IEEE P802.11  
Wireless LANs

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| 11ac Sounding protocol | | | | |
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Abstract

This document provides resolution for the comments listed below

Comments are from: 11-11-0276-00-00ac-tgac-d0-1-comments.xls

Comments refer to: Draft P802.11ac\_D0.1.pdf

Changes in the text refer to: Draft P802.11ac\_D0.1.pdf

**Comments**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 160 | 9.21.5 | 57 | 2 | TR | If the NDPA frame and VHT Compress Beamforming frames are sent in non VHT legacy format, the sounding sequence defined in this subclause can provide protection against hidden nodes. | Define a mechanism where sounding and protection can be provided at the same time to improve efficiency. | Modified  (Simone)  According to other comments, description in NDPA section defines the setting for the Duration field | MU |
| 170 | 9.21.5 | 57 | 13 | TR | You define how to decide SU Beamformer/Beamformee Capability field in a STA. But the Mu TX/RX (MU beamformer/beamformee ) is missing. | add the text accordingly. | Agree. Added text (Simone) | MU |
| 1423 | 9.21.5 | 57 | 1 | TR | Cluase 9.21.5 VHT sounding protocol needs some more clarification on the transmission of NDPA, NDP, and VHT compressed beamforming; that is, non-HT duplicate form, Reporting management under interference in secondary channels, etc. | Define clear behavior. | Deferred resolution | MU |
| 1466 | 9.21.5 | 57 | 42 | TR | bandwidth of poll frames is not clear, and bandwidth of responses to the poll frame is also not clear | clarify | Deferred resolution | MU |
| 784 | 9.21.5 | 57 | 42-53 | TR | Why using AP instead of beamformer here? Can a non-AP beamformer send a NDPA with multiple STA info fields? | clarify that a non-AP beamformer can only send a NDPA with a single STA info field and using a unicast NDPA | Modify.  Used beamformer instead of AP. Non-AP can also send NDPA with multiple STA Info field, there is no reason to impose a limit (Simone) | MU |
| 803 | 9.21.5 | 57 | 1 | TR | Sub-clause 22.3.13 states that NDP is the only VHT sounding format. The use of sounding poll as shown in Figure 9.37b violates this rule | In Figure 9.37b, replace the sounding poll frames with NDPs | Disagree  Sounding poll is used for solicit sounding FBs, not for sounding purpose. Don’t see why it violates the rule. (Yong) | MU  Statement need be modified to clarify that is refers to VHT only. Chenge name to sounding feedback poll. |
| 949 | 9.21.5 | 57 | 1 | TR | "A STA that has the value true for dot11VHTBeamformerEnabled shall set the SU Beamformer Capability field to 1 in transmitted VHT Capabilities elements. A STA that has the value true for dot11VHTBeamformeeEnabled shall set the SU Beamformee Capability field to 1 in transmitted VHT Capabilities elements. A STA that does not have the value true for dot11VHTBeamformerEnabled shall not act in the role of a beamformer. A STA that does not have the value true for dot11VHTBeamformeeEnabled shall not act in the role of a beamformee." dot11VHTBeamformeeEnabled is not defined anywhere | Add: A STA that has the value true for dot11VHTMUBeamformerEnabled shall set the MU Tx Capable field to 1 in transmitted VHT Capabilities elements. A STA that has the value true for dot11VHTMUBeamformeeEnabled shall set the MU Rx Capable field to 1 in transmitted VHT Capabilities elements.  A STA that does not have the value true for dot11VHTBeamformerEnabled or dot11VHTMUBeamformerEnabled shall not act in the role of a beamformer. A STA that does not have the value true for dot11VHTBeamformeeEnabled or dot11VHTBeamformeeEnabled shall not act in the role of a beamformee. | Agree in principle.  Modified text  (Simone) | MU |
| 950 | 9.21.5 | 57 | 1 | TR | The section should be consistently using the concept of beamformer and beamformee instead of AP and STA; the way it is currently written would even forbid a STA to STA SU TxBF; | change AP with beamformer and STA to beamformee when appropriate; | Agree (Simone) | MU |
| 952 | 9.21.5 | 57 | 42 | TR | "A beamformee that receives an NDPA from an AP to which it is associated and that contains the AID assigned it during association in the STA ID subfield of the first STA Info field shall [...]" this sentence is specific for AP to STA TXBF and would not allow STA to STA TxBF | Suggest to change to: "A beamformee that receives an NDPA from a beamformer to which it is associated or has a DLS or TDLS session setup and that contains the beamformee AID [...] " | Agree  Refer to suggested changes in the following  (Yong) | MU |
| 951 | 9.21.5 | 57 | 49 | TR | There are cases when the sounding feedback does not fit in a PPDU, due to exceeded duration; this can happen in case the Sounding Poll frame is sent with a BW smaller than the BW of the channel feedback included in the response frame; For this case it is useful that the beamformee responds with a short frame not containing the feedback; this is useful in enabling a more robust operation in case other frames need be sent subsequently (e.g. a poll foe another STA); it also provides the beamformee with the indication that STA is still within range and is active; | Propose to modify the paragraph as follows: "If the beamformee does not have a valid VHT Compressed Beamforming Report, of if the transmission duration of the VHT Compressed Beamforming Report frame would exceed the maximum PPDU duration, the beamformee shall transmit a VHT Compressed Beamforming frame without including the VHT Compressed Beamforming Report field or MU Exclusive Beamforming Report and indicating this in the VHT MIMO Control field as described in 7.3.1.31 (VHT MIMO Control field).G74 | Agree. (Simone)  As in comment  Need to clarify “If the beamformee does not have a valid VHT Compressed Beamforming Report”  Refer to suggested changed in the following  (Yong) | MU |
| 1079 | 9.21.5 | 57 | 1 | TR | In current specification, a Sounding Poll frame may include some additional fields to improve sounding procedures. The following is one suggestion for the usage of new fields. VHT Compressed Beamforming Report field can grow up to approximately 26Kbytes, which is larger than the maximum allowed MPDU limit for management frames. This makes a VHT Compressed Beamforming frame in the form of A-MPDU. Since each MPDUs in the A-MPDU can be checked with individual FCS whether the transmission is success or not, selective retransmission of only failed segments in the A-MPDU can considerably increase the transmission efficiency in sounding procedures. To support the selective retransmission of segments in VHT Compressed Beamforming frame, a new information field which indicates the transmission successes or failures of individual segments need to be added in a Sounding Poll frame. Upon the reception of the Sounding Poll frame which includes the segment information field, a STA may transmit all segments in the VHT Compressed Beamforming frame or transmit only the failed segments. This selective retransmission of segments is an optional feature. | Add an optional STA behavior to support the selective retransmission of segments in VHT Compressed Beamforming frame. | Agree. (Simone, Illsoo) | MU |
| 1080 | 9.21.5 | 57 | 1 | TR | In VHT sounding protocol, the specification is unclear on the relations of BWs of the frames; NDPA, NDP, VHT Compressed Beamforming, and Sounding Poll frames.  (a) What is the expected behavior of a STA when it does not have a valid channel information (e.g., due to interference) on some part of the BW for which channel information is requested by the beamforer? May the STA supposed to compute VHT Compressed Beamforming Report only using valid BW? (b) In the above case that a STA transmit may report VHT Compressed Beamforming Report on reduced BW than requested, what is the transmit BW of VHT Compressed Beamforming frame PPDU? (c) When the beamformer receives VHT Compressed Beamforming Report for only partial BW of requested BW, the beamformer needs to determine whether the BW of Sounding Poll frame to be the original value which is the same with that of NDPA/NDP or be the reduced BW as in the VHT Compressed Beamforming Report. (d) What is the expected behavior of a STA when the BW of the Sounding Poll frame is not equal to NDPA/NDP? Should a STA consider it to be detection error due to interference or to be beamformer's decision to reduce it? (e) When a STA is requested VHT Compressed Beamforming Report for only a partial BW of NDPA/NDP and the WM is idle for full BW of NDPA/NDP, may a STA transmit VHT Compressed Beamforming frame through NDPA/NDP BW to shorten the transmission time? | Clarify VHT sounding protocol. Some rules for specifiy BWs of NDPA, NDP, VHT Compressed Beamforming, and Sounding Poll frames are required. | Agree in principle  Same as CID 1466 (Yong) | MU |
| 1539 | 9.21.5 | 57 | 1 | TR | There can be an additonal field for Sounding Poll. Since VHT Compressed Beamforming Report may be segmented in some cases, selective retransmission of segmented Compressed Beamforming Report should make feedback process efficient. To support this retransmission procedure, a new field which indicates the segment information needs to be adopted in Sounding Poll frame. The selective retransmission of segments is an optional feature. | Describe an STA behavior to support the selective retransmission of segments in VHT Compressed Beamforming frame. This can be optional. | Agree. (Simone) | MU |
| 1540 | 9.21.5 | 57 | 1 | TR | During the sounding procedures, BW indications for measurement and transmission are clear. For example, what is the PPDU BW of the VHT Compressed Beamforming Report when there are NDPA decoding failur in some secondary channels? What is the BW of Sounding Poll when beamformer have received VHT Compressed Beamforming Report of only partial channel? etc. | Clarify BWs of NDPA, NDP, VHT Compressed Beamforming, and Sounding Poll frames. | Deferred resolution | MU |
| 1158 | 9.21.5 | 57 | 13 | TR | The description needs to be extended for MU Rx Capable and MU Tx Capable. Also, there is a dependency: an MU Rx Capable device is also SU Beamformee Capable. | Extend description | Agree  Refer to suggested changes in the following (Yong) | MU |
| 1160 | 9.21.5 | 57 | 49 | TR | Change "AP" to beamformer for consistency in description |  | Agree. (Simone) | MU |
| 1419 | 9.21.5 | 58 | 20 | TR | 9.x.x'. A reference index is missing. | Add the clause. | Modify.  Modified text  (Simone) | MU |
| 1420 | 9.21.5 | 58 | 42 | TR | TBD' is remained. | Complete 'TBD' | Modified. (Simone). The description is in the NDPA frame section, no need to repeat here | MU |
| 785 | 9.21.5 | 58 | 2 | TR | "the Nc field in the VHT MIMO Control field may be set to any value": this sentence is confusing | When the Feedback Type is set to SU, Nc is determined by the beamformee | Agree  (Yong) | MU |
| 1486 | 9.21.5 | 58 | 20 | TR | The reference of "poll-based recovery "should be stated clearly. | Upon failure to receive the feedback, the beamformer may initiate poll-based recovery as described in 9.x.x 9.9.1.4 (Multiple frame transmission in an EDCA TXOP) | Modified.  Adapted text  (Simone) | MU |
| 1487 | 9.21.5 | 58 | 58 | TR | The texts in Line58~65 present the same meaning as described in Line 55~59 in P57, and Line20 in P58. | Remove the following sentence from Line 58~65 in P58: A beamformer that has transmitted an NDPA with more than one STA Info field should transmit any Sounding Poll frames needed to retrieve the expected VHT Compressed Beamforming frames within the TXOP that contained the NDPA while giving priority in attempting to satisfy this recommendation to the rules of 9.9.1.4 (Multiple frame transmission in an EDCA TXOP). Recovery follows the rules for multiple frame transmission in an EDCA TXOP (9.9.1.4). | Agree. Removed (Simone) | MU |
| 1514 | 9.21.5 | 58 | 20 | TR | What poll-based recovery? What is 9.x.x intended to point at? | Give reference to where poll-based recovery is described. | Modified. (Simone) sentence was removed | MU |
| 957 | 9.21.5 | 58 | 45 | TR | "The RA in the NDPA frame shall be set to the address of the beamformee when sounding feedback is requested from a single beamformee": 'sounding feedback is requested from a single beamformee' may nt be clear; add reference to the indication in the frame | change to: "When a single STA Info field is included, the RA in the NDPA frame shall be set to the MAC address of the beamformee identified in the STA Info field" also paragraph starting at line 23 can be removed and replaced with "An SU only beamformee is a STA that, in its VHT Capability element, has set the SU Beamformee Capable field to 1 and the MU Rx Capable field to 0. When soliciting feedback from an SU only beamformee a single STA info field shall be included in the NDPA and the Feedback Type shall be set to SU" | Agree. (Simone) | MU |
| 958 | 9.21.5 | 58 | 49 | TR | "The RA field in the NDPA frame shall be set to the broadcast address when sounding feedback is requested from more than one beamformee" 'sounding feedback is requested from more than one beamformee' may nt be clear; add reference to the indication in the frame | change to: "The RA field in the NDPA frame shall be set to the broadcast address when more than one STA Info field is included in the NDPA" | Agree. (Simone) As in comment | MU |
| 1076 | 9.21.5 | 58 | 20 | TR | 9.x.x' needs a reference index. | Add the clause. | Modified. (Simone) Sentence removed | MU |
| 1077 | 9.21.5 | 58 | 42 | TR | TBD' needs to be erased if no other information is defined. | Either fill the TBD of erase TBD. | Agree. (Simone) removed sentence. | MU |
| 1111 | 9.21.5 | 58 | 12 | TR | Current spec allows for feedback of delayed CV (matching an old sequence number). This can impact MU performance. Will also complicate scheduler. MU users can return CVs that relate to different NDPs. Solution: limit sounding feedback to maximum aging. Aging can be given in ms. If after Poll the available CV exceeds aging limit, BFee returns a Null CV matrix. Aging parameter can be carried in either NDPA, Poll, GID management, or any other frame. Aging can be specific to a STA or to a GID | Limit sounding feedback to maximum aging | Disagree  BFmer can control the timing of BF FB from BFmee; if aging limit exceeds, BFmer may choose to resound, instead of polling for FB.  (Yong) | MU |
| 1112 | 9.21.5 | 58 | 12 | TR | Restrict BFee to always return sounding feedback of the latest NDP it received correctly. Otherwise we leave a backdoor for delayed response implementation, that would impair MU performance. Bfee can declare itself to be MU Receiver capable, but always return old CV matrix |  | Disagree  It is not necessary to have this restriction.  BFmer knows the seq number and timing of a FB frame, and can decide whether to use the FB information for beamforming | MU |
| 1192 | 9.21.5 | 58 | 43 | TR | "may include other information TBD."  And at 59.09 | resolve the TBD | Agree. (Simone) removed sentence. | MU |
| 1600 | 9.21.5 | 58 | 20 | TR | There is no "poll-based recovery" procedure defined in this draft. | add corresponding text for "poll-based recovery" | Agree. (Simone) removed sentence. NOTE explains and gives reference to appropriate section | MU |
| 1601 | 9.21.5 | 58 | 43 | TR | Is this still a TBD? | need discussion | Agree. (Simone) removed sentence. | MU |
| 1602 | 9.21.5 | 58 | 64 | TR | 9.9.1.4 does not really define a recovery procedure for MU case. | need discussion (TBD: check baseline document) | Agree. (Simone) removed sentence. | MU |
| 1422 | 9.21.5 | 59 | 9 | TR | The maximum number of segments of VHT Compressed Beamforming Report field is 7. | Correct 'TBD' to '7' | Modified. (Simone) indicated 8 segments | MU |
| 959 | 9.21.5 | 59 | 8 | TR | "If it would otherwise result in an MMPDU that exceeds the maximum MPDU size, the VHT Compressed Beamforming Report field may be split into up to TBD segments. Each segment shall contain an equal number of octets except for the last segment, which may be smaller. All segments shall be sent within the same A-MPDU." According to the text, MU Exclusive filed is not split across multiple segments; this would result in duplicated MU Exclusive field, increasing overhead. | Add indication of what to do with MU Exclusive report field: "If it would otherwise result in an MMPDU that exceeds the maximum MPDU size, the VHT Compressed Beamforming Report field and MU Exclusive report field may be split into up to 8 segments. Each segment shall contain an equal number of octets except for the last segment, which may be smaller. All segments shall be sent within the same A-MPDU. If segmented, Beamforming Report field and MU Exclusive report field shall be split in the same number of segments." | Agree. (Simone). As in comment | MU |
| 960 | 9.21.5 | 59 | 8 | TR | It is useful to introduce a mechanism for selective retransmissions of erroneous segments | Proposed approach: In section 7.2.1.12 Sounding Poll, introduce a 1byte field in the Sounding Poll message containing a bitmap indicating the segments to be retransmitted; Each bit in the Retransmission Bitmap is set to 1 to indicate that the corresponding segment is requested to be transmitted by the recipient of the Poll frame. Bit in position k (k=0 for LSB and K=7 for MSB ) corresponds to the segment with the Remaining segment field set to k.  All bits in the Retransmission Bitmap shall be set to 1 unless a selective retransmission is requested, in which case the bits corresponding to the segments already correctly received shall be set to 0;  IN the section pointed by this comment add: A beamformer shall Poll a beamformee requesting the transmission of all the segments, by setting all the bits in the Retransmission bitmap field of the Sounding poll frame to 1; Upon failure in receiving some of the segments , the Beamformer may request a selective retransmission of missing segments by sending a Sounding Poll frame and setting to 1 the bits in the Retransmission Bitmap field corresponding to only the segments requested for retransmission; If beamformer did not receive the segment with First segment field set to 1, and the beamformer sends a poll for retransmissions, then the Retransmission Bitmap is set assuming the feedback was using the maximum number of segments. A beamformee shall reply to the Poll frame by either sending only the segments indicated in the Retransmission bitmap or by sending all the segments; | Agree (Simone). As in comment | MU |
| 961 | 9.21.5 | 59 | 8 | TR | "If it would otherwise result in an MMPDU that exceeds the [...]". Segmentation of sounding feedback need more detailed specification; Segments need be identified by an ID and receiver need be able to determine if all segments are received; | Add in VHT MIMO control field (7.3.1.31 VHT MIMO Control field) a 3-bits (bits 12-14) "remaining segments" indication and a 1-bit (B15) "first segment" indication; ; ‘Remaining Segments is Set equal to the number of remaining segments of the Compressed Beamforming Report field to be sent, excluding the current one. The field shall be set to the total number of segments minus 1 if the First Segment field set to 1.  In case of a retransmitted segment, the field is set to the same value associated with the segment in the original transmission. In case of a Compressed Beamforming frame not carrying a Compressed Beamforming report field, the field is set to all ones; 'First Segment' is Set to 1 if the segment of the Compressed Beamforming Report field carried in the frame is the first one, otherwise it is set to 0. In a retransmitted segment, the First Segment field shall be set to the same value as in the original transmission of the segment. In case of a single segment, the field is set to 1. In case of a Compressed Beamforming frame not carrying a Compressed Beamforming report field, the field is set to 0;  -------- Note that 'Remaining segments' provides an identification number for the segment; When receiving the segment with 'first segment' indication, receiver knows the total number of segments; the two indications combined allow the receiver to determine if the entire feedback is received; moreover, the two indications enable a selective retransmission of missing segments; Given that these indications would use all the reserved bits in the VHT MIMO control field, the Sounding Sequence field is reduced to 6 bits; Accordingly, the Sounding sequence field in NDPA is reduced to 6 bits | Agree. (Simone) As in comment. Part of this comment is addressed in the Poll and MIMO Control fields section | MU |
| 1081 | 9.21.5 | 59 | 9 | TR | The maximum required number of segments for VHT Compressed Beamforming Report field is 7. This number comes from the worst case scenario when the maximum size of VHT Compressed Rport field is approximately 26kBytes and the maximum A-MSDU size of STA's VHT Capability is only 3.8kBytes. | Add '7 segments' instead of 'TBD segments' | Modified. (Simone) 8 segments | MU |
| 1541 | 9.21.5 | 59 | 9 | TR | For the worst case scenario, the maximum size of VHT Compressed Rport field grows up to 26kBytes and the maximum A-MSDU size of STA's VHT Capability is 3.8kBytes. Thus, the maximum number of segmentations will be 7. | Clarify 'TBD segments' with '7 segments'. | Modified. (Simone) 8 segments | MU |
| 1163 | 9.21.5 | 59 | 1 | TR | It is not clear what this means, i.e. what it means to describe something as a valid frame exchange for the purposes of recovery | Remove sentence | Modified  Reworded (Simone)  IN section 9.9.1.4 | MU |
| 1194 | 9.21.5 | 59 | 14 | TR | "A beamformer shall only poll an SU only beamformee if it received at least one segment of the feedback from the beamformee." - I think there's something missing here | Add conditions as to why it might want to poll the beamformee.  Also note "shall only <verb> if <condition>" is always wrong. Reword "shall <verb> only if <condition>" | Agree  Refer to the suggested changes in the following (Yong) | MU |
| 1603 | 9.21.5 | 59 | 1 | TR | Acronym for VHT-CB is not defined | define acronym | Suggest removing the sentence (Yong) | MU |
| 1604 | 9.21.5 | 59 | 6 | TR | The sentence, "It also defines the recovery procedure in case of a missing response to NDPA or Sounding Poll", is not true. The procedure is not defined. | define corresponding procedure (TBD: check baseline document) | Suggest removing recovery text (Yong) | MU |
| 1605 | 9.21.5 | 59 | 9 | TR | Has this TBD been resolved? | determine the number of segments | Modified. (Simone) 8 segments | MU |

**9.21.5 VHT sounding protocol**

Transmit Beamforming and DL MU-MIMO require knowledge of the channel state to compute a steering matrix used at the transmitter to optimize reception at one or more receivers. The STA transmitting using the steering matrix is called the beamformer and a STA for which reception is optimized is called a beamformee. An explicit feedback mechanism is used where the beamformee directly measures the channel from the training symbols transmitted by the beamformer and sends back a transformed estimate of the channel state to the beamformer. The beamformer then uses this estimate, perhaps combining estimates from multiple beamformees, to derive the steering matrix.

A STA that has the value true for dot11VHTBeamformerEnabled shall set the SU Beamformer Capability field to 1 in transmitted VHT Capabilities elements. A STA that has the value true for dot11VHTBeamformeeEnabled shall set the SU Beamformee Capability field to 1 in transmitted VHT Capabilities elements.

A STA that has the value true for dot11VHTMUTxEnabled shall set the MU Tx Capable field to 1 in transmitted VHT Capabilities elements. A STA that has the value true for dot11VHTMURxEnabled shall set the MU Rx Capable field to 1 in transmitted VHT Capabilities elements.

A STA that has the value true for dot11VHTMUTxEnabled shall set the value of dot11VHTBeamformerEnabled to true. A STA that has the value true for dot11VHTMURxEnabled shall set the value of dot11VHTBeamformeeEnabled to true.

A STA is a SU only beamformer if it sets the SU Beamformer Capability field to 1 but sets the MU Tx Capable field to 0 in transmitted VHT Capabilities elements. A STA is a SU only beamformee if it sets the SU Beamformee Capability field to 1 but sets the MU Rx Capable field to 0 in transmitted VHT Capabilities elements.

A STA that does not have the value true for dot11VHTBeamformerEnabled shall not act in the role of a beamformer. A STA that does not have the value true for dot11VHTBeamformeeEnabled shall not act in the role of a beamformee.

***Remove figure 9.37 (it is reinserted later***

***)***~~The VHT sounding protocol with more than one beamformee is shown in Figure 9.37b.~~



~~Figure 9.37b—Sounding protocol with more than one beamformee~~

~~The beamformer shall initiate a sounding feedback sequence by sending a NDPA frame followed by an NDP after a SIFS. The beamformer shall include in the NDPA a STA Info field for each STA that is expected to prepare a VHT Compressed Beamforming response frame and shall identify the STA by including the STA’s AID in the STA ID subfield. The NDPA shall include at least one STA Info field~~

A beamformer shall initiate a sounding feedback sequence by sending an NDPA frame followed by an NDP frame after a SIFS. The beamformer shall include in the NDPA frame one STA Info field for eachbeamformee that is expected to prepare a VHT Compressed Beamforming frame and shall identify the beamformee by including the beamformee’s AID in the AID subfield of the STA Info field. The NDPA frame shall include at least one STA Info field.

A beamformer that transmits an NDPA frame to a SU only beamformee shall include only one STA Info field in the NDPA frame and set the Feedback Type subfield of the STA Info field to SU.

When an NDPA frame includes more than one STA Info fields, the RA of the NDPA frame shall be set to the broadcast address. When an NDPA frame includes a single STA Info field, the RA of the NDPA frame shall be set to the MAC address of the beamformee identified by the AID in the STA Info field.

A beamformer that has transmitted an NDPA frame with more than one STA Info field should transmit any Sounding Poll frames needed to retrieve VHT Compressed Beamforming frames from the intended beamformees in the same TXOP that contained the NDPA frame, subject to the rules in 9.9.1.4 (Multiple frame transmission in an EDCA TXOP). The VHT sounding protocol with more than one beamformee is shown in Figure 9.37b.



Figure 9.37b—VHT sounding protocol with more than one beamformee

The VHT sounding protocol with a single beamformee is shown in Figure 9-37c.



Figure 9.37c—VHT sounding protocol with a single beamformee

~~A beamformee that receives an NDPA from an AP to which it is associated and that contains the AID assigned it during association in the STA ID subfield of the first STA Info field shall transmit its VHT Compressed Beamforming frame a SIFS after reception of the NDP.~~

When a beamformee receives an NDPA frame from beamformer to which it is associated or has a DLS or TDLS session set up, and the NDPA frame contains the beamformee’s AID in the AID subfield of the first STA Info field, the beamformee shall transmit its VHT Compressed Beamforming frame after a SIFS from reception of the NDP frame that follows the NDPA frame.

***[Will present resolution to comments 1423, 1466, 1080, 1540 to be inserted here]***

~~A beamformee that receives an NDPA from an AP~~

~~with which it is associated and that contains the AID assigned it during association in the STA ID subfield of a STA Info field that is not the first STA Info field shall transmit its VHT Compressed Beamforming frame after receiving a Sounding Poll with RA matching its MAC address and TA matching the MAC address of the AP.~~

When a beamformee receives an NDPA frame from a beamformer to which it is associated or has a DLS or TDLS session set up, and the NDPA frame contains the beamformee’s AID in the AID subfield of a STA Info field that is not the first STA Info field, the beamformee shall transmit its VHT Compressed Beamforming frame after a SIFS from receiving a Sounding Poll frame with RA matching its MAC address and TA matching the MAC address of the beamformer.

***[Will present resolution to comments 1423, 1466, 1080, 1540 to be inserted here]***

~~If the beamformee does not have a valid VHT Compressed Beamforming Report, the beamformee~~

~~shall transmit a VHT Compressed Beamforming frame without including the VHT Compressed Beamforming Report field or MU Exclusive Beamforming Report and indicating this in the VHT MIMO Control field as described in 7.3.1.31 (VHT MIMO Control field).~~

A beamformee shall transmit a VHT Compressed Beamforming frame without including the VHT Compressed Beamforming Report field and the MU Exclusive Beamforming Report field if:

a) the transmission duration of the VHT Compressed Beamforming frame would exceed the maximum PPDU duration; or

b) the beamformee does not have any stored VHT Compressed Beamforming Report after receiving a Sounding Poll frame.

A beamformee that transmits a VHT Compressed Beamforming frame without including the VHT Compressed Beamforming Report field and the MU Exclusive Beamforming Report field shall set the Remaining Segments subfield in the VHT MIMO Control field to all ones, and set the First Segment subfield in the VHT MIMO Control field to zero.

~~A beamformer that has transmitted an NDPA with more than one STA Info field should transmit any Sounding Poll frames needed to retrieve VHT Compressed Beamforming frames in the same TXOP that contained the NDPA while giving precedence in attempting to satisfy this recommendation to the rules of 9.9.1.4 (Multiple frame transmission in an EDCA TXOP).~~A beamformee shall send 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 NDPA frame. When the Feedback Type field is set to one, the STA shall send a feedback with the Nc field value in the VHT MIMO Control field equal to the Nc field value in the corresponding STA Info field in the NDPA frame provided the Nc requested is not larger than the number of currently active receive antennas. When the Feedback Type is set to zero, the Nc field value in the VHT MIMO Control field is determined by the beamformee.

~~The VHT sounding protocol with a single beamformee is shown in Figure 9-37c.~~

***Remove figure***

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~~Figure 9.37c—Sounding protocol with a single beamformee~~

~~When a beamformer includes only one STA Info field in the NDPA, then the beamformer does not poll the STA for the initial transmission attempt of the feedback, as is shown in Figure 9.37c. Upon failure to receive the feedback, the beamformer may initiate poll-based recovery as described in 9.x.x.~~

~~An SU only beamformee is a STA that, in its VHT Capability element, has set the SU Beamformee Capable field to 1 and the MU Rx Capable field to 0. When soliciting feedback from an SU only beamformee, the beamformer shall set the RA of the NDPA to the beamformee’s MAC address and shall include a single STA Info field in the NDPA with the STA ID subfield set to the beamformee’s AID and the Feedback Type subfield set to SU~~.

~~The NDPA frame is a control frame as defined in . The sequence number in the NDPA frame identifies this NDP sequence and is also carried in the VHT Compressed Beamforming frame.~~

*~~Note—The beamformer can use the sequence number in the VHT Compressed Beamforming frame to associate the feedback with a prior NDPA-NDP sounding sequence and thus compute the delay between sounding and receiving the feedback. The beamformer can use this delay time when making a decision regarding the applicability of the feedback for the link.~~*~~The Multi STA info field contains the IDs of the beamformees required to compute the sounding feedback and may include other information TBD.~~

~~The RA in the NDPA frame shall be set to the address of the beamformee when sounding feedback is requested from a single beamformee. The RA field in the NDPA frame shall be set to the broadcast address when sounding feedback is requested from more than one beamformee.~~

~~A beamformee shall use the SU format for the VHT Compressed Beamforming frame when the STA Info~~

~~Feedback Type field in the NDPA corresponding to that STA is set to SU.~~

A beamformee shall not include the MU Exclusive Beamforming Report field in a VHT Compressed Beamforming frame if the Feedback Type subfield in the MIMO Control field is set to 0. A beamformee shall include the MU Exclusive Beamforming Report field in a VHT Compressed Beamforming frame if the Feedback Type subfield in the MIMO Control field is set to 1.

~~A beamformee shall use the MU format for the VHT Compressed Beamforming frame when the STA Info Feedback Type field in the NDPA corresponding to that STA is set to MU.~~

***[Will present resolution to CID 1466 to be inserted here]***

~~The NDPA frame is a control frame as defined in 7.2.1.11. The sequence number in the NDPA frame identifies~~

~~this NDP sequence and is also carried in the VHT Compressed Beamforming frame.~~

The value of the Sounding Sequence subfield in the VHT MIMO Control field shall be set to the same value as the Sounding Sequence field in the corresponding NDPA frame.

*Note—The beamformer can use the sequence number in the VHT Compressed Beamforming frame to associate the feedback with a prior NDPA-NDP sounding sequence and thus compute the delay between sounding and receiving the feedback. The beamformer can use this delay time when making a decision regarding the applicability of the feedback for the link.*

~~A beamformer that has transmitted an NDPA with more than one STA Info field should transmit any Sounding Poll frames needed to retrieve the expected VHT Compressed Beamforming frames within the TXOP that contained the NDPA while giving priority in attempting to satisfy this recommendation to the rules of 9.9.1.4 (Multiple frame transmission in an EDCA TXOP).~~

Recovery in case of missing response to NDPA or Sounding Poll frame follows the rules for multiple frame transmission in an EDCA TXOP (9.9.1.4). ~~For the purpose of the recovery mechanism, the sequence [NDPA NDP VHT-CB] is a valid frame exchange, and the VHT-CB frame is a valid response to the NDPA.~~ A Compressed Beamforming frame sent as a response to the NDPA, SIFS time after the NDP, is to be considered a valid response to the NDPA in the terms used in 9.9.1.4.

*~~Note--Section 9.9.1.4 defines the rules that allow for sending multiple frames within a TXOP with a SIFS separation. It also defines the recovery procedure in case of a missing response to NDPA or Sounding Poll~~*

~~If it would otherwise result in an MMPDU that exceeds the maximum MPDU size, the VHT Compressed~~

~~Beamforming Report field may be split into up to TBD segments. Each segment shall contain an equal number~~

~~of octets except for the last segment, which may be smaller. All segments shall be sent within the same~~

~~A-MPDU.~~If a VHT Compressed Beamforming frame would result in an MMPDU that exceeds the maximum MPDU length, the VHT Compressed Beamforming Report field and MU Exclusive report field may be split into up to 8 segments, with each segment sent in a different MPDU. Each segment shall contain an equal number of octets except for the last segment, which may be smaller. Each segment is identified by the value of the Remaining Segments subfield and the First segment subfield in the VHT MIMO Control field as defined in Section 7.3.1.31. All segments shall be sent within a single A-MPDU.

In its first attempt to retrieve a VHT Compressed Beamforming Report field from a beamformee that is not the one indicated by the first STA Info field, a beamformer shall transmits a Sounding Poll frame to poll all possible segments of the VHT Compressed Beamforming frame from the beamformee, by setting all the bits in the Segment Retransmission Bitmap field of the Sounding Poll frame to 1.

If a beamformer fails to receive some or all segments of a VHT Compressed Beamforming frame, the beamformer may request a selective retransmission of missing segments by sending a Sounding Poll frame with the Segment Retransmission Bitmap field set as decribed in Section 7.2.1.12 to indicate the segments requested for retransmission. If the beamformer fails to receive the segment with the First Segment field set to 1, it may request a selective retransmission of missing segments assuming the VHT Compressed Beamforming frame is split into 8 segments.

A beamformee shall reply to a Sounding Poll frame by either sending only the segments indicated in the Segment Retransmission Bitmap field in the Sounding Poll fame or by sending all the segments disregarding the Segment Retransmission Bitmap field in the Sounding Poll fame.

~~A beamformer shall only poll an SU only beamformee if it received at least one segment of the feedback from the beamformee~~

A beamformer shall not transmit a Sounding Poll frame to a SU only beamformee unless it has received at least one segment of the VHT Compressed Beamforming frame from the beamformee.

**9.21.6 Transmission of a VHT NDP**

A STA shall transmits a VHT format NDP using the following TXVECTOR parameters:

— LENGTH shall be set to 0.

— NUM\_USERS shall be set to 1.

— GROUP ID shall be set to 63 (all ones).

— NUM\_STS shall indicate two or more space-time streams.

**Final version**

***If the above changes are implemented, the revised section should look like:***

**9.21.5 VHT sounding protocol**

Transmit Beamforming and DL MU-MIMO require knowledge of the channel state to compute a steering matrix used at the transmitter to optimize reception at one or more receivers. The STA transmitting using the steering matrix is called the beamformer and a STA for which reception is optimized is called a beamformee. An explicit feedback mechanism is used where the beamformee directly measures the channel from the training symbols transmitted by the beamformer and sends back a transformed estimate of the channel state to the beamformer. The beamformer then uses this estimate, perhaps combining estimates from multiple beamformees, to derive the steering matrix.

A STA that has the value true for dot11VHTBeamformerEnabled shall set the SU Beamformer Capability field to 1 in transmitted VHT Capabilities elements. A STA that has the value true for dot11VHTBeamformeeEnabled shall set the SU Beamformee Capability field to 1 in transmitted VHT Capabilities elements.

A STA that has the value true for dot11VHTMUTxEnabled shall set the MU Tx Capable field to 1 in transmitted VHT Capabilities elements. A STA that has the value true for dot11VHTMURxEnabled shall set the MU Rx Capable field to 1 in transmitted VHT Capabilities elements.

A STA that has the value true for dot11VHTMUTxEnabled shall set the value of dot11VHTBeamformerEnabled to true. A STA that has the value true for dot11VHTMURxEnabled shall set the value of dot11VHTBeamformeeEnabled to true.

A STA is a SU only beamformer if it sets the SU Beamformer Capability field to 1 but sets the MU Tx Capable field to 0 in transmitted VHT Capabilities elements. A STA is a SU only beamformee if it sets the SU Beamformee Capability field to 1 but sets the MU Rx Capable field to 0 in transmitted VHT Capabilities elements.

A STA that does not have the value true for dot11VHTBeamformerEnabled shall not act in the role of a beamformer. A STA that does not have the value true for dot11VHTBeamformeeEnabled shall not act in the role of a beamformee.

A beamformer shall initiate a sounding feedback sequence by sending an NDPA frame followed by an NDP frame after a SIFS. The beamformer shall include in the NDPA frame one STA Info field for eachbeamformee that is expected to prepare a VHT Compressed Beamforming frame and shall identify the beamformee by including the beamformee’s AID in the AID subfield of the STA Info field. The NDPA frame shall include at least one STA Info field.

A beamformer that transmits an NDPA frame to a SU only beamformee shall include only one STA Info field in the NDPA frame and set the Feedback Type subfield of the STA Info field to SU.

When an NDPA frame includes more than one STA Info fields, the RA of the NDPA frame shall be set to the broadcast address. When an NDPA frame includes a single STA Info field, the RA of the NDPA frame shall be set to the MAC address of the beamformee identified by the AID in the STA Info field.

A beamformer that has transmitted an NDPA frame with more than one STA Info field should transmit any Sounding Poll frames needed to retrieve VHT Compressed Beamforming frames from the intended beamformees in the same TXOP that contained the NDPA frame, subject to the rules in 9.9.1.4 (Multiple frame transmission in an EDCA TXOP). The VHT sounding protocol with more than one beamformee is shown in Figure 9.37b.



Figure 9.37b—VHT sounding protocol with more than one beamformee

The VHT sounding protocol with a single beamformee is shown in Figure 9-37c.



Figure 9.37c—VHT sounding protocol with a single beamformee

When a beamformee receives an NDPA frame from beamformer to which it is associated or has a DLS or TDLS session set up, and the NDPA frame contains the beamformee’s AID in the AID subfield of the first STA Info field, the beamformee shall transmit its VHT Compressed Beamforming frame after a SIFS from reception of the NDP frame that follows the NDPA frame.

***[Will present resolution to comments 1423, 1466, 1080, 1540 to be inserted here]***

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When a beamformee receives an NDPA frame from a beamformer to which it is associated or has a DLS or TDLS session set up, and the NDPA frame contains the beamformee’s AID in the AID subfield of a STA Info field that is not the first STA Info field, the beamformee shall transmit its VHT Compressed Beamforming frame after a SIFS from receiving a Sounding Poll frame with RA matching its MAC address and TA matching the MAC address of the beamformer.

***[Will present resolution to comments 1423, 1466, 1080, 1540 to be inserted here]***

A beamformee shall transmit a VHT Compressed Beamforming frame without including the VHT Compressed Beamforming Report field and the MU Exclusive Beamforming Report field if:

a) the transmission duration of the VHT Compressed Beamforming frame would exceed the maximum PPDU duration; or

b) the beamformee does not have any stored VHT Compressed Beamforming Report after receiving a Sounding Poll frame.

A beamformee that transmits a VHT Compressed Beamforming frame without including the VHT Compressed Beamforming Report field and the MU Exclusive Beamforming Report field shall set the Remaining Segments subfield in the VHT MIMO Control field to all ones, and set the First Segment subfield in the VHT MIMO Control field to zero.

A beamformee shall send 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 NDPA frame. When the Feedback Type field is set to one, the STA shall send a feedback with the Nc field value in the VHT MIMO Control field equal to the Nc field value in the corresponding STA Info field in the NDPA frame provided the Nc requested is not larger than the number of currently active receive antennas. When the Feedback Type is set to zero, the Nc field value in the VHT MIMO Control field is determined by the beamformee.

A beamformee shall not include the MU Exclusive Beamforming Report field in a VHT Compressed Beamforming frame if the Feedback Type subfield in the MIMO Control field is set to 0. A beamformee shall include the MU Exclusive Beamforming Report field in a VHT Compressed Beamforming frame if the Feedback Type subfield in the MIMO Control field is set to 1.

***[Will present resolution to CID 1466 to be inserted here]***

The value of the Sounding Sequence subfield in the VHT MIMO Control field shall be set to the same value as the Sounding Sequence field in the corresponding NDPA frame.

*Note—The beamformer can use the sequence number in the VHT Compressed Beamforming frame to associate the feedback with a prior NDPA-NDP sounding sequence and thus compute the delay between sounding and receiving the feedback. The beamformer can use this delay time when making a decision regarding the applicability of the feedback for the link.*

Recovery in case of missing response to NDPA or Sounding Poll frame follows the rules for multiple frame transmission in an EDCA TXOP (9.9.1.4). A Compressed Beamforming frame sent as a response to the NDPA, SIFS time after the NDP, is to be considered a valid response to the NDPA in the terms used in 9.9.1.4.

If a VHT Compressed Beamforming frame would result in an MMPDU that exceeds the maximum MPDU length, the VHT Compressed Beamforming Report field and MU Exclusive report field may be split into up to 8 segments, with each segment sent in a different MPDU. Each segment shall contain an equal number of octets except for the last segment, which may be smaller. Each segment is identified by the value of the Remaining Segments subfield and the First segment subfield in the VHT MIMO Control field as defined in Section 7.3.1.31. All segments shall be sent within a single A-MPDU.

In its first attempt to retrieve a VHT Compressed Beamforming Report field from a beamformee that is not the one indicated by the first STA Info field, a beamformer shall transmits a Sounding Poll frame to poll all possible segments of the VHT Compressed Beamforming frame from the, beamformee by setting all the bits in the Segment Retransmission Bitmap field of the Sounding Poll frame to 1.

If a beamformer fails to receive some or all segments of a VHT Compressed Beamforming frame, the beamformer may request a selective retransmission of missing segments by sending a Sounding Poll frame with the Segment Retransmission Bitmap field set as decribed in Section 7.2.1.12 to indicate the segments requested for retransmission. If the beamformer fails to receive the segment with the First Segment field set to 1, it may request a selective retransmission of missing segments assuming the VHT Compressed Beamforming frame is split into 8 segments.

A beamformee shall reply to a Sounding Poll frame by either sending only the segments indicated in the Segment Retransmission Bitmap field in the Sounding Poll fame or by sending all the segments disregarding the Segment Retransmission Bitmap field in the Sounding Poll fame.

A beamformer shall not transmit a Sounding Poll frame to a SU only beamformee unless it has received at least one segment of the VHT Compressed Beamforming frame from the beamformee.