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 Sounding 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 3.2.

**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 sounding 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

27.6.3 – slight modification to wording to make it clearer

27.11 – new subclause for setting the INACTIVE\_SUBCHANNELS parameter, needed to cover the non-SCP PPDU case, refers to 27.16.6a 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

27.16.6a Subchannel Punctured sounding – 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 INACTIVE\_SUBCHANNELS and FORMAT and CH\_BANDWIDTH, includes settings for NDP and HE\_MU and NON\_HT\_DUP cases, mesh STA prohibited

28.1.1 – optional feature lists, added Subchannel Punctured Sounding

28.2.2 – add INACTIVE\_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 INACTIVE\_SUBCHANNELS parameter

10.6.6.6 – added a few text changes to point to 27.16.6a for control response frames that are SCP PPDU for setting of TXVECTOR parameters

Updated author list

**R8**:

Added more CID tags to proposed changes.

Updated document reference.

**R9**:

Throughout document – removed most instances of “or the Disambiguation subfield is equal to 0”

9.3.1.20 HE NDPA – brought table for bitmap encoding from operational subchannel bitmap to this subclause to unify the encoding of all such bitmaps – now it encodes 20 MHz subchannels that are disallowed, and includes language for determining which 242-tone RUs are disallowed.

9.4.1.63 – HE Comp BF Rpt Field – added language to indicate that FB information for tones disallowed by the bitmap is not included in the field – also added text to indicate that the average SNR value is computed on allowed tones only

9.4.1.64 – HE MU Exclusive BF Rpt Field – added language to indicate that FB information for tones disallowed by the bitmap is not included in the field – also added text to indicate that the average SNR value is computed on allowed tones only

9.4.1.65 – HE CQI-only Rpt Field – added language to indicate that FB information for tones disallowed by the bitmap is not included in the field – no need for average SNR statement, because it does not apply in this case

9.4.2.238 HE operation element – slight modification to the encoding table of the bitmap and text above it to indicate that the bit in the bitmap corresponding to the primary 20 MHz subchannel is always set to 1, also, moved the table from this subclause into 9.3.1.20 for HE NDPA, since the same encoding is used there

Add SCP Center Channel Freq Seg 0 and 1, because cannot reuse existing CCFS1 and CCFS2 values because they are indicated as 0 in many cases when SCP needs a non-zero value.

27.16.6a Subchannel Punctured sounding subclause:

* Fixed problem of inverted bit sense between Disallowed Subchannel Bitmap subfield and INACTIVE\_SUBCHANNELS parameters
* modified table entry slightly to remove redundant information on all zeros case
* Removed allowance of a non-AP STA to transmit an SCP PPDU that has FORMAT HE\_MU

Updated document reference.

**R10**:

Add CID 15920

Updated document reference.

**R11**:

Channel Switch and Extended Channel Switch Announcement SAPs – add Operational Subchannel Information to parameter lists and tables

Create a new element to hold the Operational Subchannel Information that uses the existing Operational Subchannel Bitmap field

Channel Switch and Extended Channel Switch Announcement frames – add Operational Subchannel Information element

Add a few co-authors

Updated document references.

**R12**:

MIB name – changed dot11PuncturedSoundingActivated to dot11PuncturedSoundingOptionImplemented

Updated document references.

**R13**:

Removed Operationnal Subchannel Bitmap from HE Op IE

Removed Op Subch Bitmap from Ch Sw IE, Ext Ch SW IE

Removed the HE Operational Subchannel IE

Removed definitions and use of terms SCP PPDU and SCP

Change ACTIVE\_SUBCHANNELS name to INACTIVE\_SUBCHANNELS to match polarity of Disallowed Subchannel bitmap

Remove SCP operation subclause and moved any necessary text to sounding procedure and INACTIVE\_SUBCHANNELS TXVECTOR setting subclause, in the process, removed all reference to HE MU PPDU use of puncturing

Removed a few co-authors

Change punctured operation to punctured sounding and PuncturedOperation to PuncturedSounding

Updated document references.

**R14**:

27.6.3 - Added language on the allowed settings of the TXVECTOR parameter RU\_ALLOCATION for the HE NDP

28.2.2 – removed INACTIVE\_SUBCHANNELS TXVECTOR parameter

28.2.2 – added modification to RU\_ALLOCATION TXVECTOR parameter to be used for NDP and NON\_HT cases

28.3.13 – modified NON\_HT DUP TXVECTOR settings to use RU\_ALLOCATION to indicate puncturing

28.2.5 – modify NON\_HT reference table in Table 28-3

28.2.5 – add new Table 28-3a to describe effect of TXVECTOR parameter INACTIVE\_SUBCHANNELS when modulation is NON\_HT\_DUP\_OFDM

27.11.7a – added instructions on RU\_ALLOCATION parameter setting

21.3.10.12 – added modification to equation 21-100 which provides the mathematical description for a non-HT DUP PPDU

Update text to D3.2

Updated document references.

**R15**:

Doc references were not properly updated in R14 – so this version changes them from r13 to r15

**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 11-18/0496r15 that are marked with CID 16723 |
| 15920 | Lochan Verma | 28.3.16 | 547.22 | Enable sounding in transmissions where certain channels are punctured | As in comment | Revise - TGax editor to make changes as shown in 11-18/0496r15 that are marked with CID 16723 which are redundant to changes for CID 15920. |

**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 Sounding 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 INACTIVE\_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 D3.1:**

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

***TGax editor: change the caption of Figure 9-60b – 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”***

***TGax editor: add a new figure with the caption “Figure 9-60bx – STA Info subfield format in an HE NDP Announcement frame when the value in the AID11 subfield is equal to 2047” 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 9-60bx – STA Info subfield format in an HE NDP Announcement frame when the value in the AID11 subfield is equal to 2047**

***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, then the remaining bits of the STA Info subfield have the meaning indicated in Figure 9-60bx – STA Info subfield format in an HE NDP Announcement frame when the value in the AID11 subfield is equal to 2047. **(#16723)**

The Disallowed Subchannel Bitmap subfield indicates which 20 MHz subchannels and which 242-tone RUs are present in NDP PPDUs announced by the HE NDP Announcement and which 242-RUs are to be included in requested sounding feedback. A 20 MHz subchannel is 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 242-tone RU is as defined in 28.3.2 (Subcarrier and resource allocation). The lowest numbered bit of the Disallowed Subchannel Bitmap subfield corresponds to the 20 MHz subchannel that lies within the BSS width and that has the lowest frequency of the set of all 20 MHz subchannels within the BSS width. Each successive bit in the bitmap corresponds to the next higher frequency 20 MHz subchannel. A bit in the bitmap is set to 1 to indicate that for the corresponding 20 MHz subchannel, no energy is present in the NDP frames associated with this NDP Announcement frame. For each disallowed 20 MHz subchannel, the 242-tone RU that is most closely aligned in frequency with the 20 MHz subchannel is disallowed for PPDUs that use a tone plan as specified in clause 28 (High Efficiency (HE) PHY specification). STAs addressed by the NDP Announcement frame do not include tones from disallowed 242-tone RUs when determining the average SNR of space time streams 1 to Nc and when generating requested sounding feedback. If a 20 MHz subchannel and its corresponding 242-tone RU is not disallowed, the corresponding bit in the bitmap is set to 0. **(#16723)**

In 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, the Nc field indicates the number of columns *Nc*, in the Compressed Beamforming Feedback Matrix subfield and is set to *Nc* minus 1. In an individually addressed HE NDP Announcement frame that has only one STA Info field that has a value in the AID11 field other than 2047, the Nc field is reserved. **(#16723)**

**9.4.1.64 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 9-143a – 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. **(#16723)**

The Disallowed Subchannel Bitmap subfield is defined in 9.3.1.19 (VHT/HE NDP Announcement frame format). **(#16723)**

**9.4.1.65 HE Compressed Beamforming Report field**

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

The size of the HE Compressed Beamforming Report field depends on the values in the HE MIMO Control field. The HE Compressed Beamforming Report field contains HE Compressed Beamforming Report information or successive (possibly zero-length) portions thereof in the case of segmented HE compressed beamforming/CQI report (see 27.6.4 (Rules for generating segmented feedback)). HE Compressed Beamforming Report information is included in the HE compressed beamforming/CQI report if the Feedback Type subfield in the HE MIMO Control field indicates SU or MU. If the HE MIMO Control field contains a Disallowed Subchannel Bitmap subfield, then the HE Compressed Beamforming Report field does not include information for tones that are included within 242-tone RUs that are indicated as disallowed by the bitmap. **(#16723)**

The AvgSNRi in Table 9-71 (Average SNR of Space-Time Stream i subfield) is found by computing the SNR per subcarrier in decibels for the subcarriers identified in Table 9-76c (Feedback subcarrier indices indicating start 26-tone RU index and end 26-tone RU index for Ng = 4) for Ng = 4 and Table 9-76d (Feedback subcarrier indices indicating start 26-tone RU index and end 26-tone RU index for Ng = 16) for Ng = 16, and then computing the arithmetic mean of those values. Each SNR value per subcarrier in stream i (before being averaged) corresponds to the SNR associated with column i of the beamforming feedback matrix V determined at the beamformee. Each SNR corresponds to the predicted SNR at the beamformee when the beamformer applies all columns of the matrix V.

The computation of the *AvgSNR*i values does not include channel information from subcarriers that lie within 242-tone RUs that are indicated as punctured by the Disallowed Subchannel Bitmap subfield, if present, of the HE NDP Announcement frame that solicited the feedback. **(#16723)**

**9.4.1.66 HE MU Exclusive Beamforming Report field**

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

The size of the HE MU Exclusive Beamforming Report field depends on the values in the HE MIMO Control field. The HE MU Exclusive Beamforming Report field contains HE MU Exclusive Beamforming Report information or successive (possibly zero-length) portions thereof in the case of segmented HE compressed beamforming/CQI report (see 27.6.4 (Rules for generating segmented feedback)). HE MU Exclusive Beamforming Report information is included in the HE compressed beamforming/CQI report (in addition to HE Compressed Beamforming Report information) if the Feedback Type subfield in the HE MIMO Control field indicates MU. If the HE MIMO Control field contains a Disallowed Subchannel Bitmap subfield, then the HE MU Exclusive Beamforming Report field does not include information for tones that are included within 242-tone RUs that are indicated as disallowed by the bitmap. **(#16723)**

No padding is present between *ΔSNRk,i*, in the HE MU Exclusive Beamforming Report field, even if they correspond to different subcarriers. The subset of subcarriers included is determined by the values of the RU Start Index, RU End Index, and Grouping subfields of the HE MIMO Control field. For each subcarrier included, the deviation in dB of the SNR of that subcarrier for each column of *V* relative to the average SNR of the corresponding space-time stream is computed using Equation (9-2). In Equation (9-2), *k* is the subcar-rier index in the range scidx(0), …, scidx(*Ns*  1). In equation (9-2), the average SNR value is computed only for tones that are not indicated as disallowed by a Disallowed Subchannel Bitmap subfield, when it is present. **(#16723)**

**9.4.1.67 HE CQI Report field**

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

The size of the HE CQI Report field depends on the values in the HE MIMO Control field. The HE CQI Report field contains HE CQI Report information. HE CQI Report information is included in the HE compressed beamforming/CQI report if the Feedback Type subfield in the HE MIMO Control field indicates CQI feedback. . If the HE MIMO Control field contains a Disallowed Subchannel Bitmap subfield, then the HE CQI Report field does not include information for tones that are included within 26-tone RUs that are indicated as disallowed by the bitmap. **(#16723)**

**9.4.2.241.2 HE MAC Capabilities Information field**

***TGax editor: change one of the reserved bits of the HE Capability element MAC Capabilities subfield depicted in Figure 9-768b-HE MAC Capabilities Information field format to be “Punctured Sounding Support” and add the following row to Table 9-322a – Subfields of the HE MAC Capabilities Information field, noting that the column headings are shown for editing convenience:***

|  |  |  |
| --- | --- | --- |
| **Subfield** | **Definition** | **Encoding** |
| Punctured Sounding Support **(#16723)** | Indicates support for Punctured Sounding as described in 27.6 (HE Sounding protocol)). | Set to 1 if dot11PuncturedSoundingOptionImplemented is true (see 27.6 (HE Sounding protocol)).  Set to 0 otherwise. |

***TGax editor: to TGax D3.2, add the following header, editing instructions and text, as shown:***

**21.3.10.12 Non-HT duplicate transmission**

***Change as follows:***

***TGax editor: create a modification to equation 21-100 by inserting a new term as a new multiplicand immediately preceding the sum that has the range of k = -26, +26, as shown, and insert the modified formula as a replacement for the existing baseline equation 21-100:***

(1 – INACTIVE\_SUBCHANNELS[*iBW*]) **(#16723)**

***Insert the following:***

INACTIVE\_SUBCHANNELS[*x*] is the *x*th bit of the TXVECTOR parameter INACTIVE\_SUBCHANNELS if present, and is 0, otherwise **(#16723)**

**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 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 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 sounding 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 sounding by setting the Punctured Sounding 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 within an HE NDP Announcement frame. An SU beamformer that includes a value of 2047 for AID11 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 INACTIVE\_SUBCHANNELS according to 27.11.7 (INACTIVE\_SUBCHANNELS). **(#16723)**

An SU beamformee that supports punctured sounding shall generate feedback corresponding to the tones indicated in the STA Info field with an AID11 value matching the eleven 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 followed after a SIFS by an HE NDP. An HE beamformer that initiates an HE non-TB sounding sequence shall transmit an HE NDP Announcement frame with a single STA Info field that has a value in the AID11 field other than 2047 and with the AID11 field in that STA Info field set to the AID of the STA identified by the RA field or to 0 if the STA identified by the RA field is a mesh STA, AP or IBSS member STA. **(#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 the STA Info field addressed to a non-AP STA to the 11 LSBs of the AID of the non-AP STA. 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 to indicate disallowed subchannels during punctured channel operation. When present, the STA Info field with AID11 value of 2047 shall be the first STA Info field in the frame. **(#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 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/CQI report (see 9.3.1.20 (VHT/HE NDP Announcement frame format)). For preamble punctured sounding, 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. **(#16723)**

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:***

A non-AP HE beamformee that transmits an HE Compressed Beamforming/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/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 indicates support for punctured sounding by setting the Punctured Sounding Support subfield to 1 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 field 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**

**27.11.7a INACTIVE\_SUBCHANNELS and RU\_ALLOCATION (#16723)**

The indication of which subchannels are punctured in an HE NDP PPDU or in an HE NDP Announcment that is carried in a non-HT Duplicate PPDU is conveyed from the MAC to the PHY through the TXVECTOR parameters INACTIVE\_SUBCHANNELS and RU\_ALLOCATION. The INACTIVE\_SUBCHANNELS parameter is not present for other PPDUs. The setting of the RU\_ALLOCATION parameter for other PPDUs is specified in 27.5.3.3.2 (TXVECTOR parameters for HE TB PPDU response to Trigger frame), 27.5.3.3.3 (TXVECTOR parameters for HE TB PPDU response to TRS Control subfield) and 27.5.6.2.1 (Transmission of the HE NDP feedback report response).

INACTIVE\_SUBCHANNELS is an eight-bit bitmap with an encoding that is the same as the encoding for the Disallowed Subchannel Bitmap subfield defined in 9.3.1.20 (VHT/HE NDP Announcement frame format). A bit in the INACTIVE\_SUBCHANNELS bitmap is set to 1 to indicate that no energy is transmitted on the corresponding subchannel for the corresponding PPDU. The RU\_ALLOCATION parameter is set to a value that corresponds to the puncturing signalled by the INACTIVE\_SUBCHANNELS bitmap.

A STA transmitting a frame that is an HE NDP PPDU may set the TXVECTOR parameter INACTIVE\_SUBCHANNELS to any value provided that the bit representing the primary 20 MHz channel is set to 0. **(#16723)**

If an HE AP transmits an HE NDP Announcment in a PPDU with punctured channels, then the TXVECTOR parameters FORMAT, NON\_HT\_MODULATION, CH\_BANDWIDTH and INACTIVE\_SUBCHANNELS shall be set as follows:

* The TXVECTOR parameter FORMAT shall be set to NON\_HT
* The TXVECTOR parameter NON\_HT\_MODULATION shall be set to NON\_HT\_DUP\_OFDM.
* The INACTIVE\_SUBCHANNELS parameter may have any value, except that the bit in the bitmap representing the primary 20 MHz subchannel shall be set to 0.
* The CH\_BANDWIDTH parameter value shall be set to CBW80 if there are no bits set to 0 in the INACTIVE\_SUBCHANNELS bitmap that correspond to any 20 MHz subchannel of the secondary 80 MHz and at least one bit set to 0 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 0 in the INACTIVE\_SUBCHANNELS bitmap that corresponds to any 20 MHz subchannel of the secondary 80 MHz

Each 8 bits of the RU\_ALLOCATION are set to 01110001 for the 242-tone RU that is most closely aligned in frequency with the 20 MHz subchannel that is indicated as disallowed by the value 1 in the INACTIVE\_SUBCHANNELS parameter. Each 8 bits of the RU\_ALLOCATION are set to 11000000 for the 242-tone RU that is most closely aligned in frequency with the 20 MHz subchannel that is indicated as not disallowed by the value 0 in the INACTIVE\_SUBCHANNELS parameter.

**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:***

Punctured Sounding Operation **(#16723)**

***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:***

Punctured Sounding Operation **(#16723)**

**28.2.2 TXVECTOR and RXVECTOR parameters**

***TGax editor: add the following new row to the RU\_ALLOCATION section of Table 28-1 TXVECTOR and RXVECTOR parameters, noting that the header row and leftmost column are shown only for convenience and are not part of the proposed change and that the change is an addition of the 2nd through 5th columns of the RU\_ALLOCATION section:***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
| RU\_ALLOCATION | Any of the following:   1. FORMAT is HE\_SU with APEP\_LENGTH equal to 0 2. NON\_HT\_MODULATION is NON\_HT\_DUP\_OFDM **(#16723)** | For the TXVECTOR, indicates the active RUs.  8 bits for 20 MHz and 40 MHz PPDU;  16 bits for 80 MHz PPDU;  32 bits for 160 MHz and 80+80 MHz PPDU.  For each 8 bits, only the following values are allowed:  01110001  11000000  See 28.3.10.8.4 (HE-SIG-B common content) for details. **(#16723)** | Y | N |

**28.2.5 Effects of CH\_BANDWIDTH parameter on PPDU format**

***TGax editor: modify Table 28-3 - Interpretation of FORMAT, NON\_HT Modulation and CH\_BANDWIDTH parameters as shown:***

**Table 28-3— Interpretation of FORMAT, NON\_HT Modulation and CH\_BANDWIDTH parameters**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **FORMAT** | **NON\_HT\_MODULATION** | **CH\_BANDWIDTH** | **CH\_OFFSET** | **PPDU format** |
| HE | N/A | CBW20 | N/A | The STA transmits an HE PPDU of 20 MHz bandwidth. If the BSS bandwidth is wider than 20 MHz, then the transmission shall use the primary 20 MHz channel. |
| HE | N/A | CBW40 | N/A | The STA transmits an HE PPDU of 40 MHz bandwidth. If the BSS bandwidth is wider than 40 MHz, then the transmission shall use the primary 40 MHz channel. |
| HE | N/A | CBW80 | N/A | The STA transmits an HE PPDU of 80 MHz bandwidth. If the BSS bandwidth is wider than 80 MHz, then the transmission shall use the primary 80 MHz channel. |
| HE | N/A | CBW160 | N/A | The STA transmits an HE PPDU of 160 MHz bandwidth. |
| HE | N/A | CBW80+80 | N/A | The STA transmits an HE PPDU of 80+80 MHz bandwidth. |
| HE | N/A | CBW-PUNC80-PRI | N/A | The STA transmits an HE PPDU on the punctured 80 MHz bandwidth where only the secondary 20 MHz is punctured. |
| HE | N/A | CBW-PUNC80-SEC | N/A | The STA transmits an HE PPDU on the punctured 80 MHz bandwidth where only one of the two 20 MHz subchannels in secondary 40 MHz is punctured. |
| HE | N/A | CBW-PUNC160- PRI20 | N/A | The STA transmits an HE PPDU on the punctured 160 MHz or 80+80 MHz bandwidth where only the secondary 20 MHz in the primary 80 MHz is punctured. |
| HE | N/A | CBW-PUNC160- SEC40 | N/A | The STA transmits an HE PPDU on the punctured 160 MHz or 80+80 MHz bandwidth where the primary 40 MHz in the primary 80 MHz is present. |
| HT\_MF, HT\_GF, VHT | See Table 21-2 (Interpretation of FORMAT, NON\_HT\_MODULATION, CH\_BANDWIDTH, and CH\_OFFSET parameters) and Table 19-2 (Interpretation of FORMAT, CH\_BANDWIDTH and CH\_OFFSET parameters) | | | |
| NON\_HT | If INACTIVE\_SUBCHANNELS is not present, see Table 21-2 (Interpretation of FORMAT, NON\_HT\_MODULATION, CH\_BANDWIDTH, and CH\_OFFSET parameters) and Table 19-2 (Interpretation of FORMAT, CH\_BANDWIDTH and CH\_OFFSET parameters) **(#16723)** | | | |
| NON\_HT | If INACTIVE\_SUBCHANNELS is present, see Table 28-3a (Interpretation of CH\_BANDWIDTH and INACTIVE\_SUBCHANNELS parameters when FORMAT is equal to NON\_HT and NON\_HT\_MODULATION is equal to NON\_HT\_DUP\_OFDM) **(#16723)** | | | |

***TGax editor: insert new text and a new table, Table 28-3a - Interpretation of CH\_BANDWIDTH and INACTIVE\_SUBCHANNELS parameters when FORMAT is equal to NON\_HT and NON\_HT\_MODULATION is equal to NON\_HT\_DUP\_OFDM as shown:***

Table 28-3a (Interpretation of CH\_BANDWIDTH and INACTIVE\_SUBCHANNELS parameters when FORMAT is equal to NON\_HT and NON\_HT\_MODULATION is equal to NON\_HT\_DUP\_OFDM) shows the valid combinations of the CH\_BANDWIDTH and INACTIVE\_SUBCHANNELS parameters when FORMAT is equal to NON\_HT and the corresponding PPDU format and value of CH\_OFFSET (if applicable). Other combinations are reserved. **(#16723)**

**Table 28-3a— Interpretation of CH\_BANDWIDTH and INACTIVE\_SUBCHANNELS parameters when FORMAT is equal to NON\_HT and NON\_HT\_MODULATION is equal to NON\_HT\_DUP\_OFDM (#16723)**

|  |  |  |  |
| --- | --- | --- | --- |
| **CH\_BANDWIDTH** | **INACTIVE\_SUBCHANNELS** | **CH\_OFFSET** | **PPDU format** |
| CBW20 | All bits set to 1 except for the bit corresponding to the primary 20 MHz channel which is set to 0 | N/A | The STA transmits a NON\_HT PPDU of 20 MHz bandwidth. If the BSS bandwidth is wider than 20 MHz, then the transmission shall use the primary 20 MHz channel. |
| CBW40 | All bits set to 1 except for the two bits corresponding to the primary 40 MHz channel which are set to 0 | N/A | The STA transmits a NON\_HT PPDU of 40 MHz bandwidth. If the BSS bandwidth is wider than 40 MHz, then the transmission shall use the primary 40 MHz channel. |
| CBW80 | All bits set to 1 except for the four bits corresponding to the primary 80 MHz channel which are set to 0 | N/A | The STA transmits a NON\_HT PPDU of 80 MHz bandwidth. If the BSS bandwidth is wider than 80 MHz, then the transmission shall use the primary 80 MHz channel. |
| CBW80 | The bit corresponding to the primary 20 MHz channel set to 0 and one or two other bits set to 0 that correspond to any other subchannels in the primary 80 MHz, all other bits set to 1. | N/A | The STA transmits a punctured NON\_HT PPDU of 80 MHz bandwidth. If the BSS bandwidth is wider than 80 MHz, then the transmission shall use the primary 80 MHz channel. |
| CBW160 | All eight bits set to 0. | N/A | The STA transmits a NON\_HT PPDU of 160 MHz bandwidth. |
| CBW160 | The bit corresponding to the primary 20 MHz channel set to 0 and one to six other bits set to 0 that correspond to any other subchannels in the 160 MHz, all other bits set to 1. | N/A | The STA transmits a punctured NON\_HT PPDU of 160 MHz bandwidth. |
| CBW80+80 | All eight bits set to 0. | N/A | The STA transmits a NON\_HT PPDU of 80+80 MHz bandwidth. |
| CBW80+80 | The bit corresponding to the primary 20 MHz channel set to 0 and one to six other bits set to 0 that correspond to any other subchannels in the 80+80 MHz, all other bits set to 1. | N/A | The STA transmits a punctured NON\_HT PPDU of 80+80 MHz bandwidth. |

**28.3.13 Non-HT duplicate transmission**

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

If 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 transmissions, the Data field shall be as defined by Equation (21-100).

In a noncontiguous 80+80 MHz non-HT duplicate transmission, data transmission in each frequency segment shall be as defined for an 80 MHz non-HT duplicate transmission in Equation (21-100).

For each non-HT duplicate PPDU transmission that is a preamble punctured PPDU, each punctured 20 MHz subchannel is indicated as punctured by including the value of 01110001 in the 8 bits of the TXVECTOR parameter RU\_ALLOCATION corredponding to the 242-tone RU that is most closely aligned with the punctured 20 MHz subchannel. Each 20 MHz subchannel that is not punctured is indicated as such by including the value of 11000000 in the 8 bits of the TXVECTOR parameter RU\_ALLOCATION corredponding to the 242-tone RU that is most closely aligned with that 20 MHz subchannel. **(#16723)**

**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. 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. 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. **(#16723)**

**28.3.4 HE PPDU formats**

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

The HE NDP PPDU has the following properties:

— Uses the HE SU PPDU format but without the Data field

— Has a Packet Extension field that is 4 s in duration

The preamble tones overlapping the 242 RUs corresponding to bits with a value of 0 in the bitmap of the TXVECTOR parameter INACTIVE\_SUBCHANNELS or overlapping a punctured center 26 RU of an HE NDP PPDU are punctured. The center 26-tone RU of the HE NDP PPDU 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**

dot11PuncturedSoundingOptionImplemented OBJECT-TYPE **(#16723)**

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-RUs 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.**