IEEE P802.11
Wireless LANs

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| Single-STA trigger-based sounding |
| Date: 2018-04-19 |
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Abstract

This submission proposes changes to 802.11ax/D2.2 to allow an AP to use trigger-based sounding with a single STA.

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| Identifiers | Comment | Proposed change |
| CID 11766GEORGE CHERIAN | Please clarify how a TB soundng is done with a single STA. If not possible, please clarify that too:"An HE beamformer initiates an HE trigger-based (TB) sounding sequence by sending a broadcast NDP Announcement frame that contains two or more STA Info fields, where each STA Info field is addressed to an HE beamformee" | As in the comment |
| CID 11768GEORGE CHERIAN | Add normative requirement to cpature the following: "The HE sounding sequence is a non-TB sounding sequence if the HE NDP Announcement frame is an individually addressed frame; otherwise it is a TB soundingsequence" | As in the comment |
| CID 12698Mark RISON | "A non-AP HE beamformee that receives a broadcast HE NDP Announcement frame from the HE beam-former with which it is associated and that contains the HE beamformee's 11 LSBs of the AID in any of theSTA Info fields and also receives an HE NDP a SIFS after the HE NDP Announcement frame shall computethe HE compressed beamforming feedback using the feedback type, Ng and codebook size indicated in thereceived HE NDP Announcement frame." -- what if it's broadcast but has only one STA Info field? | Change the cited text to "A non-AP HE beamformee that receives an HE NDP Announcement frame from the HE beam-former with which it is associated, that has more than one STA Info field and that contains the HE beamformee's 11 LSBs of the AID in any of theSTA Info fields and also receives an HE NDP a SIFS after the HE NDP Announcement frame shall computethe HE compressed beamforming feedback using the feedback type, Ng and codebook size indicated in thereceived HE NDP Announcement frame. " |
| CID 12699Mark RISON | "The HE beamformee that is theintended receiver of an HE NDP Announcement frame that has only one STA Info field shall ignore the values of the Nc subfield, Ng subfield (B26 of the STA Info subfield) and Codebook Size subfield" -- and then do what for those params? And if the Feedback Type And Ng subfield is 0 (previous sentence) then only SU-type feedback can be provided | Change the cited text to "The HE beamformee that is the intended receiver of an HE NDP Announcement frame that has only one STA Info field shall ignore the values of the Feedback Type And Ng, Codebook Size and Nc subfields and shall provide SU-type feedback" |
| CID 13218Robert Stacey | This is a definition for the HE non-TB sounding sequence. Write it as such. | Replace with "An HE non-TB sounding sequence is a sounding sequence where the initiating frame is an individually addressed HE NDP Announcement frame with a single STA Info field. An individually addressed HE NPD Announcement frame shall have one and only one STA Info field. The RA field of the HE NDP Announcement frame shall be set to to the address of the STA addressed in the STA Info field." Remove the associated RA field statement at P265L20. |
| CID 13220Robert Stacey | Can an HE non-TB sounding sequence solicit MU-type feedback? CQI feedback? Presumably, since a non-AP STA must support the MU beamformee role but may not support the Triggered MU feedback. | Rewrite as: "The HE NDP Announcement frame in an HE non-TB sounding sequence may solicit SU, MU or CQI-only feedback." |
| CID 13225Robert Stacey | This is a definition for the HE TB sounding sequence. Write it as such. | "An HE TB sounding sequence is a sounding sequence where the initiating frame is a broadcast HE NDP Annoucment frame that contains two or more STA Info fields." Remove the statement at P265L20. |
| CID 13226Robert Stacey | Why does the HE TB sounding sequence require two STA Info fields in the HE NDP Announcement frame? Surely the fact that the HE NDP is broadcast is sufficient? How would a STA behave it it received a broadcast HE NDP Annoucement with one STA Info field and it was the STA addressed by that STA Info field? | Define an HE TB sounding sequence as one where the HE NDP Announcement is broadcast: "An HE TB sounding sequence is a sounding sequence initiated by a broadcast HE NDP Announcement frame. A broadcast NDP Annoucement frame may include one or more STA Info fields." |
| CID 13227Robert Stacey | Can an HE TB sounding sequence solicit SU-type feedback? CQI feedback? Presumably since we have capability fields for triggered feedback of each of these. | Replace with "The HE NDP Annoucement frame in an HE TB sounding sequence shall not solicit MU, SU or CQI feedback unless all the STAs addressed in the STA Info fields have indicated support for triggered feedback of that type in the Triggered MU Beamforming Feedback, Triggered SU Beamforming feedback, or Triggered CQI Feedback subfield, respectively, in the HE PHY Capabilities Information field of the HE Capabilities element." |
| CID 13235Robert Stacey | Can SU feedback be returned using the TB sounding sequence? If so, the Nc field can't be reserved for SU. | Clarify (in 27.6.3) whether or not SU feedback can be returned in a TB sounding sequence. If so, define Nc for SU feedback. |
| CID 13287Robert Stacey | It is not clear if there are restrictions on the feedback variants that can be part of a TB sounding sequence. Can SU feedback be return? (If so we will need tighter rules on generating the report based on parameters in the NDP Announcement). Can CQI feedback be returned? Note that we have capabilitiy bits for triggered feedback of each of these types. | Identify the feedback types that can be used with TB sounding |
| CID 13288Robert Stacey | The definitions for HE non-TB sounding sequence and HE TB sounding sequence have already been given at P264L32 and P264L52. The new requirement here is that the HE NDP Annoucement is always followed by an HE NDP. | Replace the paragraph with "An HE beamformer that initiates an HE non-TB sounding sequence or HE TB sounding sequence shall transmit an HE NDP PPDU a SIFS after the HE NDP Announcement frame." |
| CID 13865Yongho Seok | When the Feedback Type is the CQI feedback, Nr Index shall be reserved.Please add this missing statement. | As in comment. |
| CID 13866Yongho Seok | When the Feedback Type is the CQI feedback, Grouping shall be reserved.Please add this missing statement. | As in comment. |
| CID 13867Yongho Seok | When the Feedback Type is the CQI feedback, Codebook Information shall be reserved.Please add this missing statement. | As in comment. |

Discussion:

There is a desire to permit an AP to perform trigger-based sounding with a single STA (including the case where there is only one non-AP STA in the BSS). At the moment, the draft does not allow this, because 27.6.3 states explicitly that:

An HE beamformer initiates an HE trigger-based (TB) sounding sequence by sending a broadcast NDP Announcement frame that contains two or more STA Info fields, where each STA Info field is addressed to an HE beamformee.

The changes below make the choice between TB and non-TB sounding not dependent on the number of STA Info fields, but rather purely on the RA of the HE NDP Announcement frame (which is already specified to be broadcast for TB sounding and unicast for non-TB sounding); TB sounding can then be performed with a single STA by broadcasting an NDP Announcement frame with one STA Info field.

Note the changes assume the material in 18/0446 that allows for non-TB full-BW CQI feedback.

A few other fixes have been made at the same time:

* To avoid confusion between “addresses” in the context of the RA and in the context of a STA Info field’s AID11, the latter is referred to as “identifies”
* The wording for non-infrastructure BSSes was self-contradictory
* The requirement for each STA Info to identify a different STA has been taken out of Clause 9 (was already in Clause 27)
* The Codebook Size subfield is ignored in non-TB sounding too, so should (like the Nc and Feedback Type And Ng subfields) be set to 0
* HE NDPAs can only be transmitted by HE STAs to HE STAs, so qualifiers like “to/from an HE beamformee” do not need to be constantly repeated (a single statement at the beginning suffices)
* TB sounding can be used for SU and CQI feedback, not just MU feedback
* The various fields are N/A or ignored as follows:

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| --- | --- | --- | --- |
|  | SU feedback | MU feedback | CQI feedback |
| Nc | Ignored (BFee chooses) if non-TB; valid if TB | N/A (not allowed) if non-TB; valid if TB | Valid for both non-TB and TB |
| Feedback Type And Ng | Ng part ignored (BFee chooses) if non-TB; Ng part valid if TB | N/A (not allowed) if non-TB; Ng part valid if TB | No Ng part |
| Codebook Size | Ignored (BFee chooses) if non-TB; valid if TB | N/A (not allowed) if non-TB; valid if TB | Ignored (not applicable) for both non-TB and TB |

* Various small editorials

Proposed changes:

Change 27.6.3 as follows:

An HE beamformer initiates an HE non-trigger-based (non-TB) sounding sequence by transmitting an individually addressed NDP Announcement frame to an HE beamformee that contains one STA Info field that identifies that HE beamformee (or, as described below, has the AID11 subfield set to 0).

An HE beamformer may initiate an HE non-TB sounding sequence to solicit SU or CQI feedback over full bandwidth, where supported by the HE beamformee.

An HE beamformer may initiate an HE non-TB sounding sequence to solicit a feedback variant over full bandwidth only if the feedback variant is computed based on parameters supported by the HE beamformee; otherwise the HE beamformer shall not solicit that feedback variant (see 27.6.2 (Sounding sequences and support)).

An HE beamformer shall not initiate an HE non-TB sounding sequence to solicit any feedback variant over partial bandwidth.

An HE beamformer initiates an HE trigger-based (TB) sounding sequence by transmitting a broadcast NDP Announcement frame that contains one or more STA Info fields, where each STA Info field identifies an HE beamformee.

An HE beamformer may initiate an HE TB sounding sequence to solicit SU, MU or CQI feedback over full or partial bandwidth, where supported by the HE beamformee(s).

An HE beamformer may initiate an HE TB sounding sequence to solicit a feedback variant only if the feedback variant is computed based on parameters supported by the HE beamformee(s); otherwise the HE beamformer shall not solicit that feedback variant (see 27.6.2 (Sounding sequences and support)).

The HE beamformer shall initiate an HE sounding sequence by transmitting an HE NDP Announcement frame followed by an HE NDP after a SIFS.

An HE AP shall not transmit an HE NDP Announcement frame with STA Info fields that identify STAs from two or more BSSs of a multiple BSSID set to a STA unless the STA has set the Rx Control Frame To MultiBSS subfield in the HE MAC Capabilities Information field of the HE Capabilities element it transmits to 1.

An AP that transmits an HE NDP Announcement frame shall set the TA field of the frame to the MAC address of the AP, except when dot11MultiBSSIDActivated is true and the HE NDP Announcement frame is directed to STAs from at least two different BSSs of the multiple BSSID set, in which case, the AP shall set the TA field of the frame to the transmitted BSSID.

An HE beamformer that transmits an HE NDP Announcement frame to an AP, mesh STA or IBSS STA, shall set the AID11 subfield in the STA Info field of the frame to 0 and shall not broadcast the HE NDP Announcement frame. Otherwise, an HE beamformer that transmits an HE NDP Announcement frame shall set the AID11 subfield in each STA Info field to the 11 LSBs of the AID of the non-AP STA that the STA Info field identifies. An HE NDP Announcement frame shall not include multiple STA Info fields that have the same value in the AID11 subfield.

The HE NDP Announcement frame shall indicate the subcarrier grouping, Ng, codebook size and the number of columns, Nc, in the compressed beamforming feedback matrix to be used by the intended HE beamformees for the generation of the HE compressed beamforming and CQI report except when the HE NDP Announcement frame is individually addressed and SU feedback is requested, in which case the subcarrier grouping, Ng, codebook size and the number of columns, Nc, in the compressed beamforming feedback matrix to be used for the generation of the HE compressed beamforming and CQI report shall be determined by the recipient of the HE NDP Announcement frame, and except when CQI feedback is requested, in which case the subcarrier grouping, Ng, and codebook size are not applicable to the generation of the HE compressed beamforming and CQI report.

An HE beamformer that transmits a broadcast HE NDP Announcement frame shall transmit a BRP Trigger frame a SIFS after the HE NDP to solicit an HE compressed beamforming and CQI report from the intended HE beamformees in the same TXOP. The HE beamformer may transmit additional BRP Trigger frames to solicit a subset of the HE compressed beamforming and CQI report in the same TXOP as shown in Figure 27-7 (An example of the sounding protocol with more than one HE beamformee).

An HE beamformer that transmits an HE NDP Announcement frame shall set the Nc subfield of each STA Info field, except when the HE NDP Announcement frame is individually addressed and SU feedback is requested, to a value less than or equal to the minimum of:

— The maximum number of supported spatial streams according to the corresponding HE beamformee's Rx HE-MCS Map For ≤ 80 MHz and Rx HE-MCS Map For > 80 MHz subfields in the Supported HE-MCS And NSS Set field of the HE Capabilities element sent by the HE beamformee.

— The maximum number of supported spatial streams according to the Rx NSS subfield value in the most recently received Operating Mode Notification frame, Operating Mode Notification element with the Rx NSS Type subfield equal to 0, or OM Control subfield sent by the corresponding HE beamformee (see 27.8 (Operating mode indication)).

— The maximum Nc indicated by the Max Nc subfield in the HE PHY Capabilities Information field of the HE Capabilities element sent by the HE beamformee.

The HE beamformee indicates the maximum number of space-time streams it can receive in an HE NDP, NSTS,max, as defined in 27.6.2 (Sounding sequences and support).

An HE beamformer that transmits an HE NDP Announcement frame and sets the Feedback Type And Ng subfield of the STA Info field to indicate MU shall indicate Ng = 4 or Ng = 16 in the Feedback Type And Ng subfield of the STA Info field (see Table 9-25a (Feedback Type And Ng subfield and Codebook Size subfield encoding)).

An HE beamformee may support Ng = 16 in the HE Compressed Beamforming Report field for both SU and MU feedback types. An HE beamformer shall not request Ng = 16 for SU or MU feedback in an HE NDP Announcement frame unless the HE beamformee(s) indicate(s) support in the Ng = 16 For SU Feedback subfield or Ng = 16 For MU Feedback subfield, respectively, in the HE PHY Capabilities Information field of the HE Capabilities element it transmits (see 9.4.2.237 (HE Capabilities element)).

An HE beamformee may support a codebook size (ϕ, ψ) = {4, 2} in the HE Compressed Beamforming Report field for SU feedback type. An HE beamformer shall not request codebook size (ϕ, ψ) = {4, 2} in an HE NDP Announcement frame unless the HE beamformee(s) indicate(s) support in the Codebook Size (ϕ, ψ) = {4, 2} SU Feedback subfield in the HE PHY Capabilities Information field in the HE Capabilities element it transmits (see 9.4.2.237 (HE Capabilities element)).

An HE beamformee may support a codebook size (ϕ, ψ) = {7, 5} in the HE Compressed Beamforming Report field for MU feedback type. An HE beamformer shall not request the codebook size (ϕ, ψ) = {7, 5} in an HE NDP Announcement frame unless the HE beamformee(s) indicate(s) support for the Codebook Size (ϕ, ψ) = {7, 5} MU Feedback subfield in the HE PHY Capabilities Information field in the HE Capabilities element it transmits (see 9.4.2.237 (HE Capabilities element)).

An HE beamformer that transmits an HE NDP Announcement frame shall set the RU Start Index and RU End Index subfields in a STA Info field to indicate the starting 26-tone RU and the ending 26-tone RU, respectively, of the solicited HE compressed beamforming and CQI report (see 9.3.1.20 (VHT/HE NDP Announcement frame format)).

The HE beamformer shall indicate a starting 26-tone RU and an ending 26-tone RU that is equal to the lowest 26-tone RU and the highest 26-tone RU, respectively, to indicate that the feedback is solicited over full bandwidth. The HE beamformer shall indicate a starting 26-tone RU and/or an ending 26-tone RU that is greater than the lowest 26-tone RU and/or less than the highest 26-tone RU, respectively, to indicate that the feedback is solicited over partial bandwidth.

Each 26-tone RU location is based on the RXVECTOR parameter CH\_BANDWIDTH of the HE NDP Announcement when received in an HE PPDU or the RXVECTOR parameter CH\_BANDWIDTH\_IN\_NON\_HT when the HE NDP Announcement is received in a non-HT PPDU.

The HE beamformer shall solicit feedback over full bandwidth when the HE NDP Announcement frame is individually addressed or when the STA Info field identifies an HE beamformee that has indicated no support for partial bandwidth feedback. The HE beamformer may solicit feedback over partial bandwidth when the HE NDP Announcement frame is broadcast and the STA Info field identifies an HE beamformee that has indicated support for partial bandwidth feedback (see 27.6.2 (Sounding sequences and support)). For example, the HE beamformer can request full 80 MHz bandwidth feedback for Ng = 4 by setting the RU Start Index and RU End Index subfields in the STA Info field to 0 and 36, respectively, as shown in Table 28-8 (Data and pilot subcarrier indices for RUs in an 80 MHz HE PPDU). For Ng = 4 and 160 or 80+80 MHz full bandwidth feedback, the RU Start Index and RU End Index subfields are 0 and 74, respectively.

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

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

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

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

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

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

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

An HE beamformer that transmits an individually addressed HE NDP Announcement frame shall set the Nc subfield (unless CQI feedback is requested), the Feedback Type And Ng subfield and the Codebook Size subfield to 0. An HE beamformee that is the intended receiver of an individually addressed HE NDP Announcement frame shall ignore the values of the Nc subfield (unless CQI feedback is requested), Ng subfield (B26 of the STA Info subfield) and Codebook Size subfield. An HE beamformee that is identified by a STA Info field that requests CQI feedback shall ignore the value of the Codebook Size subfield.

An example of the HE non-TB sounding protocol with a single HE beamformee is shown in Figure 27-6 (An example of the sounding protocol with a single HE beamformee).

An HE beamformee that receives an HE NDP Announcement frame that contains the HE beamformee's MAC address in the RA field and also receives an HE NDP a SIFS after the HE NDP Announcement frame shall transmit its HE compressed beamforming and CQI report a SIFS after the HE NDP. The TXVECTOR parameter CH\_BANDWIDTH for the PPDU containing the HE compressed beamforming and CQI report shall be set to indicate a bandwidth not wider than that indicated by the RXVECTOR parameter CH\_BANDWIDTH of the HE NDP.

An example of HE TB sounding protocol with more than one HE beamformee is shown in Figure 27-7 (An example of the sounding protocol with more than one HE beamformee).

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

NOTE—A non-AP HE beamformee that transmits an OM Control subfield with UL MU Disable field set to 1 does not respond to BRP Trigger frames (see 27.8 (Operating mode indication)).

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

The HE compressed beamforming and CQI report shall be transmitted in a single HE Compressed Beamforming And CQI frame unless the size of the feedback results in an HE Compressed Beamforming And CQI frame that would exceed 11 454 octets, in which case the feedback shall be segmented as defined in 27.6.4 (Rules for generating segmented feedback). The HE beamformee shall not segment an HE compressed beamforming and CQI report that is CQI feedback.

An HE beamformer shall support a maximum MPDU length for the HE compressed beamforming and CQI report which is the minimum between 11 454 octets and the maximum length of the HE compressed beamforming and CQI report that the HE beamformer intends to solicit from its HE beamformees.

An HE beamformer that transmits a BRP Trigger frame shall set the Feedback Segment Retransmission Bitmap fields of the BRP Trigger frame to all 1s except when the HE beamformer intends to solicit the retransmission of segmented feedback as defined in 27.6.4 (Rules for generating segmented feedback).

Changes 28.3.15.2 as follows:

The number of bits for quantization, the tone grouping factor, and the number of columns in the HE compressed beamforming and CQI report are set by the HE beamformer if the HE NDP Announcement frame is broadcast and does not request CQI feedback. The number of columns in the HE compressed beamforming and CQI report is set by the HE beamformer if the HE NDP Announcement frame requests CQI feedback. The number of bits for quantization, the tone grouping factor, and the number of columns in the HE compressed beamforming and CQI report are determined by the HE beamformee if the HE NDP Announcement frame is individually addressed and requests SU feedback.

Change 9.3.1.20 as follows:

The Nc field indicates the number of columns, Nc, in the Compressed Beamforming Feedback Matrix subfield minus 1, unless the HE NDP Announcement frame is individually addressed and SU feedback is requested, in which case it is reserved

Change 28.3.16 as follows:

If the Beamformed field in HE-SIG-A of an HE NDP PPDU is 1, then the receiver of the HE NDP PPDU shall not perform channel smoothing when generating the compressed beamforming feedback matrix.

**References:**

802.11md/D2.2