

EXHIBIT 2

U.S. Patent No. RE47,720 – Lenovo Group Limited

Claim 53

USTA Technology, LLC (“USTA”) provides evidence of infringement of claim 53 of U.S. Patent No. RE47,720 (hereinafter “the ’720 patent”) by Lenovo Group Limited (“Lenovo”). In support thereof, USTA provides the following exemplary claim chart.

“Accused Instrumentalities” as used herein refers to at least 802.11ac-compliant stations made, used, and/or sold by Lenovo, including, but not limited to: the ThinkPad Stack Wireless Router, Lenovo Tab P12/P12 Pro, Ideapad Y700, IdeaPad 5G, K12 Pro, and associated hardware and/or software. These examples are not limiting.

This claim chart demonstrates Lenovo’s infringement by comparing each element of the asserted claims to corresponding components, aspects, and/or features of the Accused Instrumentalities. This claim chart is not intended to constitute an expert report on infringement. This claim chart includes information provided by way of example, and not by way of limitation. USTA reserves the right to supplement this analysis in the event additional information is uncovered.

The analysis set forth below is based only upon information from publicly available resources regarding the Accused Instrumentalities, as Lenovo has not yet provided any non-public information. An analysis of Lenovo’s (or other third parties’) technical documentation and/or software source code may assist in fully identify all infringing features and functionality. Accordingly, USTA reserves the right to supplement this infringement analysis once such information is made available to USTA. Furthermore, USTA reserves the right to revise this infringement analysis, as appropriate, upon issuance of a court order construing any terms recited in the asserted claims.

USTA provides this evidence of infringement and related analysis without the benefit of claim construction or expert reports or discovery. USTA reserves the right to supplement, amend or otherwise modify this analysis and/or evidence based on any such claim construction or expert reports or discovery.

Unless otherwise noted, USTA contends that Lenovo directly infringes the ’720 patent in violation of 35 U.S.C. § 271(a) by selling, offering to sell, making, and/or using, the Accused Instrumentalities. The following exemplary analysis demonstrates that

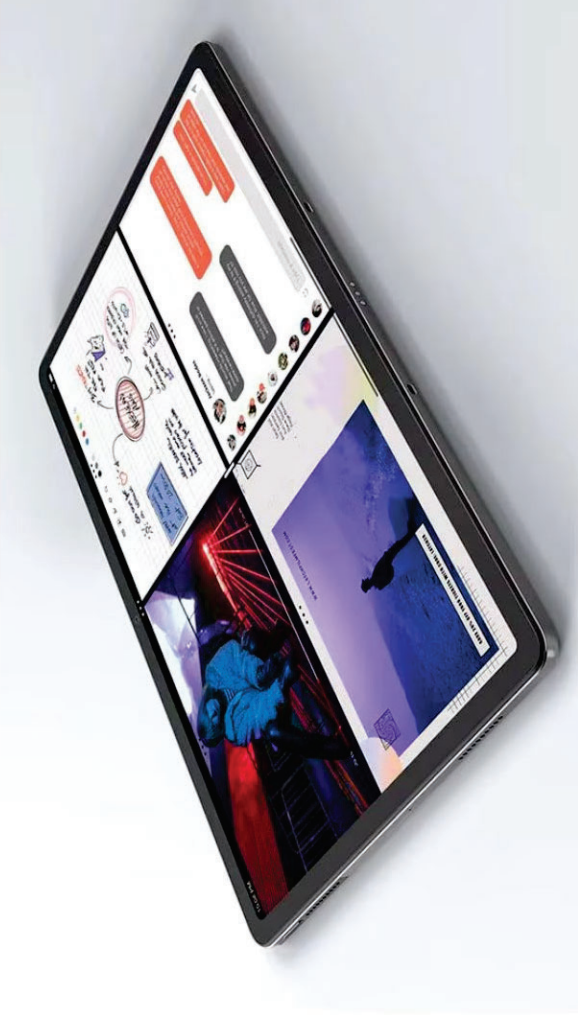
infringement. Lenovo makes, uses, sells, imports, or offers for sale in the United States, or has made, used, sold, or offered for sale in the past, without authority, products, equipment, or services that infringe claim 53 of the '720 patent, including without limitation, the Accused Instrumentalities.

Unless otherwise noted, USTA believes and contends that each element of the claim asserted herein is literally met through Lenovo's provision of the Accused Instrumentalities. However, to the extent that Lenovo attempts to allege that any asserted claim element is not literally met, USTA believes and contends that such elements are met under the doctrine of equivalents. More specifically, in its investigation and analysis of the Accused Instrumentalities, USTA did not identify any substantial differences between the elements of the patent claim and the corresponding features of the Accused Instrumentalities, as set forth herein. In each instance, the identified feature of the Accused Instrumentalities performs at least substantially the same function in substantially the same way to achieve substantially the same result as the corresponding claim element.

To the extent the chart relies on evidence about certain specifically-identified Accused Instrumentalities, USTA asserts that, on information and belief, any similarly-functioning instrumentalities also infringe the charted claim. USTA reserves the right to amend this infringement analysis based on other products made, used, sold, imported, or offered for sale by Lenovo. USTA also reserves the right to amend this infringement analysis by citing other claims of the '720 patent, not listed in the claim chart, that are infringed by the Accused Instrumentalities. USTA further reserves the right to amend this infringement analysis by adding, subtracting, or otherwise modifying content in the "Accused Instrumentalities" column of the chart.

RE47720 - Claim 53	Accused Instrumentalities
A method for managing interference in a radio communications network, comprising the steps of:	The Accused Instrumentalities, when operated by Lenovo's internal testers and/or Lenovo's customers, require performance of a method for managing interference in a radio communications network (e.g., a 802.11ac-compliant network), perform a method for managing interference in a radio communications network. Lenovo makes, uses, and sells 802.11ac-compliant stations (STA) (including, but not limited to the Lenovo Tab P12/P12 Pro, Ideapad Y700, IdeaPad 5G, K12 Pro, and associated hardware and/or software) which, when operated by Lenovo's internal testers and/or Lenovo's customers, require performance of a method for managing interference in a radio communications network (e.g., a 802.11ac-compliant network). For example:

	Overview for ThinkPad Stack Wireless Router/ 1 TB Hard Drive Kit (4XH0H34184) ThinkPad Stack Wireless Router / 1TB Hard Drive kit includes one Wireless Router and one 1TB Hard Drive, this combination provides below key features: • A personalized 1TB high capacity storage sharable with multiple devices • Enjoy an instant information backup through high speed USB 3.0 port • Configured 2.4GHz/5GHz frequency and 3G/4G dongle support delivers ultimate connectivity with greater coverage • ThinkPad Stack Assistant, the dedicated IT to help you run your stack components with ease ELECTRICAL SPECIFICATIONS - ThinkPad Stack Wireless Router Device Interfaces • IEEE 802.11 a/b/g/n/ac wireless LAN • 10/100 WAN port • x1 USB port (one USB 2.0) • Reset button • Power button (https://download.lenovo.com/pccbbs/options/tpstack_wireless_router_1tb_hd_kit_4xh0h34184.p df.)
--	--

	
(https://www.lenovo.com/us/en/p/tablets/android-tablets/lenovo-tab-series/lenovo-tab-p12/len10310018#tech_specs.)	
Wireless	• WiFi 6 802.11AX (2 x 2) • Bluetooth® 5.1



(https://psref.lenovo.com/syspool/Sys/PDF/Lenovo_Laptops/ideapad_Y700_15/ideapad_Y700_15_Spec.PDF.)

	CONNECTIVITY Network Ethernet No onboard Ethernet WLAN + Bluetooth®¹¹ 802.11ac 2x2 Wi-Fi* + Bluetooth 5.0 WWAN Qualcomm Snapdragon X55 5G Modem-RF System, Sub-6 GHz, M.2 card SIM Card eSIM (https://psref.lenovo.com/syspool/Sys/PDF/IdeaPad/IdeaPad_5G_14Q8X05/IdeaPad_5G_14Q8X05_Spec.pdf.)
--	--

Lenovo K12 Pro



Released 2020, December 12
 221g, 9.7mm thickness
 <> Android 10
 64GB/128GB storage, microSDXC

 **6.8"**
 720x1640 pixels

 **64MP**
 1080p

COMMS	
WLAN	Wi-Fi 802.11 a/b/g/n/ac, dual-band, Wi-Fi Direct
Bluetooth	5.0, A2DP, LE
Positioning	GPS, GLONASS, GALILEO
NFC	Yes
Radio	FM radio
USB	USB Type-C 2.0, OTG

(https://www.gsmarena.com/lenovo_k12_pro-10605.php)

See excerpt(s) below, for example (emphasis added):

"10.3 DCF

10.3.1 General

The basic medium access protocol is a DCF that allows for automatic medium sharing between compatible PHYs through the use of CSMA/CA and a random backoff time following a busy medium condition. In addition, all individually addressed traffic uses immediate positive acknowledgment (Ack frame), in which retransmission is scheduled by the sender if no Ack frame is received.

The CSMA/CA protocol is designed to reduce the collision probability between multiple STAs accessing a medium, at the point where collisions would most likely occur. Just after the medium becomes idle following a busy medium (as indicated by the CS function) is when the highest probability of a collision exists. This is because multiple STAs could have been waiting for the medium to become available again. This is the situation that necessitates a random backoff procedure to resolve medium contention conflicts.

The DCF is modified for use by DMG STAs to allow sharing of the medium between compatible DMG PHYs (see 10.3.4). A DMG STA has no direct knowledge of when it might interfere (collide with the transmission of) another STA.

The CS function of a DMG STA might not indicate the medium busy condition due to the predominant nature of directional transmissions and receptions. The transmission of a STA might interfere (collide) with the transmission of another STA even though the CS function at the first STA does not indicate medium busy. The interference (collision) is identified when the expected response frame is not received. SPSH is achieved by the proper combination of the STA antenna configuration during the media access and data transfer phases.

CS shall be performed both through physical and virtual mechanisms.

The virtual CS mechanism is achieved by distributing reservation information announcing the impending use of the medium. The exchange of RTS and CTS frames prior to the actual Data frame is one means of distribution of this medium reservation information. The RTS and CTS frames contain a Duration field that defines the period of time that the medium is to be reserved to transmit the actual Data frame and the returning Ack frame. A STA receiving either the RTS

frame (sent by the originating STA) or the CTS frame (sent by the destination STA) shall process the medium reservation. Thus, a STA might be unable to receive from the originating STA and yet still know about the impending use of the medium to transmit a Data frame.

Another means of distributing the medium reservation information is the Duration/ID field in individually addressed frames. This field gives the time that the medium is reserved, either to the end of the immediately following Ack frame, or in the case of a fragment sequence, to the end of the Ack frame following the next fragment.

The RTS/CTS exchange also performs both a type of fast collision inference and a transmission path check. If the return CTS frame is not detected by the STA originating the RTS, the originating STA may repeat the process (after observing the other medium-use rules) more quickly than if the long Data frame had been transmitted and a return Ack frame had not been detected. An RTS/CTS exchange by VHT STAs also performs fast collision inference on the secondary 20 MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel and helps the VHT STA transmitting the RTS to determine the available bandwidth at the responder.

Another advantage of the RTS/CTS mechanism occurs where multiple BSSs utilizing the same channel overlap. The medium reservation mechanism works across the BSS boundaries. The RTS/CTS mechanism might also improve operation in a typical situation in which all STAs are able to receive from the AP, but might not be able to receive from all other STAs in the BSA.

Except for MPDUs transmitted via the GCR service, the RTS/CTS mechanism cannot be used for MPDUs with a group addressed immediate destination because there are multiple recipients for the RTS frame, and thus potentially multiple concurrent senders of the CTS frame in response. For MPDUs transmitted via the GCR service, an RTS frame may be used if it is directed to a STA within the GCR group (see 10.22.2.11.2 and 10.24.10). The RTS/CTS mechanism is not used for every Data frame transmission. Because the additional RTS and CTS frames add overhead inefficiency, the mechanism is not always justified, especially for short Data frames.

The use of the RTS/CTS mechanism is under control of dot11RTSThreshold. This attribute may be set on a per-STA basis. This mechanism allows STAs to be configured to initiate RTS/CTS either always, never, or only on frames longer than a specified length.

NOTE—A STA configured not to initiate the RTS/CTS mechanism updates its virtual CS mechanism with the duration information contained in a received RTS or CTS frame, and responds to an RTS frame addressed to it with a CTS frame if permitted by medium access rules.

All non-DMG STAs that are members of a BSS are able to receive and transmit at all of the data rates in the BSSBasicRateSet parameter of the MLME-START.request primitive or BSSBasicRateSet parameter of the SelectedBSS parameter of the MLME-JOIN.request primitive; see 6.3.4.2.4 and 6.3.11.2.4.

NOTE—A STA's operational rate set does not necessarily contain all the mandatory rates. However a STA has to be capable of receiving using a mandatory rate (as required by the rules in 10.7) even if it is not present in this set.

All HT STAs that are members of a BSS are able to receive and transmit using all of the MCSs in the Basic HT-MCS Set field of the HT Operation parameter of the MLME-START.request primitive or Basic HT-MCS Set field of the HT Operation parameter of the SelectedBSS parameter of the MLME-JOIN.request primitive; see 6.3.4.2.4 and 6.3.11.2.4.

All VHT STAs that are members of a BSS are able to receive and transmit using all of the <VHT-MCS, NSS> tuples in the basic VHT-MCS and NSS set (see 11.40.7) except as constrained by the rules of 10.7.12.

All DMG STAs that are members of a BSS are able to receive and transmit using all of the MCSs in the OperationalRateSet parameter of the MLME-START.request primitive or OperationalRateSet parameter of the SelectedBSS parameter of the MLME-JOIN.request primitive; see 6.3.4.2.4 and 6.3.11.2.4.

To support the proper operation of the RTS/CTS by non-DMG STAs, RTS/DMG CTS by DMG STAs, and the virtual CS mechanism, a non-DMG STA shall be able to interpret Control frames with the Subtype subfield equal to RTS or CTS, and a DMG STA shall be able to interpret Control frames with the Subtype subfield equal to RTS or DMG CTS.

A Data frame sent under the DCF shall have the Type subfield set to Data and the Subtype subfield set to Data or Null. A STA receiving a frame with the Type subfield equal to Data shall not indicate the frame to the LLC when the Subtype subfield is equal to Null, but shall indicate the frame to the LLC when the Subtype subfield is equal to Data, even if the frame body contains zero octets.

While in the awake state and operating under DCF but not transmitting, a DMG STA can configure its receive antenna to a quasi-omni pattern in order to receive frames transmitted by any STA that is covered by this antenna pattern.”

Pages 1303-1305 of 802.11-2016

“10.3.2.7 CTS and DMG CTS procedure

A STA that receives an RTS frame addressed to it considers the NAV in determining whether to respond with CTS, unless the NAV was set by a frame originating from the STA sending the RTS frame (see 10.22.2.2). In this subclause, “NAV indicates idle” means that the NAV count is 0 or that the NAV count is nonzero but the nonbandwidth signaling TA obtained from the TA field of the RTS frame matches the saved TXOP holder address.

A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a bandwidth signaling TA and that has the RXVECTOR parameter

DYN_BANDWIDTH_IN_NON_HT equal to Static behaves as follows:

- If the NAV indicates idle and CCA has been idle for all secondary channels (secondary 20 MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel) in the channel width indicated by the RTS frame’s RXVECTOR parameter

	CH_BANDWIDTH_IN_NON_HT for a PIFS prior to the start of the RTS frame, then the STA shall respond with a CTS frame carried in a non-HT or non-HT duplicate PPDU after a SIFS. The CTS frame's TXVECTOR parameters CH_BANDWIDTH and CH_BANDWIDTH_IN_NON_HT shall be set to the same value as the RTS frame's RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT. — Otherwise, the STA shall not respond with a CTS frame. A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a bandwidth signaling TA and that has the RXVECTOR parameter DYN_BANDWIDTH_IN_NON_HT equal to Dynamic behaves as follows: — If the NAV indicates idle, then the STA shall respond with a CTS frame in a non-HT or non-HT duplicate PPDU after a SIFS. The CTS frame's TXVECTOR parameters CH_BANDWIDTH and CH_BANDWIDTH_IN_NON_HT shall be set to any channel width for which CCA on all secondary channels has been idle for a PIFS prior to the start of the RTS frame and that is less than or equal to the channel width indicated in the RTS frame's RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT. — Otherwise, the STA shall not respond with a CTS frame. A non-VHT STA that is addressed by an RTS frame or a VHT STA that is addressed by an RTS frame carried in a non-HT or non-HT duplicate PPDU that has a nonbandwidth signaling TA or a VHT STA that is addressed by an RTS frame in a format other than non-HT or non-HT duplicate behaves as follows: — If the NAV indicates idle, the STA shall respond with a CTS frame after a SIFS. — Otherwise, the STA shall not respond with a CTS frame. The RA field of the CTS frame shall be set to the nonbandwidth signaling TA obtained from the TA field of the RTS frame to which this CTS frame is a response. The Duration field in the CTS frame shall be the duration field from the received RTS frame, adjusted by subtraction of aSIFSTime and the number of microseconds required to transmit the CTS frame at a data rate determined by the rules in 10.7.
--	---

	After transmitting an RTS frame, the STA shall wait for a CTSTimeout interval with a value of $aSIFSTime + aSlotTime + aRxPHYStartDelay$. This interval begins when the MAC receives a PHY-TXEND.confirm primitive. If a PHY-RXSTART.indication primitive does not occur during the CTSTimeout interval, the STA shall conclude that the transmission of the RTS frame has failed, and this STA shall invoke its backoff procedure upon expiration of the CTSTimeout interval. If a PHY-RXSTART.indication primitive does occur during the CTSTimeout interval, the STA shall wait for the corresponding PHY-RXEND.indication primitive to determine whether the RTS frame transmission was successful. The recognition of a valid CTS frame sent by the recipient of the RTS frame, corresponding to this PHY-RXEND.indication primitive, shall be interpreted as successful response, permitting the frame exchange sequence to continue (see Annex G). The recognition of anything else, including any other valid frame, shall be interpreted as failure of the RTS frame transmission. In this instance, the STA shall invoke its backoff procedure at the PHY-RXEND.indication primitive and may process the received frame. A DMG STA follows the procedure defined in this subclause, except that it uses a DMG CTS frame instead of a CTS frame. A non-DMG STA does not transmit DMG CTS frames.” Page 1313-1314 of 802.11-2016
receiving at a first node in the radio communications network an instruction transmitted from a second node in the radio communications network to avoid using a plurality of frequencies to transmit to the second node;	The Accused Instrumentalities perform the step of receiving at a first node in the radio communications network an instruction transmitted from a second node in the radio communications network to avoid using a plurality of frequencies to transmit to the second node. Lenovo makes, uses, and sells 802.11ac-compliant stations (STA) which, when operated by Lenovo’s internal testers and/or Lenovo’s customers, require performance of a method that includes receiving at a first node (e.g. first STA) in the radio communications network an instruction [e.g. “Clear to Send” (CTS) instruction] transmitted from a second node (e.g. second STA) in the radio communications network to avoid using a plurality of frequencies (e.g. at least one secondary channel) to transmit to the second node. Note: Following is evidence that 802.11ac-compliant STAs are each capable of gaining access to both primary and secondary channels (e.g. different sets of frequencies).

“primary 20 MHz channel: In a 40 MHz, 80 MHz, 160 MHz, or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 20 MHz channel that is used to transmit 20 MHz physical layer (PHY) protocol data units (PPDUs). In a VHT BSS, the primary 20 MHz channel is also the primary channel.

primary 40 MHz channel: In an 80 MHz, 160 MHz, or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 40 MHz channel that is used to transmit 40 MHz physical layer (PHY) protocol data units (PPDUs).

primary 80 MHz channel: In a 160 MHz or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 80 MHz channel that is used to transmit 80 MHz physical layer (PHY) protocol data units (PPDUs).

primary access category (AC): The access category (AC) associated with the enhanced distributed channel access function (EDCAF) that gains channel access.

...

secondary 20 MHz channel: In a 40 MHz very high throughput (VHT) basic service set (BSS), the 20 MHz channel adjacent to the primary 20 MHz channel that together form the 40 MHz channel of the 40 MHz VHT BSS. In an 80 MHz VHT BSS, the 20 MHz channel adjacent to the primary 20 MHz channel that together form the primary 40 MHz channel of the 80 MHz VHT BSS. In a 160 MHz or 80+80 MHz VHT BSS, the 20 MHz channel adjacent to the primary 20 MHz channel that together form the primary 40 MHz channel of the 160 MHz or 80+80 MHz VHT BSS. In a VHT BSS, the secondary 20 MHz channel is also the secondary channel.

secondary 40 MHz channel: In an 80 MHz very high throughput (VHT) basic service set (BSS), the

40 MHz channel adjacent to the primary 40 MHz channel that together form the 80 MHz channel of the 80 MHz VHT BSS. In a 160 or 80+80 MHz VHT BSS, the 40 MHz channel adjacent to the primary 40 MHz channel that together form the primary 80 MHz channel.

secondary 80 MHz channel: In a 160 MHz or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 80 MHz channel not including the primary 20 MHz channel, that together with the primary 80 MHz channel forms the 160 MHz or 80+80 MHz channel of the 160 MHz or 80+80 MHz VHT BSS.

secondary access category (AC): An access category (AC) that is not associated with the enhanced distributed channel access function (EDCAF) that gains channel access.

NOTE—Traffic associated with a secondary AC can be included in a multi-user (MU) physical layer (PHY) protocol data unit (MU PPDU) that includes traffic associated with the primary AC. There could be multiple secondary ACs at a given time.”

Page 161-163 of 802.11-2016

Note: Following is evidence that 802.11ac-compliant STAs are each configured to receive a CTS instruction that is interpreted in such a manner that the use of a first set of frequencies (e.g. at least one secondary channel) is to be avoided, in favor of a second set of frequencies (e.g. the primary channel, at least one other secondary channel). Specifically, a CH_BANDWIDTH_IN_NON_HT parameter (that is included in the CTS instruction) indicates a value that, if less than a full channel width, results in the avoidance of use of certain one or more secondary channels.

“10.3.2.7 CTS and DMG CTS procedure

A STA that receives an RTS frame addressed to it considers the NAV in determining whether to respond with CTS, unless the NAV was set by a frame originating from the STA sending the RTS frame (see 10.22.2.2). In this subclause, “NAV indicates idle” means that the NAV count is 0 or

that the NAV count is nonzero but the nonbandwidth signaling TA obtained from the TA field of the RTS frame matches the saved TXOP holder address.

A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a bandwidth signaling TA and that has the RXVECTOR parameter

DYN_BANDWIDTH_IN_NON_HT equal to Static behaves as follows:

- If the NAV indicates idle and CCA has been idle for all secondary channels (secondary 20 MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel) in the channel width indicated by the RTS frame's RXVECTOR parameter
- CH_BANDWIDTH_IN_NON_HT for a PIFS prior to the start of the RTS frame, then the STA shall respond with a CTS frame carried in a non-HT or non-HT duplicate PPDU after a SIFS. The CTS frame's TXVECTOR parameters CH_BANDWIDTH and
- CH_BANDWIDTH_IN_NON_HT shall be set to the same value as the RTS frame's RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT.
- Otherwise, the STA shall not respond with a CTS frame.

A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a bandwidth signaling TA and that has the RXVECTOR parameter

DYN_BANDWIDTH_IN_NON_HT equal to Dynamic behaves as follows:

- If the NAV indicates idle, then the STA shall respond with a CTS frame in a non-HT or non-HT duplicate PPDU after a SIFS. The CTS frame's TXVECTOR parameters
- CH_BANDWIDTH and CH_BANDWIDTH_IN_NON_HT shall be set to any channel width for which CCA on all secondary channels has been idle for a PIFS prior to the start of the RTS frame and that is less than or equal to the channel width indicated in the RTS frame's RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT.
- Otherwise, the STA shall not respond with a CTS frame.

A non-VHT STA that is addressed by an RTS frame or a VHT STA that is addressed by an RTS frame carried in a non-HT or non-HT duplicate PPDU that has a nonbandwidth signaling TA or a VHT STA that is addressed by an RTS frame in a format other than non-HT or non-HT duplicate behaves as follows:

- If the NAV indicates idle, the STA shall respond with a CTS frame after a SIFS.
- Otherwise, the STA shall not respond with a CTS frame.

The RA field of the CTS frame shall be set to the nonbandwidth signaling TA obtained from the TA field of the RTS frame to which this CTS frame is a response. The Duration field in the CTS frame shall be the duration field from the received RTS frame, adjusted by subtraction of aSIFSTime and the number of microseconds required to transmit the CTS frame at a data rate determined by the rules in 10.7.

After transmitting an RTS frame, the STA shall wait for a CTSTimeout interval with a value of aSIFSTime + aSlotTime + aRxPHYStartDelay. This interval begins when the MAC receives a PHY-TXEND.confirm primitive. If a PHY-RXSTART.indication primitive does not occur during the CTSTimeout interval, the STA shall conclude that the transmission of the RTS frame has failed, and this STA shall invoke its backoff procedure upon expiration of the CTSTimeout interval. If a PHY-RXSTART.indication primitive does occur during the CTSTimeout interval, the STA shall wait for the corresponding PHY-RXEND.indication primitive to determine whether the RTS frame transmission was successful. The recognition of a valid CTS frame sent by the recipient of the RTS frame, corresponding to this PHY-RXEND.indication primitive, shall be interpreted as successful response, permitting the frame exchange sequence to continue (see Annex G). The recognition of anything else, including any other valid frame, shall be interpreted as failure of the RTS frame transmission. In this instance, the STA shall invoke its backoff procedure at the PHY-RXEND.indication primitive and may process the received frame.

A DMG STA follows the procedure defined in this subclause, except that it uses a DMG CTS frame instead of a CTS frame. A non-DMG STA does not transmit DMG CTS frames.”

Page 1313-1314 of 802.11-2016

“10.3.1 General

...

The RTS/CTS exchange also performs both a type of fast collision inference and a transmission path check. If the return CTS frame is not detected by the STA originating the RTS, the originating STA may repeat the process (after observing the other medium-use rules) more quickly than if the long Data frame had been transmitted and a return Ack frame had not been detected. An RTS/CTS exchange by VHT STAs also performs fast collision inference on the secondary 20 MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel and helps the VHT STA transmitting the RTS to determine the available bandwidth at the responder.“

Page 1304 of 802.11-2016

“10.3.2.6 VHT RTS procedure

A VHT STA transmitting an RTS frame carried in non-HT or non-HT duplicate format and addressed to a VHT STA shall set the TA field to a bandwidth signaling TA and shall set the TXVECTOR parameters CH_BANDWIDTH_IN_NON_HT and CH_BANDWIDTH to the same value. If the STA sending the RTS frame is capable of dynamic bandwidth operation (see 10.3.2.7), the STA shall set the TXVECTOR parameter DYN_BANDWIDTH_IN_NON_HT to Dynamic. Otherwise, the STA shall set the TXVECTOR parameter DYN_BANDWIDTH_IN_NON_HT to Static.

A VHT STA that initiates a TXOP by transmitting an RTS frame with the TA field set to a bandwidth signaling TA shall not send an RTS frame to a non-VHT STA for the duration of the TXOP.

NOTE—A non-VHT STA considers the bandwidth signaling TA as the address of the TXOP holder. If an RTS frame is sent to a non-VHT STA during a TXOP that is initiated by an RTS frame with a bandwidth signaling TA, the non-VHT STA does not recognize the RTS sender as the TXOP holder.

10.3.2.7 CTS and DMG CTS procedure

A STA that receives an RTS frame addressed to it considers the NAV in determining whether to respond with CTS, unless the NAV was set by a frame originating from the STA sending the RTS frame (see 10.22.2.2). In this subclause, “NAV indicates idle” means that the NAV count is 0 or that the NAV count is nonzero but the nonbandwidth signaling TA obtained from the TA field of the RTS frame matches the saved TXOP holder address.

A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a bandwidth signaling TA and that has the RXVECTOR parameter

DYN_BANDWIDTH_IN_NON_HT equal to Static behaves as follows:

- If the NAV indicates idle and CCA has been idle for all secondary channels (secondary 20 MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel) in the channel width indicated by the RTS frame’s RXVECTOR parameter
- CH_BANDWIDTH_IN_NON_HT for a PIFS prior to the start of the RTS frame, then the STA shall respond with a CTS frame carried in a non-HT or non-HT duplicate PPDU after a SIFS. The CTS frame’s TXVECTOR parameters CH_BANDWIDTH and
- CH_BANDWIDTH_IN_NON_HT shall be set to the same value as the RTS frame’s
- RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT.
- Otherwise, the STA shall not respond with a CTS frame.

A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a bandwidth signaling TA and that has the RXVECTOR parameter

DYN_BANDWIDTH_IN_NON_HT equal to Dynamic behaves as follows:

- If the NAV indicates idle, then the STA shall respond with a CTS frame in a non-HT or non-HT duplicate PPDU after a SIFS. The CTS frame’s TXVECTOR parameters
- CH_BANDWIDTH and CH_BANDWIDTH_IN_NON_HT shall be set to any channel width
- for which CCA on all secondary channels has been idle for a PIFS prior to the start of the
- RTS frame and that is less than or equal to the channel width indicated in the RTS frame’s
- RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT.
- Otherwise, the STA shall not respond with a CTS frame.

A non-VHT STA that is addressed by an RTS frame or a VHT STA that is addressed by an RTS frame carried in a non-HT or non-HT duplicate PPDU that has a nonbandwidth signaling TA or a VHT STA that is addressed by an RTS frame in a format other than non-HT or non-HT duplicate behaves as follows:

- If the NAV indicates idle, the STA shall respond with a CTS frame after a SIFS.
- Otherwise, the STA shall not respond with a CTS frame.

The RA field of the CTS frame shall be set to the nonbandwidth signaling TA obtained from the TA field of the RTS frame to which this CTS frame is a response. The Duration field in the CTS frame shall be the duration field from the received RTS frame, adjusted by subtraction of aSIFSTime and the number of microseconds required to transmit the CTS frame at a data rate determined by the rules in 10.7.

After transmitting an RTS frame, the STA shall wait for a CTSTimeout interval with a value of $aSIFSTime + aSlotTime + aRxPHYStartDelay$. This interval begins when the MAC receives a PHY-TXEND.confirm primitive. If a PHY-RXSTART.indication primitive does not occur during the CTSTimeout interval, the STA shall conclude that the transmission of the RTS frame has failed, and this STA shall invoke its backoff procedure upon expiration of the CTSTimeout interval. If a PHY-RXSTART.indication primitive does occur during the CTSTimeout interval, the STA shall wait for the corresponding PHY-RXEND.indication primitive to determine whether the RTS frame transmission was successful. The recognition of a valid CTS frame sent by the recipient of the RTS frame, corresponding to this PHY-RXEND.indication primitive, shall be interpreted as successful response, permitting the frame exchange sequence to continue (see Annex G). The recognition of anything else, including any other valid frame, shall be interpreted as failure of the RTS frame transmission. In this instance, the STA shall invoke its backoff procedure at the PHY-RXEND.indication primitive and may process the received frame.

A DMG STA follows the procedure defined in this subclause, except that it uses a DMG CTS frame instead of a CTS frame. A non-DMG STA does not transmit DMG CTS frames.”

Page 1313-1314 of 802.11-2016

	<u>“If a TXOP is protected by an RTS or CTS frame carried in a non-HT or a non-HT duplicate PPDU, the TXOP holder shall set the TXVECTOR parameter CH_BANDWIDTH of a PPDU as follows:</u> <u>— To be the same or narrower than RXVECTOR parameter CH_BANDWIDTH IN NON_HT of the last received CTS frame in the same TXOP, if the RTS frame with a bandwidth signaling TA and TXVECTOR parameter DYN_BANDWIDTH IN NON_HT set to Dynamic has been sent by the TXOP holder in the last RTS/CTS exchange.</u> <u>— Otherwise, to be the same or narrower than the TXVECTOR parameter CH_BANDWIDTH of the RTS frame that has been sent by the TXOP holder in the last RTS/CTS in the same TXOP.”</u> Page 1386 of 802.11-2016 “17.2.2.1 General ...
--	--

Table 17-1—TXVECTOR parameters (continued)

Parameter	Associated primitive	Value
TIME OF DEPARTURE REQUESTED	PHY-TXSTART.request (TXVECTOR)	false, true. When true, the MAC entity requests that the PHY entity measures and reports time of departure parameters corresponding to the time when the first frame energy is sent by the transmitting port; when false, the MAC entity requests that the PHY entity neither measures nor reports time of departure parameters.
CH_BANDWIDTH_IN_NON_HT	PHY-TXSTART.request (TXVECTOR)	If present, CBW20, CBW40, CBW80, CBW160, or CBW80+80
DYN_BANDWIDTH_IN_NON_HT	PHY-TXSTART.request (TXVECTOR)	If present, Static or Dynamic

...

17.2.2.8 TXVECTOR DYN_BANDWIDTH_IN_NON_HT

If present, the allowed values for DYN_BANDWIDTH_IN_NON_HT are Static and Dynamic. If present, this parameter is used to modify the first 7 bits of the scrambling sequence to indicate if the transmitter is capable of Static or Dynamic bandwidth operation. If DYN_BANDWIDTH_IN_NON_HT is present, then CH_BANDWIDTH_IN_NON_HT is also present.

NOTE—The DYN_BANDWIDTH_IN_NON_HT parameter is not present when the frame is transmitted by a non-VHT STA. The DYN_BANDWIDTH_IN_NON_HT parameter is not present when the frame is transmitted by a VHT STA to a non-VHT STA. See 10.7.11.”

Page 2279-2280 of 802.11-2016

“17.2.3.1 General

...

Table 17-2—RXVECTOR parameters (continued)

Parameter	Associated primitive	Value
RX_START_OF_FRAME_OFFSET	PHY-RXSTART.indication (RXVECTOR)	0 to $2^{32}-1$. An estimate of the offset (in 10 ns units) from the point in time at which the start of the preamble corresponding to the incoming frame arrived at the receive antenna connector to the point in time at which this primitive is issued to the MAC.
CH_BANDWIDTH_IN_NON_HT	PHY-RXSTART.request (RXVECTOR)	If present, CBW20, CBW40, CBW80, CBW160, or CBW80+80
DYN_BANDWIDTH_IN_NON_HT	PHY-RXSTART.request (RXVECTOR)	If present, Static or Dynamic
NOTE—Parameter is present only when dot11RadioMeasurementActivated is true.		

...

17.2.3.7 RXVECTOR CH_BANDWIDTH_IN_NON_HT

If present, the allowed values for CH_BANDWIDTH_IN_NON_HT are CBW20, CBW40, CBW80, CBW160, and CBW80+80. If present and valid, this parameter indicates the bandwidth of the non-HT duplicate PPDU. This parameter is used by the MAC only when valid (see 10.3.2.7 and 10.7.6.6).

NOTE—The CH_BANDWIDTH_IN_NON_HT parameter is not present when the frame is received by a non-VHT STA (see 10.7.11).”

Page 2281-2282 of 802.11-2016

Table 18-6b—TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

Enumerated value	Value
CBW20	0
CBW40	1
CBW80	2
CBW160 or CBW80+80	3

Table 18-6c—RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

CbwInNonHtTemp (see Table 18-6a)	dot11CurrentChannelCenter FrequencyIndex1	RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT
0	0	CBW20
1	0	CBW40
2	0	CBW80
3	0	CBW160
3	1 to 200	CBW80+80

Table 17-8—TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

Enumerated value	Value
CBW20	0
CBW40	1
CBW80	2
CBW160 or CBW80+80	3

During reception by a VHT STA, the CbwInNonHtTemp variable shall be set to selected bits in the scrambling sequence as shown in Table 17-7 and then mapped as shown in Table 17-9 to the RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT. During reception by a VHT STA, the RXVECTOR parameter DYN_BANDWIDTH_IN_NON_HT shall be set to selected bits in the scrambling sequence as shown in Table 17-7. The fields shall be interpreted as being sent LSB-first.

Table 17-9—RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

CbwInNonHtTemp (see Table 17-7)	dot11CurrentChannelCenter FrequencyIndex1	RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT
0	0	CBW20
1	0	CBW40
2	0	CBW80
3	0	CBW160
3	1 to 200	CBW80+80

filtering a transmission signal to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided;	Page 2294 of 802.11-2016 The Accused Instrumentalities perform the step of filtering a transmission signal to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided. Lenovo makes, uses, and sells 802.11ac-compliant stations (STA) which, when operated by Lenovo's internal testers and/or Lenovo's customers, require performance of a method that includes filtering a transmission signal (e.g. via a mask PPDU and resulting scrambling, and/or another filtering that results in power (that was used or could be used) being removed, etc.) to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided (e.g. based on the CTS instruction). See excerpt(s) below, for example (emphasis added): <u>Note:</u> Following is evidence that 802.11ac-compliant STAs are each configured to filter a transmission signal by setting requirements on a transmitter to remove power from the transmission signal at each frequency in the secondary channel(s) based on the CH_BANDWIDTH_IN_NON_HT parameter of the CTS instruction. This is accomplished via a mask PPDU and resulting data scrambling. Further, power (that was used or could be used) is dynamically removed. “10.22.2.5 EDCA channel access in a VHT or TVHT BSS If the MAC receives a PHY-CCA.indication primitive with the channel-list parameter present, the channels considered idle are defined in Table 10-10.
--	--

Table 10-10—Channels indicated idle by the channel-list parameter

PHY-CCA.indication primitive channel-list element	Idle channels
primary	None
secondary	Primary 20 MHz channel
secondary40	Primary 20 MHz channel and secondary 20 MHz channel
secondary80	Primary 20 MHz channel, secondary 20 MHz channel, and secondary 40 MHz channel

When a STA and the BSS, of which the STA is a member, both support multiple channel widths, an EDCA TXOP is obtained based solely on activity of the primary channel. “Idle medium” in this subclause means “idle primary channel.” Likewise “busy medium” means “busy primary channel.” Once an EDCA TXOP has been obtained according to this subclause, further constraints defined in 11.16.9 and 10.22.3 might limit the width of transmission during the TXOP or deny the channel access, based on the state of CCA on secondary channel, secondary 40 MHz channel, or secondary 80 MHz channel.

In the following description, the CCA is sampled according to the timing relationships defined in 10.3.7. Slot boundaries are determined solely by activity on the primary channel. “Channel idle for an interval of PIFS” means that the STATE parameter of the most recent PHY-CCA.indication primitive was IDLE, and no PHYCCA. Indication (BUSY) occurred during the period of PIFS that ends at the start of transmission, the CCA for that channel was determined to be idle.

If a STA is permitted to begin a TXOP (as defined in 9.19.2.3) and the STA has at least one MSDU pending for transmission for the AC of the permitted TXOP, the STA shall perform exactly one of the following steps:

	a) <u>Transmit a 160 MHz or 80+80 MHz mask PPDU if the secondary channel, the secondary 40 MHz channel, and the secondary 80 MHz channel were idle during an interval of PIFS immediately preceding the start of the TXOP.</u> b) <u>Transmit an 80 MHz mask PPDU on the primary 80 MHz channel if both the secondary channel and the secondary 40 MHz channel were idle during an interval of PIFS immediately preceding the start of the TXOP.</u> c) <u>Transmit a 40 MHz mask PPDU on the primary 40 MHz channel if the secondary channel was idle during an interval of PIFS immediately preceding the start of the TXOP.</u> d) <u>Transmit a 20 MHz mask PPDU on the primary 20 MHz channel.</u> e) <u>Restart the channel access attempt by invoking the backoff procedure as specified in 10.22.2 as though the medium is busy on the primary channel as indicated by either physical or virtual CS and the backoff timer has a value of 0.”</u> Pages 1383 of 802.11-2016 “17.3.2.2 Overview of the PPDU encoding process ... e) <u>If the TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT is not present, initiate the scrambler with a pseudorandom nonzero seed and generate a scrambling sequence. If the TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT is present, construct the first 7 bits of the scrambling sequence from CH_BANDWIDTH_IN_NON_HT, DYN_BANDWIDTH_IN_NON_HT (if present), and a pseudorandom integer constrained such that the first 7 bits of the scrambling sequence are not all 0s; then set the scrambler state to these 7 bits and generate the remainder of the scrambling sequence. XOR the scrambling sequence with the extended string of data bits. Refer to 17.3.5.5 for details.</u> Pages 1383-2284 of 802.11-2016 “17.3.5.5 PHY DATA scrambler and descrambler
--	--

The DATA field, composed of SERVICE, PSDU, tail, and pad parts, shall be scrambled with a length-127 PPDU-synchronous scrambler. The octets of the PSDU are placed in the transmit serial bit stream, bit 0 first and bit 7 last. The PPDU synchronous scrambler uses the generator polynomial $S(x)$ as follows and is illustrated in Figure 17-7:

$$S(x) = x^7 + x^4 + 1 \quad (17-14)$$

Replace Figure 18-7 with the following:

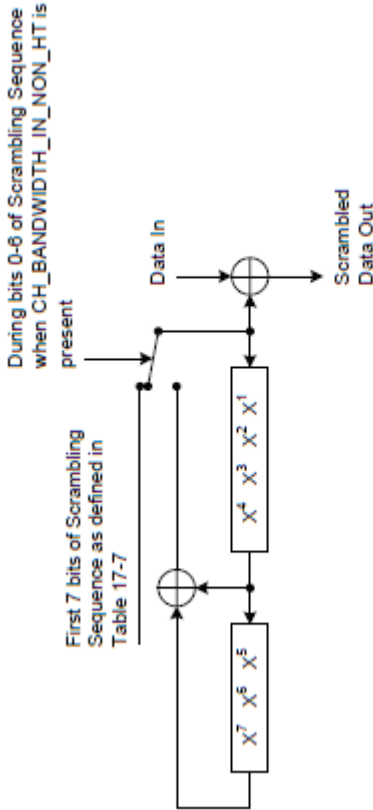
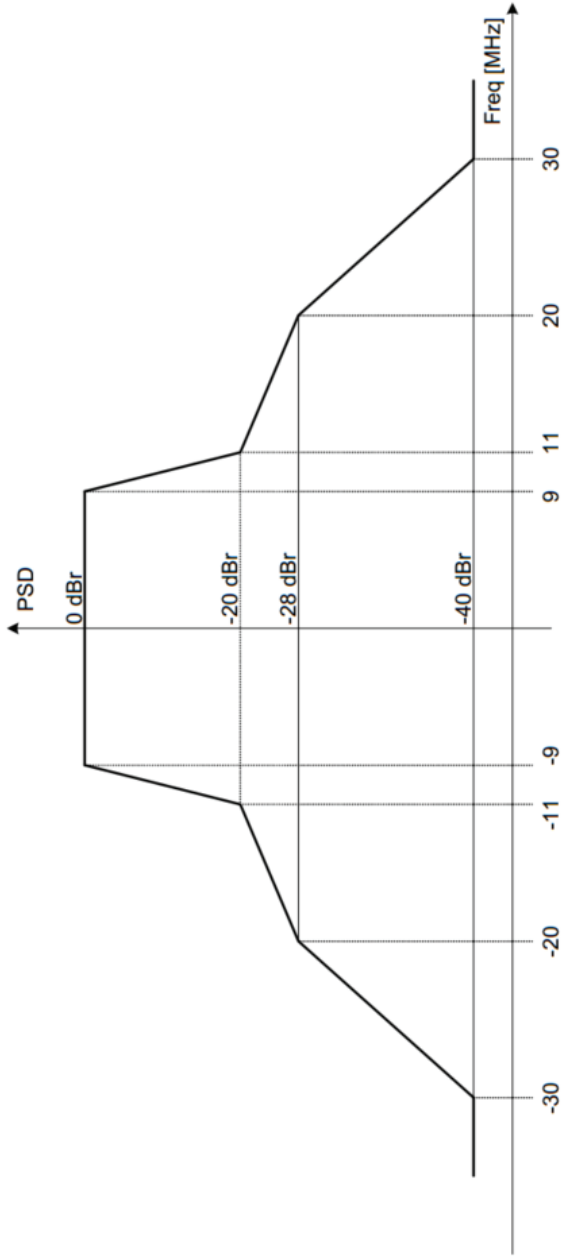


Figure 17-7—Data scrambler

The 127-bit sequence generated repeatedly by the scrambler shall be (leftmost used first), 00001110 11110010 11001001 00000010 00100110 00101110 10110110 00001100 11010100 11100111 10110100 00101010 11111010 01010001 10111000 11111111, when the all 1s initial state is used. The same scrambler is used to scramble transmit data and to descramble receive data. If the TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT is not present, when

transmitting, the initial state of the scrambler shall be set to a pseudorandom nonzero state. If the TXVECTOR parameter <u>CH_BANDWIDTH_IN_NON_HT</u> is present, — The first 7 bits of the scrambling sequence shall be set as shown in Table 17-7 (with field values defined in Table 17-8 and Table 17-10) and shall be also used to initialize the state of the scrambler — The scrambler with this initialization shall generate the remainder (i.e., after the first 7 bits) of the scrambling sequence as shown in Figure 17-7 — <u>CH_BANDWIDTH_IN_NON_HT</u> is transmitted LSB first. For example, if CBW80 has a value of 2, which is ‘10’ in binary representation, then B5=0 and B6=1 ... During reception by a VHT STA, the CbwInNonHtTemp variable shall be set to selected bits in the scrambling sequence as shown in Table 17-7 and then mapped as shown in Table 17-9 to the RXVECTOR parameter <u>CH_BANDWIDTH_IN_NON_HT</u>. During reception by a VHT STA, the RXVECTOR parameter <u>DYN_BANDWIDTH_IN_NON_HT</u> shall be set to selected bits in the scrambling sequence as shown in Table 17-7. The fields shall be interpreted as being sent LSB-first.” Pages 2292-2294 of 802.11-2016 “21.3.17 VHT transmit specification 21.3.17.1 Transmit spectrum mask NOTE 1—In the presence of additional regulatory restrictions, the device has to meet both the regulatory requirements and the mask defined in this subclause. NOTE 2—Transmit spectral mask figures in this subclause are not drawn to scale. NOTE 3—For rules regarding TX center frequency leakage levels, see 21.3.17.4.2. The spectral mask requirements in this subclause do not apply to the RF LO.	
---	--

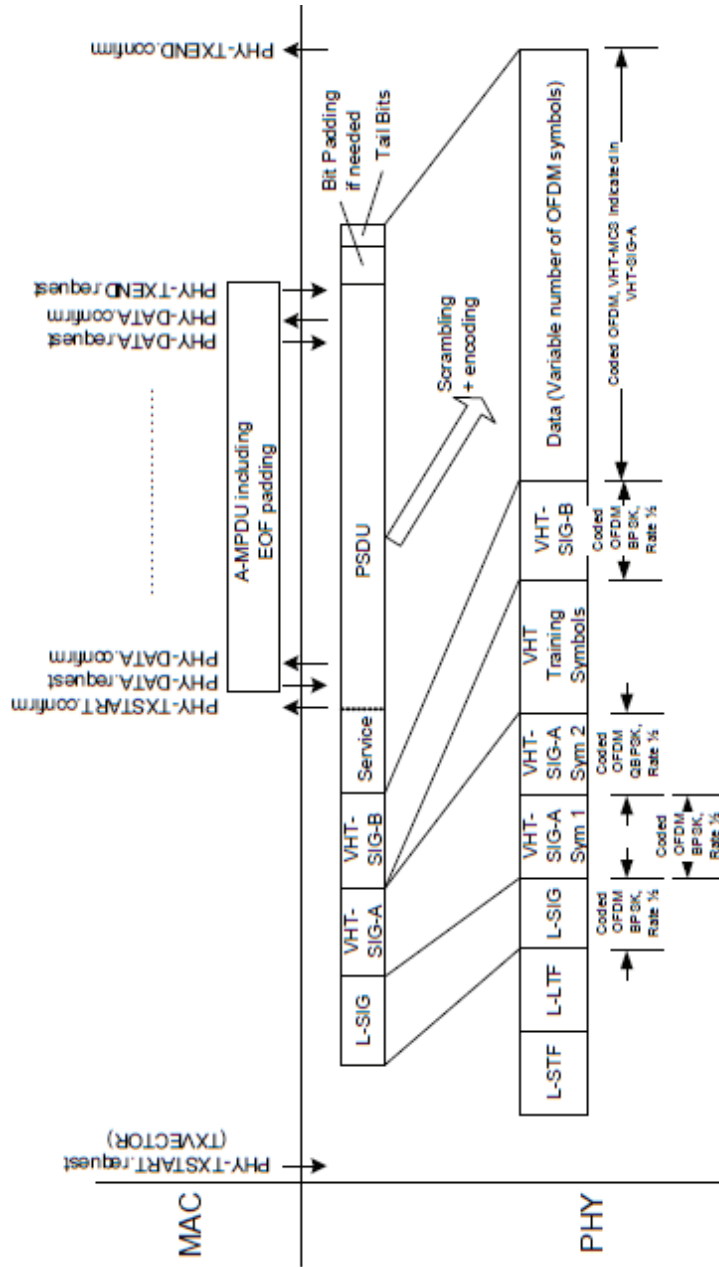
For a 20 MHz mask PPDU of non-HT, HT or VHT format, the interim transmit spectral mask shall have a 0 dB relative to the maximum spectral density of the signal) bandwidth of 18 MHz, -20 dB at 11 MHz frequency offset, -28 dB at 20 MHz frequency offset, and -40 dB at 30 MHz frequency offset and above. The interim transmit spectral mask for frequency offsets in between 9 and 11 MHz, 11 and 20 MHz, and 20 and 30 MHz shall be linearly interpolated in dB domain from the requirements for 9 MHz, 11 MHz, 20 MHz, and 30 MHz frequency offsets. The transmit spectrum shall not exceed the maximum of the interim transmit spectral mask and -53 dBm/MHz at any frequency offset. Figure 21-29 shows an example of the resulting overall spectral mask when the -40 dBm spectrum level is above -53 dBm/MHz.



For a 40 MHz mask PPDU of non-HT, non-HT duplicate, HT or VHT format, the interim transmit spectral mask shall have a 0 dB relative to the maximum spectral density of the signal) bandwidth of 38 MHz, -20 dB at 21 MHz frequency offset, -28 dB at 40 MHz frequency offset, and -40 dB at 60 MHz frequency offset and above. The interim transmit spectral mask for frequency offsets in between 19 and 21 MHz, 21 and 40 MHz, and 40 and 60 MHz shall be

	linearly interpolated in dB domain from the requirements for 19 MHz, 21 MHz, 40 MHz, and 60 MHz frequency offsets. The transmit spectrum shall not exceed the maximum of the interim transmit spectral mask and -56 dBm/MHz at any frequency offset greater than 19 MHz. Figure 21-30 shows an example of the resulting overall spectral mask when the -40 dBm spectrum level is above -56 dBm/MHz.” Page 2582-2583 of 802.11-2016
transmitting the filtered transmission signal to the second node;	The Accused Instrumentalities perform the step of transmitting the filtered transmission signal to the second node. Lenovo makes, uses, and sells 802.11ac-compliant stations (STA) which, when operated by Lenovo’s internal testers and/or Lenovo’s customers, require performance of a method that includes transmitting the filtered transmission signal to the second node. See excerpt(s) below, for example (emphasis added): “21.3.19 PHY transmit procedure There are two paths for the transmit PHY procedure: — The first path, for which typical transmit procedures are shown in Figure 21-34, is selected if the FORMAT parameter of the PHY-TXSTART.request(TXVECTOR) primitive is VHT. These transmit procedures do not describe the operation of optional features, such as LDPC, STBC or MU. — The second path is to follow the transmit procedure in Clause 17 if the FORMAT parameter of the PHY-TXSTART.request(TXVECTOR) primitive is NON_HT and the NON_HT_MODULATION parameter is set to NON_HT_DUP_OFDM <u>except that the signal referred to in Clause 17 is instead generated simultaneously on each of the 20 MHz channels that are indicated by the CH_BANDWIDTH parameter as defined in 21.3.8 and 21.3.10.12.”</u>

Page 2595 of 802.11-2016



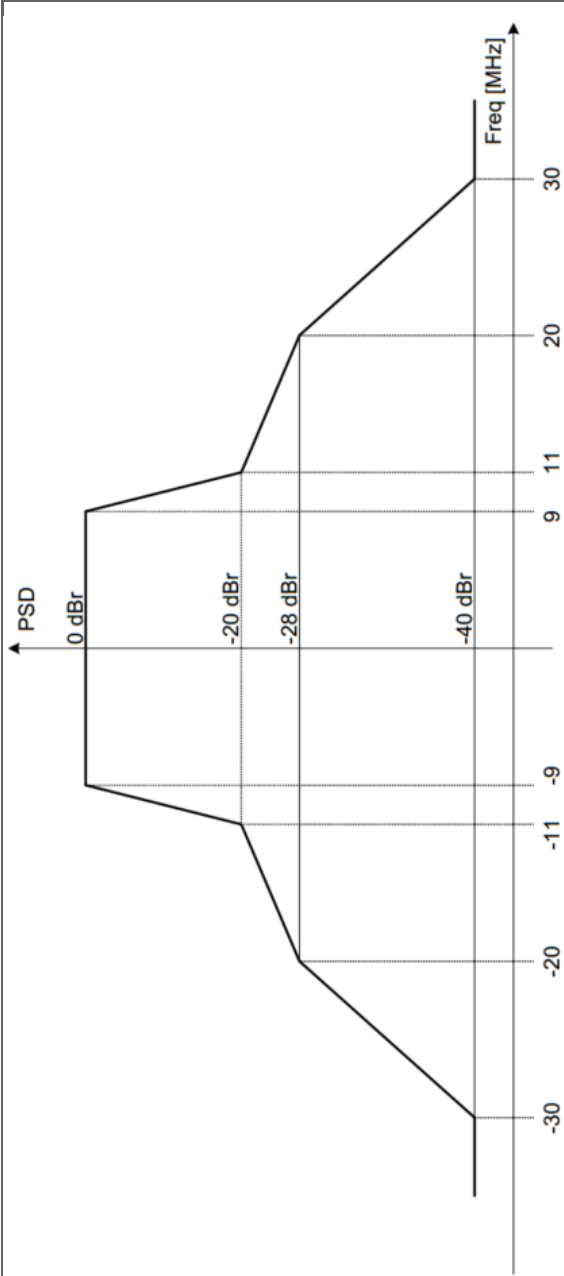
NOTE—This procedure does not describe the operation of optional features, such as MU-MIMO, LDPC or STBC.

Figure 21-34—PHY transmit procedure for SU transmission

...

“After the PHY preamble transmission is started, the PHY entity immediately initiates data scrambling and data encoding. The encoding method for the Data field is based on the

FEC_CODING, CH_BANDWIDTH, NUM_STS, STBC, MCS, and NUM_USERS parameter of the TXVECTOR, as described in 21.3.2.” Page 2596 of 802.11-2016 “21.3.17 VHT transmit specification 21.3.17.1 Transmit spectrum mask NOTE 1—In the presence of additional regulatory restrictions, the device has to meet both the regulatory requirements and the mask defined in this subclause. NOTE 2—Transmit spectral mask figures in this subclause are not drawn to scale. NOTE 3—For rules regarding TX center frequency leakage levels, see 21.3.17.4.2. The spectral mask requirements in this subclause do not apply to the RF LO. For a 20 MHz mask PPDU of non-HT, HT or VHT format, the interim transmit spectral mask shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth of 18 MHz, -20 dBr at 11 MHz frequency offset, -28 dBr at 20 MHz frequency offset, and -40 dBr at 30 MHz frequency offset and above. The interim transmit spectral mask for frequency offsets in between 9 and 11 MHz, 11 and 20 MHz, and 20 and 30 MHz shall be linearly interpolated in dB domain from the requirements for 9 MHz, 11 MHz, 20 MHz, and 30 MHz frequency offsets. The transmit spectrum shall not exceed the maximum of the interim transmit spectral mask and -53 dBm/MHz at any frequency offset. Figure 21-29 shows an example of the resulting overall spectral mask when the -40 dBr spectrum level is above -53 dBm/MHz.	
---	--



For a 40 MHz mask PPDU of non-HT, non-HT duplicate, HT or VHT format, the interim transmit spectral mask shall have a 0 dBm/MHz relative to the maximum spectral density of the signal) bandwidth of 38 MHz, -20 dBm/MHz at 21 MHz frequency offset, -28 dBm/MHz at 40 MHz frequency offset, and -40 dBm/MHz at 60 MHz frequency offset and above. The interim transmit spectral mask for frequency offsets in between 19 and 21 MHz, 21 and 40 MHz, and 40 and 60 MHz shall be linearly interpolated in dB domain from the requirements for 19 MHz, 21 MHz, 40 MHz, and 60 MHz frequency offsets. The transmit spectrum shall not exceed the maximum of the interim transmit spectral mask and -56 dBm/MHz at any frequency offset greater than 19 MHz. Figure 21-30 shows an example of the resulting overall spectral mask when the -40 dBm/MHz level is above -56 dBm/MHz.”

Page 2582-2583 of 802.11-2016

receiving a compressed first feedback from the second node that characterizes receipt of a first signal sent from the first node to the second node;

receiving a compressed second feedback from a third node that characterizes receipt of a second signal sent from the first node to the third node;

The Accused Instrumentalities perform the steps of receiving a compressed first feedback from the second node that characterizes receipt of a first signal sent from the first node to the second node; and receiving a compressed second feedback from a third node that characterizes receipt of a second signal sent from the first node to the third node

Lenovo makes, uses, and sells 802.11ac-compliant stations (STA) which, when operated by Lenovo's internal testers and/or Lenovo's customers, require performance of a method that includes receiving a compressed first feedback (e.g. a first feedback matrix) from the second node that characterizes receipt of a first signal (e.g. a first VHT NDP sounding PPDU) sent from the first node to the second node; and receiving a compressed second feedback (e.g. a second feedback matrix) from a third node that characterizes receipt of a second signal (e.g. a first VHT NDP sounding PPDU) sent from the first node to the third node.

21.3.11.2 Beamforming Feedback Matrix V

"Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in Table 21-11 from the measured channel before computing a set of matrices for feedback to the beamformer. The beamforming feedback matrix, $V_{k,u}$, found by the beamformee u for subcarrier k shall be compressed in the form of angles using the method described in 19.3.12.3.6. The angles, $\varphi(k,v)$ and $\psi(k,u)$, are quantized according to Table 9-68. The number of bits for quantization is chosen by the beamformee, based on the indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DLMU-MIMO beamforming. The compressed beamforming feedback using 19.3.12.3.6 is the only Clause 21 beamforming feedback format defined.

The beamformee shall generate the beamforming feedback matrices with the number of rows (Nr) equal to the N_{STS} of the NDP.

After receiving the angle information, $\varphi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,\theta}$ matrix to

determine the steering matrix $\mathbf{Q}_k$. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $\mathbf{Q}_k = [\mathbf{Q}_{k,0}, \mathbf{Q}_{k,1}, \dots, \mathbf{Q}_{k,N_{\text{user}}-1}]$ using $V_{k,u}$ and $\text{SNR}_{k,u}$ ($0 \leq u \leq N_{\text{user}}-1$) in order to suppress crosstalk between participating beamformees. The method used by the beamformer to calculate the steering matrix $\mathbf{Q}_k$ is implementation specific.

The beamformee decides the tone grouping value to be used in the beamforming feedback matrix V . A beamformer shall support all tone grouping values and Codebook Information values.”

Page 2579 of 802.11-2016

“10.34.5 VHT sounding protocol

10.34.5.1 General

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

If dot11VHTSUBeamformerOptionImplemented is true, a STA shall set the SU Beamformer Capable field in the VHT Capabilities element to 1. If

dot11VHTSUBeamformeeOptionImplemented is true, a STA shall set the SU Beamformee Capable field in the VHT Capabilities element to 1.

If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set the MU Beamformer Capable field in the VHT Capabilities element to 1. If

dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set the MU Beamformee Capable field in the VHT Capabilities element to 1.

If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set dot11VHTSUBeamformerOptionImplemented to true. If dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set dot11VHTSUBeamformeeOptionImplemented to true.

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

If dot11VHTSUBeamformerOptionImplemented is false, a STA shall not act in the role of a VHT beamformer. If dot11VHTSUBeamformeeOptionImplemented is false, a STA shall not act in the role of a VHT beamformee. “

Page 1488 of 802.11-2016

“9.4.1.49 VHT Compressed Beamforming Report field

The VHT Compressed Beamforming Report field is used by the VHT Compressed Beamforming feedback (see 9.6.23.2) to carry explicit feedback information in the form of angles representing compressed beamforming feedback matrices V for use by a transmit beamformer to determine steering matrices Q , as described in 10.32.3 and 19.3.12.3.

The size of the VHT Compressed Beamforming Report field depends on the values in the VHT MIMO Control field. The VHT Compressed Beamforming Report field contains VHT Compressed Beamforming Report information or successive (possibly zero-length) portions thereof in the case of segmented VHT Compressed Beamforming feedback (see 10.34.5). VHT

	Compressed Beamforming Report information is always included in the VHT Compressed Beamforming feedback. The VHT Compressed Beamforming Report information contains the channel matrix elements indexed, first, by matrix angles in the order shown in Table 9-67 and, second, by data subcarrier index from lowest frequency to highest frequency. The explanation on how these angles are generated from the beamforming feedback matrix V is given in 19.3.12.3.6. In Table 9-67, N_C is the number of columns in a compressed beamforming feedback matrix determined by the N_C Index field of the VHT MIMO Control field, N_r is the number of rows in a compressed beamforming feedback matrix determined by the N_r Index field of the VHT MIMO Control field.” Page 764-765 of 802.11-2016
decompressing the compressed first feedback resulting in a decompressed first feedback; and decompressing the compressed second feedback resulting in a decompressed second feedback;	The Accused Instrumentalities perform the steps of decompressing the compressed first feedback resulting in a decompressed first feedback; and decompressing the compressed second feedback resulting in a decompressed second feedback. Lenovo makes, uses, and sells 802.11ac-compliant stations (STA) which, when operated by Lenovo's internal testers and/or Lenovo's customers, require performance of a method that includes: decompressing the compressed first feedback (e.g. the first feedback matrix) resulting in a decompressed first feedback; and decompressing the compressed second feedback (e.g. the second feedback matrix) resulting in a decompressed second feedback. Note: Each compressed feedback matrix must necessarily be decompressed by the beamformer, based on the compression method defined below. “19.3.12.3.6 Compressed beamforming feedback matrix

	In compressed beamforming feedback matrix, the beamformee shall remove the space-time stream CSD in Table 19-10 from the measured channel before computing a set of matrices for feedback to the beamformer. The beamforming feedback matrices, $V(k)$, found by the beamformee are compressed in the form of angles, which are sent to the beamformer. The beamformer might use these angles to <u>decompress the matrices</u> and determine the steering matrices Q_k. The matrix per tone shall be compressed as follows: The $N_r \times N_c$ beamforming feedback orthonormal column matrix V found by the beamformee shall be represented as shown in Equation (19-79). When the number of rows and columns is equal, the orthonormal column matrix becomes a unitary matrix.” Page 2398 of 802.11-2016
wherein the filtered transmission signal is a filtered first transmission signal that is transmitted to the second node using an 802.11-based orthogonal frequency-division multiplexing (OFDM) protocol via at least one antenna of a plurality of antennas, using a first power that is based on the decompressed first feedback; Lenovo makes, uses, and sells 802.11ac-compliant stations (STA) which, when operated by Lenovo's internal testers and/or Lenovo's customers, require performance of a method, wherein the filtered transmission signal is a filtered first transmission signal that is transmitted to the second node using an 802.11-based orthogonal frequency-division multiplexing (OFDM) protocol via at least one antenna (e.g. one or more antennas) of a plurality of antennas, using a first power (e.g. per one or more respective steering matrices) that is based on the decompressed first feedback (e.g. first feedback matrix).	• IEEE 802.11-2016: <u>21.3.11 SU-MIMO and DL-MU-MIMO Beamforming</u> and <u>21.3.11.1 General</u> specifies the steering matrix Q_k for DL-MU-MIMO, where k is one of the subcarriers, and Q_k is consisted of sub-matrices $Q_{k,u}$, each corresponding to one receiving STA u.

- IEEE 802.11-2016: **21.3.11.2 Beamforming Feedback Matrix V** further specifies that $Q_{k,u}$ is dependent on the feedback matrix $V_{k,u}$ provided by each STA u , which is based on the actual channel measurement by each STA u .
- IEEE 802.11-2016: Figure 10-53 (below) illustrates that each STA (beamformee) is getting a different polling packet, based on which the feedback matrix $V_{k,u}$ is measured and should be different from STA to STA.

An example of the VHT sounding protocol with more than one VHT beamformee is shown in Figure 10-8.

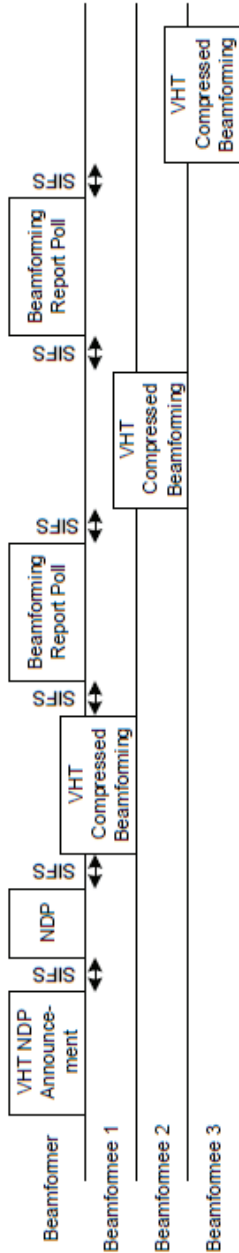


Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

Page 1490-2579 of 802.11-2016

“21.3.11 SU-MIMO and DL-MU-MIMO Beamforming

21.3.11.1 General

SU-MIMO and DL-MU-MIMO beamforming are techniques used by a STA with multiple antennas (the beamformer) to steer signals using knowledge of the channel to improve throughput. With SU-MIMO beamforming all space-time streams in the transmitted signal are intended for reception at a single STA. With DL-MU-MIMO beamforming, disjoint subsets of the space-time streams are intended for reception at different STAs.

	For SU-MIMO beamforming, <u>the steering matrix Q_k can be determined from the beamforming feedback matrix V_k that is sent back to the beamformer by the beamformee using the compressed beamforming feedback matrix format as defined in 19.3.12.3.6. The feedback report format is described in 9.4.1.49.</u> For DL-MU-MIMO beamforming, the receive signal vector in subcarrier k at beamformee u, $y_{k,u} = [y_{k,0}, y_{k,1}, \dots, y_{k,N_{RX,u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}, x_{k,1}, \dots, x_{k,N_{user}-1}]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \dots, x_{k,N_{RX,u}-1}]^T$ being the transmit signal for beamformee u. $Y_{k,u} = H_{k,u} \times [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user}-1}] \times x_k + n$ where $H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RX,u} \times N_{TX}$ $N_{RX,u}$ is the number of receive antennas at beamformee u $Q_{k,0}$ is a steering matrix for beamformee u in subcarrier k with dimensions N_{user} n is the number of VHT MU PPDU recipients (see Table 21-6) n is a vector of additive noise and may include interference <u>The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user}-1}]$ can be determined by the beamformer using the beamforming feedback matrices for subcarrier k from beamformee u, $V_{k,u}$, and SNR information for subcarrier k from beamformee u, $SNR_{k,u}$, where $u = 0, 1, \dots, N_{user} - 1$. The steering matrix that is computed (or updated) using new beamforming feedback matrices and</u>
--	--

	new SNR information from some or all of participating beamformers might replace the existing steering matrix Q_k for the next DL-MU-MIMO data transmission. The beamformer group for the MU transmission is signaled using the Group ID field in VHT-SIG-A (see 21.3.8.3.3 and 21.3.11.4).” Page 2578-2579 of 802.11-2016 “19.3.12.3 Explicit feedback beamforming 19.3.12.3.1 General In explicit beamforming, in order for STA A to transmit a beamformed packet to STA B, STA B measures the channel matrices and sends STA A either the effective channel, $H_{eff,k}$, or the beamforming feedback matrix, V_k, for STA A to determine a steering matrix, $Q_{steer,k} = Q_k V_k$, with V_k found from $H_k Q_k$, where Q_k is the orthonormal spatial mapping matrix that was used to transmit the sounding packet that elicited the V_k feedback. The effective channel, $H_{eff,k} = H_k Q_k$, is the product of the spatial mapping matrix used on transmit with the channel matrix. When new steering matrix $Q_{steer,k}$ is found, $Q_{steer,k}$ may replace Q_k for the next beamformed data transmission. NOTE—$Q_{steer,k}$ is a mathematical term to update a new steering matrix for Q_k in the next beamformed data transmission.” Page 2396 of 802.11-2016
transmitting, using the 802.11-based OFDM protocol, a filtered second transmission signal, simultaneously with the filtered first transmission signal, to the third node using a second power that is based on the decompressed second feedback.	The Accused Instrumentalities perform steps of a method as articulated above, further comprising transmitting, using the 802.11-based OFDM protocol, a filtered second transmission signal, simultaneously with the filtered first transmission signal, to the third node using a second power that is based on the decompressed second feedback. Lenovo makes, uses, and sells 802.11ac-compliant stations (STA) which, when operated by Lenovo’s internal testers and/or Lenovo’s customers, require performance of a method that includes transmitting, using the 802.11-based OFDM protocol, a filtered second transmission

signal, simultaneously with the filtered first transmission signal [e.g. via multiple-user-multiple-input-multiple-output (MU-MIMO) technology], to the third node, using a second power (e.g. per one or more respective steering matrices) that is based on the decompressed second feedback (e.g. second feedback matrix).

- IEEE 802.11-2016: **21.3.11 SU-MIMO and DL-MU-MIMO Beamforming** and **21.3.11.1 General** specifies the steering matrix Q_k for DL-MU-MIMO, where k is one of the subcarriers, and Q_k is consisted of sub-matrices $Q_{k,u}$, each corresponding to one receiving STA u .
- IEEE 802.11-2016: **21.3.11.2 Beamforming Feedback Matrix V** further specifies that $Q_{k,u}$ is dependent on the feedback matrix $V_{k,u}$ provided by each STA u , which is based on the actual channel measurement by each STA u .
- IEEE 802.11-2016: Figure 10-53 (below) illustrates that each STA (beamformee) is getting a different polling packet, based on which the feedback matrix $V_{k,u}$ is measured and should be different from STA to STA.

An example of the VHT sounding protocol with more than one VHT beamformee is shown in Figure 10-8.

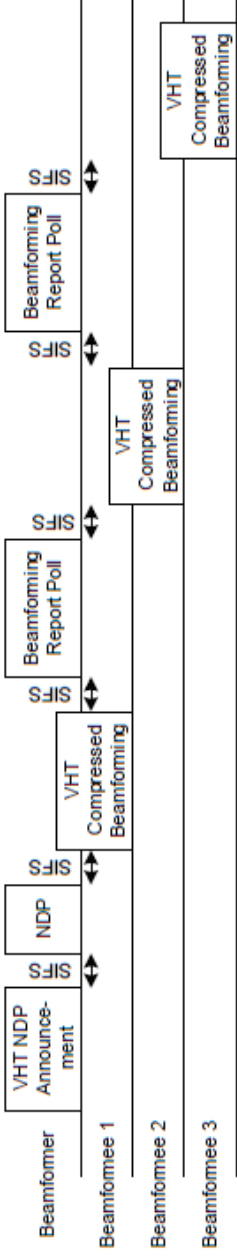


Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

Page 1490-2579 of 802.11-2016

“21.3.11 SU-MIMO and DL-MU-MIMO Beamforming

	21.3.11.1 General SU-MIMO and DL-MU-MIMO beamforming are techniques used by a STA with multiple antennas (the beamformer) to steer signals using knowledge of the channel to improve throughput. With SU-MIMO beamforming all space-time streams in the transmitted signal are intended for reception at a single STA. With DL-MU-MIMO beamforming, disjoint subsets of the space-time streams are intended for reception at different STAs. For SU-MIMO beamforming, the steering matrix Q_k can be determined from the beamforming feedback matrix V_k that is sent back to the beamformer by the beamformee using the compressed beamforming feedback matrix format as defined in 19.3.12.3.6. The feedback report format is described in 9.4.1.49. For DL-MU-MIMO beamforming, the receive signal vector in subcarrier k at beamformee u, $y_{k,u} = [y_{k,0}, y_{k,1}, \dots, y_{k,N_{RX,u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}, x_{k,1}, \dots, x_{k,N_{user}-1}]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformers, with $x_{k,u} = [x_{k,0}, x_{k,1}, \dots, x_{k,N_{RX,u}-1}]^T$ being the transmit signal for beamformee u. $Y_{k,u} = H_{k,u} \times [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user}-1}] \times x_k + n$ where $H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RX,u} \times N_{TX}$ $N_{RX,u}$ is the number of receive antennas at beamformee u $Q_{k,0}$ is a steering matrix for beamformee u in subcarrier k with dimensions
--	---

	N_{user} is the number of VHT MU PPDU recipients (see Table 21-6) n is a vector of additive noise and may include interference <u>The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user}-1}]$ can be determined by the beamformer using the beamforming feedback matrices for subcarrier k from beamformee u, $V_{k,u}$, and SNR information for subcarrier k from beamformee u, $SNR_{k,u}$, where $u = 0, 1, \dots, N_{user} - 1$. The steering matrix that is computed (or updated) using new beamforming feedback matrices and new SNR information from some or all of participating beamformees might replace the existing steering matrix Q_k for the next DL-MU-MIMO data transmission. The beamformee group for the MU transmission is signaled using the Group ID field in VHT-SIG-A (see 21.3.8.3.3 and 21.3.11.4)."</u> Page 2578-2579 of 802.11-2016 "19.3.12.3 Explicit feedback beamforming 19.3.12.3.1 General In explicit beamforming, in order for STA A to transmit a beamformed packet to STA B, STA B measures the channel matrices and sends STA A either the effective channel, $H_{eff,k}$, or the beamforming feedback matrix, V_k, for STA A to determine a steering matrix, $Q_{steer,k} = Q_k V_k$, with V_k found from $H_k Q_k$, where Q_k is the orthonormal spatial mapping matrix that was used to transmit the sounding packet that elicited the V_k feedback. The effective channel, $H_{eff,k} = H_k Q_k$, is the product of the spatial mapping matrix used on transmit with the channel matrix. When new steering matrix $Q_{steer,k}$ is found, $Q_{steer,k}$ may replace Q_k for the next beamformed data transmission. NOTE— $Q_{steer,k}$ is a mathematical term to update a new steering matrix for Q_k in the next beamformed data transmission." Page 2396 of 802.11-2016
--	---

--	--

Caveat: The notes and/or cited excerpts utilized herein are set forth for illustrative purposes only and are not meant to be limiting in any manner. For example, the notes and/or cited excerpts, may or may not be supplemented or substituted with different excerpt(s) of the relevant reference(s), as appropriate. Further, to the extent any error(s) and/or omission(s) exist herein, all rights are reserved to correct the same in connection with any subsequent correlations.