IEEE P802.11  
Wireless LANs

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| --- | --- | --- | --- | --- |
| LB188 Operating Mode Comment Resolution | | | | |
| Date: 2012-07-17 | | | | |
| Author(s): | | | | |
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Abstract

This document proposes resolutions for the following CIDs:

6437, 6395, 6671, 6672, 6150, 6148, 6153, 6149, 6004, 6308, 6066, 6151, 6152, 6309

CIDs with Resolution in RED need more discussion.

Editing instructions based on P802.11ac/D3.0.

# Revision History

r0 initial revision

r1 Fixes based on discussion ad f2f. Should statements for AP on how to notify STAs of bandwidth and Nss changes

r2 Additional statement that constrains the max Nsts that a STA can transmit after receiving OMN

# Comment

|  |  |  |  |  |  |  |
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| **CID** | **Page** | **Line** | **Clause** | **Comment** | **Proposed Change** | **Resolution** |
| 6437 | 65.58 |  |  | The Operating Mode field is used in both the Operating Mode Notification frame and the Operating Mode Notification element | Wherever one is mentioned, also mention the other (65.58, 146.27, 147.22, 159.11 (but note the OM field does not have a "Supported Channel Width Set" subfield), 163.4 (also missing article soon after), 163.9, 163.25, 163.31, 163.37, 163.39, 323.33, 323.43). Also delete "Notification" at 163.14 | REVISED. Mention Operating Mode Notification element as suggested. Editing instructions in <this document>. Note that at 159.11, a new statement is added specific to Operating Mode Notification that also covers Nss (statement moved to 10.41). The two notes at 163.25-163.39 remain unchanged (discussing only the Operatring Mode Notification frame). At 323.33 and 323.43 also add reference to 8.4.2.168. |

# Comments on 8.4.1.50 Operating Mode field

|  |  |  |  |  |  |  |
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| **CID** | **Page** | **Line** | **Clause** | **Comment** | **Proposed Change** | **Resolution** |
| 6395 | 65.60 | 60 | 8.4.1.50 | Text in 8.4.1.50 says "Operating Mode field is used to indicate the number of spatial streams and optionally the operating channel width on which the sending STA is able to receive" .However,bandwidth is not an optional field.Sending STA could change Nss,or BW ,or both by sending this field. | Suggest to revise the description of the Operating Mode field. Refer to 8.5.23.4 (Operating Mode Notification frame format):"It is used to notify STAs that the transmitting STA is changing its operating channe l width, the maximum number of spatial streams it can receive, or both." | REVISED. Removed the text describing the use of this field; keep only the statement about the frame and element in which it is used. The description of the frame and the element can indicate where these are used. Also delete: “When Rx Nss Type subfield is 1, only the Rx Nss subfield  has a non-reserved value. The length of the field is 1 octet.”. Editing instructions in <this document>. |
| 6671 | 65.61 | 61 | 8.4.1.50 | "The Operating Mode field is used in the Operating Mode Notification frame (see 8.5.23.4 (Operating Mode Notification frame format)) to indicate the number of spatial streams and optionally the operating channel  width on which the sending STA is able to receive." what about the Mode Notification element? | add that it is also used in the correspondig element. | ACCEPTED. See #6437. |
| 6672 | 66.31 | 31 | 8.4.1.50 | "Reserved if the Rx Nss subfield is 1". | "Reserved if the Rx Nss TYPE subfield is 1" | Revised. Replace “Rx Nss” with “Rx Nss Type” at the cited location. |

# Discussion

Changes reflected in the “Editing Instructions” section below.

# Comment on TDLS

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| **CID** | **Page** | **Line** | **Clause** | **Comment** | **Proposed Change** | **Resolution** |
| 6150 | 162.50 | 50 | 10.39.5 | Operation mode notification should also extended to TDLS setup frames to allow operation mode notification during TDLS setup procedure which is similar to association procedure. | Add the support of operation mode notification during TDLS setup procedure. | REVISED. As suggested, editing instructions in <this document>. |

# Discussion

The proposal here is to include the Operating Mode Notification element in the TDLS Setup Response and TDLS Setup Confirm frames. On receiving the TDLS Setup Request the destination STA knows whether or not the source STA is operating mode notification capable and can thus add the Operating Mode Notification element to the TDLS Setup Response frame. Similarly, on receiving the TDLS Setup Response the source STA knows whether or not the destination is operating mode notification capable and can thus optionally add the Operating Mode Notification element to the TDLS Setup Confirm frame.

# Editing Instructions

* TDLS Action frame details
* TDLS Setup Request frame format

Insert rows for Order 19 and 20 in Information for TDLS Setup Request frame as follows:

* Order 1 to 17 in 802.11-2012, none in P802.11ae, none in P802.11aa, +1 in P802.11ad

|  |  |  |
| --- | --- | --- |
| * Information for TDLS Setup Request frame | | |
| Order | Information | Notes |
| 19 | AID | The AID element(#4342) of the STA sending the frame is present if dot11VHTOptionImplemented (#4028)is true. |
| 20 | VHT Capabilities | The VHT Capabilities element is present if dot11VHTOptionImplemented (#4028)is true. |

* TDLS Setup Response frame format

Insert rows for Order 19 and 20 in Information for TDLS Setup Response frame as follows:

* Order 1 to 18 in 802.11-2012, none in P802.11ae, none in P802.11aa, +1 in P802.11ad

|  |  |  |
| --- | --- | --- |
| * Information for TDLS Setup Response frame | | |
| Order | Information | Notes |
| 20 | AID | The AID element(#4342) of the STA sending the frame is present if dot11VHTOptionImplemented (#4028)is true. |
| 21 | VHT Capabilities | The VHT Capabilities element is present if the dot11VHTOptionImplemented (#4028)is true. |
| 22 | Operating Mode Notification | The Operating Mode Notification element is optionally present if the TDLS Setup Request frame contained an Extended Capabilities element with the Operating Mode Notification field equal to 1. |

* TDLS Setup Confirm frame format

Insert a row for Order 11 in Information for TDLS Setup Confirm frame as follows:

|  |  |  |
| --- | --- | --- |
| * Information for TDLS Setup Confirm frame | | |
| Order | Information | Notes |
| 11 | VHT Operation | VHT Operation element (optional). The VHT Operation element is present if the dot11VHTOptionImplemented (#4028)is true, the TDLS Setup Response frame contained a VHT Capabilities element, the status code is 0 (Successful), and the BSS does not support VHT. The VHT Operation element is defined in 8.4.2.160. |
| 22 | Operating Mode Notification | The Operating Mode Notification element is optionally present if the TDLS Setup Response frame contained an Extended Capabilities element with the Operating Mode Notification field equal to 1. |

* TDLS Channel Switch Request frame format

Insert a rows for Orders 8, 9 and 10 in Information for TDLS Channel Switch Request frame as follows:

|  |  |  |
| --- | --- | --- |
| * Information for TDLS Channel Switch Request frame | | |
| Order | Information | Notes |
| 8 | Wide Bandwidth Channel Switch | Wide Bandwidth Channel Switch element (optional). The Wide Bandwidth Channel Switch element is included when a switch to an 80 MHz, 160 MHz or 80+80 MHz direct link is indicated. See **Error! Reference source not found.**. |
| 9 | Country | Country element (optional). The Country element is included to change operating classes when a switch to a direct link is indicated. The Country element indicates the same country as the BSS and includes zero Subband Triplet fields.(#4252) |
| 10 | VHT Transmit Power Envelope | VHT Transmit Power Envelope element (optional). The VHT Transmit Power Envelope element is included for TPC when a switch to a direct link is indicated.(#4252) |

# Comments on 10.39.5 Notification of operating mode changes

|  |  |  |  |  |  |  |
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| **CID** | **Page** | **Line** | **Clause** | **Comment** | **Proposed Change** | **Resolution** |
| 6148 | 162.50 | 50 | 10.39.5 | 10.39.5 is under VHT operation. A HT STA/AP can't use it. | Move the subclause under clause 10. | REVISED. Move to new subclause 10.41 |
| 6153 | 162.50 | 50 | 10.39.5 | The current protocol can't support broadcasting Operating Mode Notification element/frame in a BSS with VHT/HT STAs. | Fix the problem. | REJECTED. The commenter has not identified a problem or at least is not being specific enough about a problem that may exist. The Operating Mode Notification element may be carried in a broadcast frame (such as the Beacon). |
| 6149 | 162.58 | 58 | 10.39.5 | It is "Operating Mode Notification" in Extended Capabilities IE to notify the other STAs that the STA is operating mode notification capable of a change in its operating mode. | Change the sentence accordingly. | REVISED. Add a sentence to the previous paragraph to define operating mode notification capable: “A STA that has the Operating Mode Notification field in the Extended Capabilities element equal to 1 is referred to as operating mode notification capable.”. Editing instructions in <this document>. |
| 6004 | 162.60 | 60 | 10.39.5 | The Operating Mode Notification element should be contained in Mesh Peering Open/Confirm frames. | Replace "the Operating Mode Notification element in the Beacon, Probe Response, Association Request, Association Response, Reassociation Request, or Reassociation Response frames." with "the Operating Mode Notification element in the Beacon, Probe Response, Association Request, Association Response, Reassociation Request, Reassociation Response, Mesh Peering Open, and Mesh Peering Confirm frames." | REVISED. As suggested. Also add associated rows to Table 8-262 and 8-263. |
| 6308 | 162.60 | 60 | 10.39.5 | Many AP implementers reading this and following this as written will be startled to discover that many STAs didn't notice the operating mode change - because many clients sleep for 2 sec routinely, and sometimes longer. So just putting it in a Beacon is little help; need to put it in a bunch of beacons. Then the NOTE 1 at P163L25 is helpful - but is constrained to apply to \*individually\* addressed frames only | Need a bunch of language - "should be included in every beacon until the AP expects all clients to have received it .. (then paraphrasing note 2) An AP should widen its BW immediately upon first OMN element inclusion in the beacon, but narrow its BW only after last OMN element inclusion in the Beacon" | REVISED. Add statements to the effect that the OMN element be included in Beacon frames for a period sufficiently long that STAs in PS mode receive notification. Editing instructions in <this document>. |
| 6066 | 163.01 | 1 | 10.39.5 | "A STA shall not transmit a frame that contains the Operating Mode field to one or more STAs unless all intended receiving STAs"  1. The word "intended" is ambiguous in this normative statement. Better to make the requirement unambiguous. In particular, what is the requirement on an AP inserting this element in its beacon?  2. What is the interaction between this and the 802.11n Notify Channel Width frame? If the AP uses the Operating Mode field to indicate a 20 MHz reduced operating width, the Notify Channel Width should be used to convey the same information. | 1. Replace "intended receiving STAs" with explicit rules for the following cases: transmission by AP; transmission by non-AP, non-mesh; transmission by mesh.  These rules may also be dependent on the contents. So, for example, a reduction in N\_SS by an AP should only be possible when all STA in the BSS support this capability, but a reduction in channel width from 80 to 40 should require nothing explicit, because all STAs affected by this change are capable of interpreting this field.    2. Add rules for consistency of notified operating width with notifications using the 802.11n Notify Channel Width frame. | REVISED. Modify the cited statement so that it refers specifically to individually addressed frames. Add “should” statements listing the mechanisms by which an AP notifies associated STAs of changes in max N\_SS and operating channel width. Editing instructions in <this document>. |
| 6151 | 163.04 | 4 | 10.39.5 | An AP can use Operating Mode Notification element/frame to notify the temporary channel width that it uses. STA Channel Width subfield in the HT Operation element is the permanent channel width of the BSS. These two should not be always the same. | Change to "An HT AP that is not a VHT AP that transmits the Operating Mode Notification element shall not set the value of the Channel Width subfield in Operating Mode field wider than the channel width as the STA Channel Width subfield in the HT Operation element." | REJECTED. The group feels that the AP operating channel width should be the same as the BSS operating channel width. If the AP changes one it should change the other. |
| 6152 | 163.09 | 9 | 10.39.5 | An AP can use Operating Mode Notification element/frame to notify the temporary channel width that it uses. Channel Width subfield in the VHT Operation element is the permanent channel width of the BSS. These two should not be always the same. | Change to "A VHT AP that transmits the Operating Mode Notification element shall set the value of the Channel Width subfield in the Operating Mode field to indicate the same channel width as the Channel Width subfield in the VHT Operation element and STA Channel Width subfield in the HT Operation element (see Table 10-19)" | REJECTED. The group feels that the AP operating channel width should be the same as the BSS operating channel width. If the AP changes one it should change the other. |
| 6309 | 163.39 | 39 | 10.39.5 | Note 2 provides help for a non-AP STA, but an AP can send this too - need some help for APs too! | As in comment | REVISED. More detailed statements are added through CID 6066 on how APs notify associated STAs of operating mode changes. Editing instruction in <this document>. |

# Discussion

The use of operating mode notification between to individual non-AP STAs or between a non-AP STA and its AP is straightforward; an individually addressed frame is used:

* Operating Mode Notification frame
* Association Response frame
* TDLS Confirm frame

The use by the AP is more complicated. This has problems in the following areas:

1. Relationship to other elements/frames that perform a similar function:
   1. [Extended] Channel Switch Announcement
   2. HT and VHT Operation elements
2. Protocol issues
   1. How to ensure sleeping STAs are notified

One question is why do we need APs to support this frame/element?

Many APs are now battery powered, e.g, soft APs in handhelds, Wi-Fi Direct GOs. Operating mode notification is a power save technique where a STA adjusts its operating mode (Rx Nss, channel width) to match performance needs.

Overlap with HT and VHT Operation elements: These elements already provide operating channel width. There was confusion here: is this the BSS operating channel width or the AP’s operating channel width? It seems we have settled on it meaning both, i.e. it is the BSS operating channel width, but the AP has to operate with the same channel width. And what about TDLS peers? They are required to follow the BSS operating channel width unless they are off-channel. This means that if the AP changes its operating channel width, the BSS operating channel width changes which could limit TDLS performance.

The HT/VHT Operation elements do not allow the AP to modify its active receive chains. The Operating Mode field is the only way to do this.

# Editing Instructions

* (#5096)Operating Mode field

The (#5096)Operating Mode field is present in the (#5096)Operating Mode Notification frame (see 8.5.23.4) and Operating Mode Notification element (see 8.4.2.168)(#6437). (#6395)

The (#5096)Operating Mode field is shown in Figure 8-80e(#5096).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | B0 B1 | B2 B3 | B4 B6 | B7 |
|  | Channel Width | Reserved | Rx Nss | Rx Nss Type |
| Bits: | 2 | 2 | 3 | 1 |
| * (#5096)Operating Mode field(#4911) | | | | |

The STA transmitting this field indicates its current operating channel width and the number of spatial streams it can receive using the settings defined in Subfield values of the .

|  |  |
| --- | --- |
| * Subfield values of the (#5096)Operating Mode field | |
| Subfield | Description |
| Channel Width | If the Rx Nss Type subfield(#4911) is 0, indicates the supported channel width:  Set to 0 for 20 MHz  Set to 1 for 40 MHz  Set to 2 for 80 MHz  Set to 3 for 160 MHz or 80+80 MHz  Reserved if the Rx Nss Type(#6672) subfield(#4911) is 1. |
| Rx Nss | If the Rx Nss Type subfield(#4911) is 0, indicates the maximum number of spatial streams that(#4308) the STA can receive.  If the Rx Nss Type subfield(#4911) is 1, indicates the maximum number of spatial streams that(#4308) the STA can receive as a beamformee in an SU PPDU using a beamforming steering matrix derived from a VHT Compressed Beamforming report(#4667) with Feedback Type subfield indicating MU in the VHT Compressed Beamforming frame(s).(#4911)(#4667)  Set to 0 for *NSS* = 1  Set to 1 for *NSS* = 2  …  Set to 7 for *NSS* = 8 |
| Rx Nss Type | Set to 0 to indicate that the Rx Nss subfield carries the maximum number of spatial streams that(#4308) the STA can receive.  Set to 1 to indicate that the Rx Nss subfield carries the maximum number of spatial streams that(#4308) the STA can receive as an SU PPDU using a beamforming steering matrix derived(#4911) from a VHT Compressed Beamforming frame with the Feedback Type subfield indicating MU in the VHT Compressed Beamforming frame(s).(#4029)(#4667) |

(#4030)

* Operating Mode Notification element(#5096)

The Operating Mode Notification element is used to notify STAs that the transmitting STA is changing its operating channel width, the maximum number of spatial streams it can receive, or both. The format of the Operating Mode Notification element is defined in Operating Mode Notification element.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Element ID | Length | Operating Mode |
| Octets: | 1 | 1 | 1 |
| * Operating Mode Notification element | | | |

The Operating Mode field is defined in Operating Mode field.

* (#5096)Operating Mode Notification frame format

The (#5096)Operating Mode Notification frame is an Action frame of category VHT. It is used to notify STAs that the transmitting STA is changing its operating channel width, the maximum number of spatial streams it can receive, or both.(#4355)

The Action field of the (#5096)Operating Mode Notification frame contains the information shown in Table 8-281ak(#5096).

|  |  |
| --- | --- |
| * (#5096)Operating Mode Notification frame Action field format | |
| Order | Information |
| 1 | Category |
| 2 | VHT Action |
| 3 | (#5096)Operating Mode (see Operating Mode field) |

The Category field is set to the value for VHT, specified in **Error! Reference source not found.**.

The VHT Action field is set to the value for (#5096)Operating Mode Notification, specified in **Error! Reference source not found.**.

* VHT sounding protocol

***Change the paragraph following Figure 9-41b as follows:***

A VHT beamformer(#4432) that sets the Feedback Type subfield of a STA Info field to 1 shall set the Nc Index subfield of the same STA Info field to a value equal to(#4544) or less than the minimum of the following:

* the maximum number of supported spatial streams according to the corresponding VHT beamformee(#4432)'s Rx MCS Map(#4840) in the VHT Supported MCS Set(#4840) field, or
* the maximum number of supported spatial streams according to the Rx Nss subfield value in the Operating Mode field(#4707) of the most recently received (#5096)Operating Mode Notification frame or Operating Mode Notification element(#6437) with the Rx Nss Type subfield equal to 0 from the corresponding VHT beamformee(#4432).(#4911)

(#4667)

***Change the following paragraph:***

A VHT beamformee(#4432) shall transmit(#4543) a VHT Compressed Beamforming frame with the VHT MIMO Control Feedback Type field set to the same value as the Feedback Type field in the corresponding STA Info field in the VHT NDP Announcement(#4921) frame. If the Feedback Type field indicates MU, the STA shall send a feedback with the Nc Index field value in the VHT MIMO Control field equal to the minimum of the following:

* the Nc Index field value in the corresponding STA Info field in the VHT NDP Announcement(#4921) frame, or
* the maximum number of supported spatial streams according to its Rx MCS Map in the VHT Supported MCS Set field, or
* the maximum number of supported spatial streams according to its Rx Nss subfield value in the VHT Operation Mode field of the most recently transmitted Operating Mode Notification frame or Operating Mode Notification element(#6437).(#4439)
* VHT BSS operation
* Basic VHT BSS functionality

The STA that is creating the BSS shall be able to receive and transmit at each of the MCS values listed in the VHTBSSBasicMCSSet and VHTOperationalMCSSet.(#4016)

A STA that has a value of true for dot11VHTOptionImplemented shall set dot11HighThroughputOptionImplemented to true.(#5021)

A VHT AP and a VHT mesh STA declare their(#4680) channel width capability (#5018)in the Supported Channel Width Set subfield of the VHT Capabilities element VHT Capabilities Info field(#4707) as described in Table 8-183u.

(#5025)A VHT STA shall set the Supported Channel Width Set subfield in its HT Capabilities element HT Capabilities Info field(#4707) to 1, indicating that both 20 MHz operation and 40 MHz operation are supported.

A VHT STA sets the Rx MCS Bitmask of the Supported MCS Set field of its HT Capabilities element according to the setting of the Rx MCS Map subfield of the VHT Supported MCS Set field of its VHT Capabilities element as follows: for each subfield Max MCS For *n* SS, , of the Rx MCS Map field with a value other than 3 (no support for that number of spatial streams), the STA shall indicate support for MCSs 8(*n*-1) to 8(*n*-1)+7 in the Rx MCS Bitmask, where *n* is the number of spatial streams.

A VHT AP and a VHT mesh STA(#4680) shall set the STA Channel Width subfield in the HT Operation element HT Operation Information field and the Channel Width subfield in the VHT Operation element VHT Operation Information field(#4707) to indicate the BSS operating channel width as shown in VHT BSS operating channel width.

|  |  |  |
| --- | --- | --- |
| * VHT BSS operating channel width | | |
| HT Operation element STA Channel Width field | VHT Operation element Channel Width field | BSS operating channel width |
| 0 | 0 | 20 MHz |
| 1 | 0 | 40 MHz |
| 1 | 1 | 80 MHz |
| 1 | 2 | 160 MHz |
| 1 | 3 | 80+80 MHz |

A VHT STA shall determine the channelization using the combination of the information in the HT Operation element Primary Channel field and the VHT Operation element VHT Operation Information field Channel Center Frequency Segment 0(#4322) and Channel Center Frequency Segment 1(#4322) subfields (see 22.3.14 (Channelization

)).(#4707)

A VHT AP shall set the HT Operation element HT Operation Information field Secondary Channel Offset subfield as appropriate to the secondary 20 MHz channel, if the BSS operating channel width is more than 20 MHz.(#4707)

A VHT STA that is a member of a VHT BSS shall not transmit a 20 MHz VHT PPDU on a channel other than the primary 20 MHz channel of the BSS, except for a 20 MHz VHT PPDU transmission on an off-channel TDLS direct link.

A VHT STA that is a member of a VHT BSS with a 40 MHz, 80 MHz, 160 MHz or 80+80 MHz operating channel width shall not transmit a 40 MHz VHT PPDU that does not use the primary 40 MHz channel of the BSS, except for a 40 MHz VHT PPDU transmission on an off-channel TDLS direct link.

A VHT STA that is a member of a VHT BSS with an 80 MHz, 160 MHz or 80+80 MHz operating channel width shall not transmit an 80 MHz VHT PPDU that does not use the primary 80 MHz channel of the BSS, except for an 80 MHz VHT PPDU transmission on an off-channel TDLS direct link.

A VHT STA that is a member of a VHT BSS with a 160 or 80+80 MHz operating channel width shall not transmit a 160 or 80+80 MHz VHT PPDU that does not use the primary 80 MHz channel and the secondary 80 MHz channel of the BSS, except for a 160 or 80+80 MHz VHT PPDU transmission on an off-channel TDLS direct link.(#5022)

A VHT STA shall not transmit to a VHT STA using a bandwidth that is not indicated as supported in the Supported Channel Width Set subfield in(#4707) the HT Capabilities element or VHT Capabilities element received from that VHT STA.

Except in the case of a TDLS off-channel direct-link (which is independently constrained by 10.22.6.3), a STA shall not transmit a PPDU with a TXVECTOR parameter CH\_BANDWIDTH indicating a channel bandwidth that is wider than the BSS operating channel width.

A VHT AP announces a switch of operating channel, operating bandwidth or both, by either

* using the Channel Switch Announcement Element, Channel Switch Announcement Frame or both, following the procedure described in 10.9.8.2 (Selecting and advertising a new channel in an infrastructure BSS)
* using the Extended Channel Switch Announcement Element, Extended Channel Switch Announcement Frame or both, following the procedure described in 10.10 (Extended channel switching (ECS))

and, in addition, following the procedures in this section.

A VHT mesh STA announces a switch attempt of operating channel, operating bandwidth or both, by either

* using the Channel Switch Announcement element, Channel Switch Announcement frame or both, following the procedure described in 10.9.8.4 (MBSS channel switching)
* using the Extended Channel Switch Announcement element, Extended Channel Switch Announcement frame or both, following the procedure described in 10.10 (Extended channel switching (ECS)) and in addition following the procedures in this section.(#4680)

A VHT AP can also announce a new Country string (including a new Operating Table index), new operating classes or new TPC parameters for the BSS that come into effect at the same time as the switch of operating channel, operating bandwidth, or both.(#4252)

The New Channel Number field in the Channel Switch Announcement Element, Extended Channel Switch Announcement Element, Channel Switch Announcement Frame or Extended Channel Switch Announcement Frame, identifies the primary 20 MHz channel after the switch. The value of the New Channel Number field is set equal to dot11CurrentPrimaryChannel (see 22.3.14 (Channelization)) after the switch.

When announcing a switch to a 20 MHz operating bandwidth using the Channel Switch Announcement element in a frame, then neither a Wide Bandwidth Channel Switch element, a Wide Bandwidth Channel Switch subelement nor a Secondary Channel Offset element shall be present in the frame, excepting that a Secondary Channel Offset element may be present in a Channel Switch Annnouncement frame if the Secondary Channel Offset field within the Secondary Channel Offset element is set to SCN.(#4252)

When announcing a switch to a 20 MHz operating bandwidth using the Extended Channel Switch Announcement element in a frame or the Extended Channel Switch Announcement frame, then the Wide Bandwidth Channel Switch element shall not be present in the same frame.(#4252)

NOTE—A Secondary Channel Offset element is never present with the Extended Channel Switch Announcement element in a frame or in the Extended Channel Switch Announcement frame. Instead, the indicated operating class within the Extended Channel Switch Announcement element or frame identifies the BSS operating channel bandwidth.(#4252)

When announcing a switch to a 40 MHz operating bandwidth using the Channel Switch Announcement frame, then the Secondary Channel Offset Element shall be present in the frame.(#4252)

When announcing a switch to a 40 MHz operating bandwidth using the Channel Switch Announcement element in a Beacon or Probe Response frame, then the Wide Bandwidth Channel Switch subelement shall also be present in the Channel Switch Wrapper element in the same frame.(#4252)

When announcing a switch to a 40 MHz operating bandwidth using the Extended Channel Switch Announcement element in a Beacon or Probe Response frame, then the Wide Bandwidth Channel Switch subelement may be present in the Channel Switch Wrapper element in the same frame.(#4252)

NOTE—The indicated operating class within the Extended Channel Switch Announcement element or frame identifies the bandwidth and the relative position of the primary 20 MHz and secondary 20 MHz channels, hence a Channel Switch Wrapper element(#4252) is not required when the Extended Channel Switch Announcement element is used by itself(#4058).

When announcing a switch to a 80 MHz, 80+80 MHz or 160 MHz operating bandwidth using the Channel Switch Announcement frame, then both the Secondary Channel Offset element and the Wide Bandwidth Channel Switch element shall be present in the frame.(#4252)

When announcing a switch to a 80 MHz, 80+80 MHz or 160 MHz operating bandwidth using the Channel Switch Announcement element or Extended Channel Switch Announcement element, then a Wide Bandwidth Channel Switch subelement shall be present in the Channel Switch Wrapper element in the same frame as the Channel Switch Announcement element or Extended Channel Switch Announcement element respectively.(#4252)

When announcing a switch to a 80 MHz, 80+80 MHz or 160 MHz operating bandwidth using the Extended Channel Switch Announcement frame, then the Wide Bandwidth Channel Switch element shall be present in the frame.(#4252)

When announcing a switch to a 80 MHz, 80+80 MHz or 160 MHz BSS operating channel bandwidth using the Extended Channel Switch Announcement element or Extended Channel Switch Announcement frame, then a) the value of the New Operating Class field identifies the primary 40 MHz channel and b) the Operating Triplet fields within the New Country subelement or element respectively shall indicate all the operating class(es) for the switched BSS.(#4252)

When announcing new TPC parameters for the BSS, that come into effect at the same time as the switch, a VHT AP in a BSS, a VHT STA in an IBSS, and a mesh VHT STA in an MBSS shall include a) at least one New VHT Transmit Power Envelope element in a transmitted Channel Switch Announcement frame or Extended Channel Switch Announcement frame and b) at least one New VHT Transmit Power Envelope subelement in a transmitted Channel Wrapper element in Beacon and Probe Response frames. A receipient VHT STA in the BSS STA that has dot11SpectrumManagementRequired or dot11RadioMeasurementActivated equal to true and that maintains association with the BSS after the switch shall use the parameters in these received elements and subelements in the recipient STA's TPC calculations for the new operating channel and operating bandwidth (see 10.8 (TPC procedures)). If both New VHT Transmit Power Envelope elements and New VHT Transmit Power Envelope subelements are transmitted for the switch, the set of New VHT Transmit Power Envelope elements and set of subelements shall contain the same set of values for the Local Maximum Transmit Power Units Interpretation subfield, and New VHT Transmit Power Envelope elements and subelements that have the same value for the Local Maximum Transmit Power Units Interpretation subfield shall also have the same values for their other fields.(#4252)

When announcing a new Country string (including Operating Table index), new operating classes or both, that come into effect at the same time as the switch, a VHT AP in a BSS, a VHT STA in an IBSS, and a mesh VHT STA in an MBSS shall include a) a New Country element in a transmitted Extended Channel Switch Announcement frame and b) a New Country subelement in a transmitted Channel Wrapper element. The New Country element or subelement shall contain all the Operating Classes for the BSS after the switch. The New Country element or subelement, transmitted in an Extended Channel Switch Announcement frame or in the same frame as an Extended Channel Switch Announcement element respectively, shall include one Operating Triplet field that contains the same Operating Class as the New Operating Class field in the Extended Channel Switch Announcement frame or Extended Channel Switch Announcement element. A recipient VHT STA in the BSS STA that has dot11MultiDomainCapabilityActivated, dot11SpectrumManagementRequired or dot11RadioMeasurementActivated equal to true and that maintains association with the BSS after the switch shall use the parameters in these received elements and subelements in order to maintain regulatory compliance. If both New Country elements and New Country subelements are transmitted for the switch, their fields shall be the same.(#4252)

A Channel Switch Wrapper element shall not be included in Beacons and Probe Responses if the element contains zero subelements.(#4252)

NOTE - Channel Switch Wrapper is not defined to carry subelements in the case of a switch to 20 MHz and when no change to the Country string, operating classes or TPC parameters are announced.(#4252)

A VHT STA uses the VHT Transmit Power Envelope element only for TPC of 80 MHz, 160 MHz and(Ed) 80+80 MHz transmissions. A VHT STA shall include zero Subband Triplet fields in a Operating/Subband Sequence field in the Country element of an 80, 160 or 80+ MHz Operating Class.(#4252)

* I can’t discern the intended meaning of the following paragraph to correct grammar; quoted verbatim from resolution to #4252.

A STA that advertises a channel switch using one or more Channel Switch Announcement frames or elements, Extended Channel Switch Announcement frames or elements or a , includes a New Country subelement, Wide Bandwidth Channel Switch subelement or a New VHT Transmit Power Envelope subelement in a Channel Wrapper.(#4252)

When switching the BSS to a lower operating bandwidth, the AP may recalculate the TS bandwidth budget and may delete one or more active TSs by invoking the MLME-DELTS.request primitive with a ReasonCode value of SERVICE\_CHANGE\_PRECLUDES\_TS.

A VHT STA that is a member of an IBSS adopts the values indicated by the Secondary Channel Offset Element and Wide Bandwidth Channel Switch element in received frames according to the rules in 10.1.5 (Adjusting STA timers) and shall not transmit a value for the Wide Bandwidth Channel Switch Element and Secondary Channel Offset Element that differs from the most recently adopted value.

The use of RIFS in a VHT BSS is not allowed. A VHT AP shall set the RIFS Mode field in the HT Operation element to 0.

***Move this subclause to 10.41***

10.41 Notification of operating mode changes(#5096)

A STA that has the value true for dot11OperatingModeNotificationImplemented shall set the Operating Mode Notification field in the Extended Capabilities Element to 1. A VHT STA shall set dot11OperatingonModeNotificationImplemented to true. A STA that has the Operating Mode Notification field in the Extended Capabilities element equal to 1 is referred to as operating mode notification capable.(#6149)

A STA notifies other STAs that are operating mode notification capable of a change in its operating mode using the Operating Mode Notification frame or by including the Operating Mode Notification element in the Beacon, Probe Response, Association Request, Association Response, Reassociation Request, Reassociation Response, TDLS Setup Response, TDLS Setup Confirm,(#6150) Mesh Peering Open or Mesh Peering Confirm(#6004) frames. The Operating Mode field in the Operating Mode Notification frame or the Operating Mode Notification element is set to indicate that the STA is capable of receiving frames with a bandwidth up to and including the indicated channel width and with a number of spatial streams up to and including the indicated Rx Nss.

A STA shall not transmit an individually addressed frame that contains the Operating Mode field unless the recipient STA is operating mode notification capable.(#6066)

An AP should notify associated STAs of a change in the maximum number of space-time streams it is able to receive through one or more of the following mechanisms(#6066)

* using individually addressed Operating Mode Notification frames
* including the Operating Mode Notification element in Beacon frames for a period of time that ensures that STAs in PS mode will receive the notification(#6308)
* using the SM power save mechanism defined in 10.2.4 for HT STAs that are not operating mode notification capable

The notification should occur prior to a decrease in the maximum number of space-time streams and following an increase in the maximum number of space-time streams.

NOTE—An AP that is reducing the maximum number of space-time streams the AP is able to receive and that has associated HT STAs that are not operating mode notification capable would use the SM power save mechanism to notify the STAs that the AP is operating with a single receive chain.

An AP should notify associated STAs of a change in its operating channel width through one or more of the following mechanisms(#6066)

* using the Channel Switch Announcement element, Channel Switch Announcement frame or both following the procedure defined in 10.9.8.2 (Selecting and advertising a new channel in an infrastructure BSS))
* using the Extended Channel Switch Announcement Element, Extended Channel Switch Announcement Frame or both, following the procedure described in 10.10 (Extended channel switching (ECS))
* using individually addressed Operating Mode Notification frames
* using the STA Channel Width field in the HT Operation element and/or Channel Width field in the VHT Operation element

An HT AP that is not a VHT AP that changes its operating channel width shall indicate the new operating channel width in the STA Channel Width field in the HT Operation element. A VHT AP that changes its operating channel width shall indicate the new operating channel width in the Channel Width field in the VHT Operation element and STA Channel Width field in the HT Operation element (see Table 10-19).

An AP shall not include the Operating Mode Notification element in Beacon, Probe Response, Association Response and Reassociation Response frames when not changing the maximum number of space-time streams the AP is able to receive.

A STA shall not transmit an (#5096)Operating Mode field(#6437)(#4707) with the value of the Rx Nss subfield indicating a number of spatial streams not supported by the STA, as reported in any Supported Rates element, Extended Supported Rates element, Supported MCS Set or VHT Supported MCS Set field in management frames transmitted by the STA.(#4306)

A STA shall not transmit an (#5096)Operating Mode field(#4707) with the value of the Channel Width subfield indicating a bandwidth not supported by the STA, as reported in the Supported Channel Width Set subfield in the HT Capabilitites Info field or the VHT Capabilities Info field in management frames transmitted by the STA.

A STA that is operating mode notification capable shall not transmit a PPDU to a STA that uses a bandwidth that is greater than the channel width indicated in the most recently received Operating Mode Notification element or Operating Mode Notification frame from that STA. A STA that is operating mode notification capable shall not transmit a PPDU to a STA that uses a greater number of space-time streams than indicated in the most recently received Operating Mode Notification element or Operating Mode Notification frame received from that STA.(#6437) (#4306)

NOTE 1—To avoid possible frame loss, a VHT STA that sends an individually addressed (#5096)Operating Mode Notification frame to a second VHT STA indicating reduced operating channel bandwidth and/or reduced Rx Nss can continue with its current operating channel bandwidth and Rx Nss until it infers that the second STA has processed this notification. It might make this inference as follows:

* By receiving a frame addressed to itself from the second VHT STA in a PPDU with a bandwidth and *NSS* that are equal to or less than the channel bandwidth and *NSS*, respectively, indicated in the (#5096)Operating Mode Notification frame, or
* Based on the passage of time in some implementation dependent way, which is outside the scope of this standard.

NOTE 2—It might take a long time for a STA to change its operating mode following the transmission of the (#5096)Operating Mode Notification frame and during that time the STA might(#4185) not be able to receive frames resulting in frame loss. If a non-AP STA cannot tolerate frame loss during that period it can set the Power Management subfield of the Frame Control field(#4707) of the Operating Mode Notification frame to 1 to indicate that the STA has entered power save. When the non-AP STA has completed its operating mode change, it can send another frame (such as a QoS Null) with the Frame Control Power Management subfield set to 0 to indicate that the STA has exited power save.

* VHT MAC features

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| --- | --- | --- | --- | --- |
| Item | Protocol capability | References | Status | Support |
| VHTM12 | (#5096)Operating Mode Notification |  |  |  |
| VHTM12.1 | Transmission of (#5096)Operating Mode Notification frame and Operating Mode Notification element(#6437) | 8.5.23.4 (Operating Mode Notification  frame format), 8.4.2.168, 10.39.5 (Notification of operating mode changes) | CF29:O | Yes  No  N/A  |
| VHTM12.2 | Reception of (#5096)Operating Mode Notification frame and Operating Mode Notification element(#6437) | 8.5.23.4 (Operating Mode Notification  frame format), 8.4.2.168, 10.39.5 (Notification of operating mode changes) | CF29:M | Yes  No  N/A  |