of 1 in the Disambiguation subfield and that is part of the same sounding sequence as the PPDU.

If an HE SCP STA transmits an SCP PPDU with the TXVECTOR parameter FORMAT equal to NON\_HT, then the NON\_HT\_MODULATION, CH\_BANDWIDTH and ACTIVE\_SUBCHANNELS parameters of the TXVECTOR shall be set as follows:

* The TXVECTOR parameter NON\_HT\_MODULATION shall be set to NON\_HT\_DUP\_OFDM.
* If the PPDU is transmitted as a response to an SCP PPDU, then for each bit in the ACTIVE\_SUBCHANNELS parameter of the RXVECTOR of the received PPDU that is equal to 0, the corresponding bit in the TXVECTOR parameter ACTIVE\_SUBCHANNELS of the response PPDU shall be reset to 0.
* If the PPDU is not transmited in response to an SCP PPDU, then for each bit in the Operational Subchannel Bitmap subfield that is equal to 0, the subchannel corresponding to that bit shall be indicated as not used in the TXVECTOR parameter ACTIVE\_SUBCHANNELS by resetting the bit to 0. For each bit in the Operational Subchannel Bitmap subfield that is equal to 1, the subchannel corresponding to that bit may be indicated as used in the TXVECTOR parameter ACTIVE\_SUBCHANNELS by setting the corresponding bit to 1.
* The CH\_BANDWIDTH parameter value shall be set to CBW40 if there are no bits set to 1 in the ACTIVE\_SUBCHANNELS bitmap that correspond to any 20 MHz subchannel of the secondary 80 MHz and no bits set to 1 that correspond to any 20 MHz subchannel of the secondary 40 MHz
* The CH\_BANDWIDTH parameter value shall be set to CBW80 if there are no bits set to 1 in the ACTIVE\_SUBCHANNELS bitmap that correspond to any 20 MHz subchannel of the secondary 80 MHz and at least one bit set to 1 that corresponds to any 20 MHz subchannel of the secondary 40 MHz
* The CH\_BANDWIDTH parameter value shall be set to CBW160 if there is at least one bit set to 1 in the ACTIVE\_SUBCHANNELS bitmap that corresponds to any 20 MHz subchannel of the secondary 80 MHz

**27.6.2 Sounding sequences and support**

***TGax editor: modify the text as shown:***

The bandwidth (partial or full) of the feedback solicited by an HE beamformer from an HE beamformee depends on the Partial BW subfield in the STA Info field addressed to the HE beamformee in the HE NDP Announcement frame, the bandwidth of the HE NDP Announcement frame and for HE SCP STA, also the value of the Disallowed Subchannel Bitmap subfield, if present. Full bandwidth feedback is solicited if: **(#16723)**

- the RU Start Index subfield in the Partial BW subfield is 0;

- the HE beamformee is not an HE SCP STA, or the HE beamformee is an HE SCP STA and the Disallowed Subchannel Bitmap subfield is absent, or contains all zeroes; **(#16723)**

- and the following conditions apply:

* The RU End Index subfield in the Partial BW subfield is 8 and the bandwidth of the HE NDP Announcement frame is 20 MHz
* The RU End Index subfield is 17 and the bandwidth of the HE NDP Announcement frame is 40 MHz
* The RU End Index subfield is 36 and the bandwidth of the HE NDP Announcement frame is 80 MHz
* The RU End Index subfield is 73 and the bandwidth of the HE NDP Announcement frame is 80+80 MHz or 160 MHz

Other settings of the Partial BW subfield solicit partial bandwidth feedback. Punctured operation for HE SCP STAs is indicated by the inclusion of a non-zero Disallowed Subchannel Bitmap subfield in the NDP Announcement frame and in such a case, the disallowed subchannels are applied to the tone information to be included in the feedback after selecting tones for feedback based on the RU Start Index and RU End Index subfield values and HE NDP Announcement frame bandwidth as described above. See Table 27-4 (Settings for BW, RU Start Index, and RU End Index fields in HE NDP Announcement frame). **(#16723)**

An SU beamformer may solicit full bandwidth SU feedback from an SU beamformee in an HE non-TB sounding sequence. An SU beamformer shall not solicit partial bandwidth SU feedback in an HE non-TB sounding sequence. An SU beamformer may solicit partial bandwidth or full bandwidth SU feedback from an SU beamformee in an HE TB sounding sequence if the SU beamformee indicates support by setting the Triggered SU Beamforming Feedback subfield in the HE PHY Capabilities Information field in the HE Capabilities element it transmits to 1.

An MU beamformer may solicit full bandwidth MU feedback from an MU beamformee in an HE TB sounding sequence. An MU beamformer may solicit partial bandwidth MU feedback from an MU beamformee in an HE TB sounding sequence if the MU beamformee indicates support by setting the Triggered MU Beamforming Partial BW Feedback subfield to 1.

An MU beamformer may solicit full bandwidth or partial bandwidth CQI feedback from an MU beamformee in an HE TB sounding sequence if the MU beamformee indicates support by setting the Triggered CQI Beamforming Feedback subfield to 1.

An MU beamformer may solicit full bandwidth CQI feedback from an MU beamformee in an HE non-TB sounding sequence if the MU beamformee indicates support by setting the Non-Triggered CQI Beamforming Feedback subfield to 1.

An SU beamformer may solicit punctured feedback from an SU beamformee in an HE TB sounding sequence if the SU beamformee indicates support for punctured operation by setting the Punctured Operation Support subfield to 1. An SU beamformer shall indicate punctured subchannels in the NDP frames of an HE NDP sounding sequence by setting the appropriate bits of the Disallowed Subchannel Bitmap subfield of the STA Info field that includes the value of 2047 in the AID11 subfield and a value of 1 in the Disambiguation subfield within an HE NDP Announcement frame. An SU beamformer that includes a value of 2047 for AID11 and a value of 1 in the Disambiguation subfield in a STA Info field of an HE NDP Announcement frame shall place that STA Info field as the first STA Info field of the frame. An SU beamformer that indicates punctured subchannels in the NDP frames of an HE NDP sounding sequence shall set the TXVECTOR parameter ACTIVE\_SUBCHANNELS according to 10.65a (Subchannel Punctured Operation). **(#16723)**

An SU beamformee that supports punctured operation shall generate feedback corresponding to the tones indicated in the STA Info field with an AID11 value matching the twelve least significant bits of its AID value from within a received HE NDP Announcement frame, but excluding tones that are disallowed according to the value of the Disallowed Subchannel Bitmap subfield of the same HE NDP Announcement frame. **(#16723)**

**27.6.3 Rules for HE sounding protocol sequences**

***TGax editor: modify the following text in 27.6.3 Rules for HE sounding protocol sequences, as shown:***

An HE non-TB sounding sequence is a sounding sequence initiated by an HE beamformer with a burst of two frames comprising an individually addressed HE NDP Announcement frame with only one STA Info field that has a value in the AID11 field other than 2047 or a value of 0 in the Disambiguation subfield followed after SIFS by an HE NDP. An HE beamformer that initiates an HE non-TB sounding sequence shall transmit an HE NDP Announcement frame with one and only one STA Info field and the RA field set to the address of the HE beamformee addressed in the STA Info field as the initial frame of the sequence. **(#16723)**

***TGax editor: modify the following text in 27.6.3 Rules for HE sounding protocol sequences, as shown:***

An HE beamformer that transmits an HE NDP Announcement frame to an HE beamformee that is an AP, mesh STA or STA that is a member of an IBSS, shall include one STA Info field in the HE NDP Announcement frame and shall set the AID11 field in the STA Info field of the frame to 0. An HE beamformer that transmits an HE NDP Announcement frame to one or more HE beamformees that are non- AP STAs shall set the AID11 field in each STA Info field to the 11 LSBs of the AID of the non-AP STA to which the STA Info field is addressed. An HE NDP Announcement frame shall not include more than one STA Info fields that have the same value in the AID11 subfield. An HE beamformer that transmits an HE NDP Announcement frame may include a STA Info field with an AID11 subfield value of 2047 and a value of 1 in the Disambiguation subfield to indicate disallowed subchannels during punctured channel operation. When present, the STA Info field with AID11 value of 2047 and a value of 1 in the Disambiguation subfield shall be the first STA Info field in the frame. **(#16723)**

The HE NDP Announcement frame shall indicate the subcarrier grouping, *Ng*, codebook size and the num-ber of columns, *Nc*, in the compressed beamforming feedback matrix to be used by the intended HE beam-formees for the generation of HE compressed beamforming and CQI report except when the HE NDP Announcement frame contains only one STA Info field that has a value in the AID11 field other than 2047 or a value of 0 in the Disambiguation subfield, in which case the subcarrier grouping, *Ng*, code-book size and the number of columns, *Nc*, in the compressed beamforming feedback matrix to be used for the generation of the HE compressed beamforming and CQI report shall be determined by the recipient of the HE NDP Announcement frame.

An HE beamformer that transmits an HE NDP Announcement frame with more than one STA Info field that has a value in the AID11 field other than 2047 or a value of 0 in the Disambiguation subfield shall transmit a BFRP Trigger frame a SIFS after the HE NDP to solicit an HE compressed beamforming and CQI report from the intended HE beamformees in the same TXOP. The HE beamformer may send additional BFRP Trigger frames to solicit a subset of the HE compressed beamforming and CQI report in the same TXOP as shown in Figure 27-7 (An example of the sounding protocol with more than one HE beamformee).

***TGax editor: modify the following text in 27.6.3 Rules for HE sounding protocol sequences, as shown:***

An HE beamformer that transmits an HE NDP Announcement frame shall set the RU Start Index and RU End Index subfields in a STA Info field to indicate the starting 26-tone RU and the ending 26-tone RU, respectively, of the solicited HE compressed beamforming and CQI report (see 9.3.1.20 (VHT/HE NDP Announcement frame format)). For punctured channel operation, the RU Start Index and RU End Index correspond to the bandwidth before puncturing and the Disallowed Subchannel Bitmap subfield is used to indicate which tones are punctured in the HE NDP frames and in the solicited feedback.

***TGax editor: modify the following text in 27.6.3 Rules for HE sounding protocol sequences, as shown:***

The HE beamformer shall solicit feedback over full bandwidth when the HE NDP Announcement frame has only one STA Info field that has a value in the AID11 field other than 2047 or a value of 0 in the Disambiguation subfield or when the STA Info field is addressed to an HE beamformee that has indicated no support for partial bandwidth feedback. The HE beamformer may solicit feedback over full bandwidth or partial bandwidth when the STA Info field is addressed to an HE beamformee that has indicated support for partial bandwidth feedback and the sequence is an HE TB sounding sequence (see 27.6.2 (Sounding sequences and support)).

For 80+80 MHz, feedback is not requested for the gap between the 80 MHz segments.

The HE beamformer shall set the TXVECTOR parameter CH\_BANDWIDTH or CH\_BANDWIDTH\_ IN\_NON\_HT, the RU Start Index field, and the RU End Index field of the HE NDP Announcement frame, depending on the operating channel width and partial BW support of the HE beamformee, as defined in Table 27-4 (Settings for BW, RU Start Index, and RU End Index fields in HE NDP Announcement frame) and the Bandwidth of the HE NDP Announcement frame is determined before applying puncturing based on disallowed subchannels. **(#16723)**

***TGax editor: modify the following text in 27.6.3 Rules for HE sounding protocol sequences, as shown:***

The HE beamformer shall use a lowest 26-tone RU, which is the lower bound of the starting 26-tone in the RU Start Index subfield of a STA Info field that is equal to the maximum of:

— The minimum 26-tone RU located within the channel width in the VHT Operation Information field of either the HE Operation element or the VHT Operation element, whichever is present, and within the channel width in the HT Operation element

— The minimum 26-tone RU located within the channel width in the most recently received Operating Mode Notification frame, Operating Mode Notification element with the Rx NSS Type subfield equal to 0, or OM Control subfield sent by the corresponding HE beamformee (see 27.8 (Operating mode indication))

The HE beamformer shall use a highest 26-tone RU, which is the upper bound of the ending 26-tone RU in the RU End Index subfield of a STA Info field that is equal to the minimum of:

— The maximum 26-tone RU located within the channel width in the VHT Operation Information field of either the HE Operation element or the VHT Operation element, whichever is present, and within the channel width in the HT Operation element

— The maximum 26-tone RU located within the channel width in the most recently received Operating Mode Notification frame, Operating Mode Notification element with the Rx NSS Type subfield equal to 0, or OMI Control field sent by the corresponding HE beamformee (see 27.8 (Operating mode indication))

An HE beamformer that transmits an HE NDP Announcement frame that has only one STA Info field that has a value in the AID11 field other than 2047 or a value of 0 in the Disambiguation subfield shall set the Nc subfield to 0 and the Feedback Type And Ng subfield to 0 except when the HE NDP Announce-ment frame requests CQI-only feedback. The HE beamformee that is the intended receiver of an HE NDP Announcement frame that has only one STA Info field that has a value in the AID11 field other than 2047 or a value of 0 in the Disambiguation subfield shall provide SU-type feedback and may use differ-ent Nc, Ng, and codebook size parameters from those indicated in the HE NDP Announcement frame (i.e., the HE beamformee ignores the values of the Nc subfield except when the HE NDP Announcement frame requests CQI-only feedback, Ng subfield (B26 of the STA Info subfield), Codebook Size subfield, Partial BW Info subfield).

***TGax editor: modify the following text in 27.6.3 Rules for HE sounding protocol sequences, as shown:***

A non-AP HE beamformee that receives a broadcast HE NDP Announcement frame that has more than one STA Info field that has a value in the AID11 field other than 2047 or a value of 0 in the Disambiguation subfield from the HE beamformer with which it is associated and that contains the HE beamformee's 11 LSBs of the AID in any of the STA Info fields and also receives an HE NDP a SIFS after the HE NDP Announcement frame shall compute the HE compressed beamforming and CQI report using the feedback type, *Ng* and codebook size indicated in the received HE NDP Announcement frame. The HE beamformee shall transmit the HE TB PPDU its HE compressed beamforming and CQI report in response to a BFRP Trigger frame that contains the 11 LSBs of the AID of the HE beamformee in any of the User Info fields fol-lowing the rules defined in 27.5.3.3 (STA behavior for UL MU operation). If the HE NDP Announcement frame has the TA field set to the transmitted BSSID, and the HE beamformee is a non-AP STA associated to a nontransmitted BSSID that supports receiving Control frames with TA set to the transmitted BSSID, then the HE compressed beamforming and CQI report sent in response shall have the RA field set to either the nontransmitted BSSID or the transmitted BSSID.

A non-AP HE beamformee that transmits an HE Compressed Beamforming and CQI Report shall set the RU Start Index and RU End Index subfields of the HE MIMO Control field to indicate the range of tones for which compressed beamforming and CQI information is provided. If the HE NDP Announcement frame that solicited the feedback includes a Disallowed Subchannel Bitmap field with a non-zero value, then a beamformee that is an HE SCP STA shall include a Disallowed Subchannel Bitmap subfield in the solicited feedback with the same value as the Disallowed Subchannel Bitmap subfield of the HE NDP Announcement frame that solicited the feedback to indicate tones for which feedback information is not provided from within the range of tones indicated by the RU Start Index and RU End Index subfields. **(#16723)**

The value of the Sounding Dialog Token Number in the HE MIMO Control field shall be set to the same value as the Sounding Dialog Token Number field in the corresponding HE NDP Announcement frame.

***TGax editor: add a new subclause as shown:***

**27.11 Setting TXVECTOR parameters for an HE PPDU**

**27.11.7 ACTIVE\_SUBCHANNELS(#16723)**

A STA transmitting a frame that is not an SCP PPDU shall not include the ACTIVE\_SUBCHANNELS parameter in the TXVECTOR.

A STA transmitting a frame that is an SCP PPDU follows the rules in 10.65a Subchannel Punctured Operation to set the TXVECTOR parameter ACTIVE\_SUBCHANNELS. **(#16723)**

***TGax editor: modify the text shown:***

**27.16.1 Basic HE BSS functionality**

A STA transmitting a frame containing both an HT Capabilities element and an HE Capabilities element shall set the Supported Channel Width Set subfield of the HT Capabilities element to 1 when either B0 or B1 of the Channel Width Set subfield of the HE Capabilities element is 1 with the following exceptions:

—If the STA is a 20 MHz-only non-AP HE STA, the STA shall set the Supported Channel Width Set subfield of the HT Capabilities element to 0.

— If the frame, or the STA’s most recently transmitted HE Operation element’s Operational Subchannel Information subfield of the HE Operation Parameters field indicates a disallowed subchannel within the primary 40 MHz channel, the STA shall set the STA Channel Width subfield of the HT Operation element to 0.

A STA transmitting a frame containing both a VHT Capabilities element and an HE Capabilities element shall set the Supported Channel Width Set subfield of the VHT Capabilities element to a value that indicates the same channel width capability as the channel width capability indicated in the HE Capabilities element with the following exceptions:

—If the STA is a 20 MHz-only non-AP HE STA, the Supported Channel Width Set subfield of the VHT Capabilities element is reserved.

— If the frame, or the STA’s most recently transmitted HE Operation element’s Operational Subchannel Information subfield of the HE Operation Parameters field indicates at least one disallowed subchannel, the STA shall include the Operating Mode Notification element in the frame with one of the following settings:

—the Operating Mode field’s Rx NSS Type subfield set to 0, Channel Width subfield set to 2, and 160/80+80 BW subfield set to 0, if none of the disallowed subchannels is within the primary 80 MHz channel.

—the Operating Mode field’s Rx NSS Type subfield set to 0, Channel Width subfield set to 1, and 160/80+80 BW subfield set to 0, if at least one of the disallowed subchannels is within the secondary 40 MHz channel and none of the disallowed subchannels is within the primary 40 MHz channel.

—the Operating Mode field’s Rx NSS Type subfield set to 0, Channel Width subfield set to 0, and 160/80+80 BW subfield set to 0, if the secondary 20 MHz channel is a disallowed subchannel.

— If the frame, or the STA’s most recently transmitted HE Operation element’s Operational Subchannel Information subfield of the HE Operation Parameters field indicates at least one disallowed subchannel, the STA shall include the VHT Operation element in the frame with one of the following settings:

—the Channel Width field set to 1 if none of the disallowed subchannels is within the primary 80 MHz channel.

—the Channel Width field set to 0 if at least one of the disallowed subchannels is within the secondary 40 MHz channel and none of the disallowed subchannels is within the primary 40 MHz channel.

— the Channel Width field set to 0 if the secondary 20 MHz channel is a disallowed subchannel. **(#16723)**

A STA that is an HE AP or an HE mesh STA that transmits an HE Operation element that has the VHT Operation Information Present field set to 1 shall set the STA Channel Width subfield in the HT Operation element HT Operation Information field, the Channel Width, Channel Center Frequency Segment 0 and Channel Center Frequency Segment 1 subfields in the HE Operation element VHT Operation Information field to indicate the BSS bandwidth as defined in Table 11-24 (VHT BSS bandwidth).

The setting of the Channel Center Frequency Segment 0, Channel Center Frequency Segment 1 and Channel Center Frequency Segment 2 subfields is shown in Table 11-25 (Setting of Channel Center Frequency Segment 0, Channel Center Frequency Segment 1 and Channel Center Frequency Segment 2 subfields), except that the Max NSS support is provided by the HE STA in frames that contain an HE Capabilities element (see 9.4.2.237 (HE Capabilities element)) and an Operating Mode field (see 9.2.4.6.4.3 (Operating Mode) and 9.4.1.53 (Operating Mode field)), wherein in the table the Max NSS support refers to the HE Max NSS support instead of the VHT Max NSS support for an HE STA.

An HE STA shall determine the channelization using the information in the Primary Channel field of the HT Operation element when operating in 2.4 GHz and the combination of the information in the Primary Channel field in the HT Operation element and the Channel Center Frequency Segment 0 and Channel Center Frequency Segment 1 subfields in the VHT Operation Information field in the VHT Operation element when operating in 5 GHz (see 21.3.14 (Channelization)). **(#16723)**

For the transmission of SCP PPDUs, an HE SCP STA associated with an AP that is an HE SCP STA shall use modified dot11CurrentChannelWidth, dot11CurrentChannelCenterFrequencyIndex0 and dot11CurrentChannelCenterFrequencyIndex1 parameters as follows:

If the Operational Subchannel Information subfield is not present in the most recently received HE Operation element from the AP associated with the HE SCP STA, then the dot11CurrentChannelWidth, dot11CurrentChannelCenterFrequencyIndex0 and dot11CurrentChannelCenterFrequencyIndex1 values determined in 21.3.14 (Channelization) are unchanged for SCP PPDU transmissions.

If the Operational Subchannel Information subfield is present in the most recently received HE Operation element from the AP associated with the HE SCP STA, then the STA uses Table 27-123abc Determination of dot11CurrentChannelWidth for HE SCP STA for SCP PPDU transmission to determine the dot11CurrentChannelWidth value to use for SCP PPDU transmissions. **(#16723)**

**Table 27-123abc Determination of dot11CurrentChannelWidth for HE SCP STA for SCP PPDU transmission**

|  |  |  |
| --- | --- | --- |
| **dot11CurrentChannelWidth determined according to 21.3.14 (Channelziation) (MHz)** | **Condition indicated in the Operational Subchannel Information subfield of the HE Operation element** | **dot11CurrentChannelWidth for HE SCP STA SCP PPDU transmissions (MHz)** |
| 20, 40 or 80 | At least one subchannel within the secondary 80 MHz channel is indicated as allowed. | 160 |
| 20 or 40 | No subchannel within the secondary 80 MHz channel is indicated as allowed, but at least one subchannel within the secondary 40 MHz channel is allowed. | 80 |
| 20 | No subchannel within either the secondary 80 MHz channel or secondary 40 MHz channel is indicated as allowed, but the secondary 20 MHz channel is indicated as allowed. | 40 |

If the Operational Subchannel Information subfield is present in the most recently received HE Operation element from the AP associated with the HE SCP STA, then the dot11CurrentChannelCenterFrequencyIndex0 for SCP PPDU transmission is determined according to equation (27-1z)

dot11CurrentChannelCenterFrequencyIndex0 = dot11CurrentChannelCenterFrequencyIndex0 + ((dot11CurrentChannelWidth for HE SCP STA During Punctured Operation – dot11CurrentChannelWidth determined according to 21.3.14 (Channelization)) / 10) x 5 (27-1z)

If the Operational Subchannel Information subfield is present in the most recently received HE Operation element from the AP associated with the HE SCP STA, then the dot11CurrentChannelCenterFrequencyIndex1 value for SCP PPDU transmissions is unchanged.

If the Operational Subchannel Information subfield is present in the most recently received HE Operation element from the AP associated with the HE SCP STA, then the Primary 20 MHz channel center frequency for SCP PPDU transmissions is unchanged. **(#16723)**

An HE AP or an HE mesh STA shall set the Secondary Channel Offset subfield in the HT Operation Information field in the HT Operation element to indicate the secondary 20 MHz channel as defined in Table 9- 168 (HT Operation element fields and subfields), if the BSS bandwidth is more than 20 MHz.

An AP that is an HE SCP STA shall set the values of the Operational Subchannel Bitmap subfield to indicate on which subchannels transmissions are allowed within the BSS as specified in 9.4.2.238 (HE Operation element). The Operational Subchannel Bitmap Length field shall be set to the minimum value needed to indicate the status of all subchannels within the BSS width. If transmission is disallowed on at least one subchannel within the BSS width, then the Punctured Operation subfield shall be set to one. The Operational Subchannel Bitmap Information subfield may be omitted from the HE Operation element and the Punctured Operation subfield set to zero if transmissions are allowed on all subchannels that are in the BSS width. **(#16723)**

An HE SCP STA shall not transmit on any subchannel of the BSS channel width for which it has received an Operational Subchannel Bitmap subfield with a value of 0 in the corresponding bit position for that subchannel in the most recently received HE Operation element from the AP with which it is associated. An HE SCP STA may transmit on the subchannels that are indicated in the Operational Subchannel Bitmap as allowed. **(#16723)**

An HE STA that is a member of an HE BSS shall follow the same rules that are defined in 11.40.1 (Basic VHT BSS functionality) when transmitting a 20 MHz, 40 MHz, 80 MHz, 160 MHz or 80+80 MHz HE PPDUs with the following exceptions:

— An HE TB PPDU sent in response to a Trigger frame or a frame with a UMRS Control field(#Ed) follows the rules defined in 27.5.2.3 (STA behavior for UL MU operation(#8151))

— An 80 MHz, 160 MHz or 80+80 MHz DL HE MU PPDU(#6253) with preamble puncture may be transmitted if either the primary 20 MHz or the primary 40 MHz, or both are occupied by the transmission (see Table 28-18 (HE-SIG-A field of an HE MU PPDU)).

An HE STA shall not transmit to a second HE STA using a bandwidth that is not indicated as supported in the Supported Channel Width Set subfield in the HE Capabilities element received from that HE STA.

**28.1.1 Introduction to the HE PHY**

***TGax editor: at the end of the list of features under the heading “An HE AP may support the following features:” add the following text:***

Subchannel Punctured Operation

***TGax editor: at the end of the list of features under the heading “A non-AP HE STA may support the following features:” add the following text:***

Subchannel Punctured Operation

**28.2.2 TXVECTOR and RXVECTOR parameters**

***TGax editor: add the following new parameter to Table 28-1 TXVECTOR and RXVECTOR parameters, noting that the header row is shown only for convenience and is not part of the proposed change:***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
| ACTIVE\_SUBCHANNELS | Any of the following:   1. FORMAT is HE\_MU 2. FORMAT is HE\_SU with APEP\_LENGTH equal to 0 3. NON\_HT\_MODULATION is NON\_HT\_DUP\_OFDM | An 8-bit bitmap indicating the subchannels that are occupied by the PPDU. See 10.65a (Subchannel Punctured operation) for a description of the encoding of this parameter. | Y | Y |
|  | Otherwise | Not Present | N | N |

**28.3.13 Non-HT duplicate transmission**

***TGax editor: modify subclause 28.3.13 Non-HT duplicate transmission, as shown:***

When the TXVECTOR parameter FORMAT is NON\_HT and the TXVECTOR parameter NON\_HT\_- MODULATION is NON\_HT\_DUP\_OFDM, the transmitted PPDU is a non-HT duplicate. Non-HT duplicate transmission is used to transmit to non-HT OFDM STAs, HT STAs, VHT STAs and HE STAs that may be present in a part of a 40 MHz, 80 MHz, or 160 MHz channel (see Table 21-2 (Interpretation of FORMAT, NON\_HT Modulation and CH\_BANDWIDTH parameters)). The RL-SIG, HE-SIG-A, HE-SIG-B, HE-STF, and HE-LTF fields are not transmitted.

In a 40 MHz non-HT duplicate transmission, the Data field shall be as defined by Equation (19-61).

For 80 MHz and 160 MHz non-HT duplicate PPDU transmissions that are not SCP PPDUs, the Data field shall be as defined by Equation (21-100).

For 80 MHz non-HT duplicate PPDU transmissions that are SCP PPDUs as indicated by the presence of at least one 0 within the 4 LSBs of the ACTIVE\_SUBCHANNELS bitmap, if present, and a value of CBW80 for the CH\_BANDWITH parameter, the Data field shall be as described in section **21.3.10.12 Non-HT duplicate transmission** with the exception that 20 MHz channels that correspond to bits with zeros in the TXVECTOR field ACTIVE\_SUBCHANNELS are omitted from the transmission.

For 160 MHz non-HT duplicate PPDU transmissions that are SCP PPDUs as indicated by the presence of at least one 0 within the 8 LSBs of the ACTIVE\_SUBCHANNELS bitmap, if present, and a value of CBW160 for the CH\_BANDWITH parameter, the Data field shall be as described in section **21.3.10.12 Non-HT duplicate transmission** with the exception that 20MHz channels that correspond to bits with zeros in the TXVECTOR field ACTIVE\_SUBCHANNELS are omitted from the transmission.

In a noncontiguous 80+80 MHz non-HT duplicate PPDU transmission that is not an SCP PPDU, data transmission in each frequency segment shall be as defined for an 80 MHz non-HT duplicate transmission in Equation (21-100).

In a noncontiguous 80+80 MHz non-HT duplicate PPDU transmission that is an SCP PPDUs as indicated by the presence of at least one 0 within the 8 LSBs of the ACTIVE\_SUBCHANNELS bitmap, if present, and a value of CBW80+80 for the CH\_BANDWITH parameter, data transmission in each frequency segment shall be as defined for an 80 MHz non-HT duplicate transmission that is an SCP PPDU.

**28.3.15.2 Beamforming feedback matrix *V***

***TGax editor: modify the following text of subclause 28.3.15.2 Beamforming feedback matrix V:***

The beamforming feedback matrix, *Vk,u*, found by the beamformee *u* for subcarrier *k* in RU *r* shall be com-pressed in the form of angles using the method described in 19.3.12.3.6 (Compressed beamforming feed-back matrix). The angles, *ϕ(k,u)* and *ψ(k,u)*, are quantized according to Table 9-68 (Quantization of angles). The number of bits for quantization, tone grouping factor, and the number of columns in the HE compressed beamforming feedback are set by the HE beamformer if the HE NDP Announcement frame contains more than one STA Info field that has a value in the AID11 field other than 2047 or a value of 0 in the Disambiguation subfield. The number of bits for quantization, tone grouping factor, and the number of col-umns in the HE compressed beamforming feedback are determined by the beamformee only if the HE NDP Announcement frame contains a single STA Info field that has a value in the AID11 field other than 2047 or a value of 0 in the Disambiguation subfield. The compressed beamforming feedback matrix as defined in 19.3.12.3.6 (Compressed beamforming feedback matrix) is the only Clause 28 (High Efficiency (HE) PHY specification) beamforming feedback matrix defined.

**28.3.16 HE sounding NDP PPDU**

***TGax editor: insert the following text at the end of subclause 28.3.16 HE sounding NDP PPDU:***

The preamble tones overlapping the 242 RUs corresponding to bits with a value of 0 in the bitmap of the TXVECTOR parameter ACTIVE\_SUBCHANNELS or overlapping a punctured center 26 RU are punctured. The center 26-tone RU is punctured if either one of the adjacent 242-tone RUs is punctured. **(#16723)**

**TGax Editor: *Add a new MIB variable in C.3 MIB Detail within the dot11StationConfigEntry group as shown:***

**C.3 MIB Detail**

dot11PuncturedOperationActivated OBJECT-TYPE

SYNTAX TruthValue

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This is a capability variable. Its value is determined by device capabilities.

This attribute, when true, indicates that the STA implementation is capable of operating in a mode where some 242-tone groups are not allowed to be used within a channel of width 80 MHz or 160 MHz. The capability is disabled, otherwise"

DEFVAL { false }

::= { dot11StationConfigEntry <XX>}

**End of proposed changes.**