

EXHIBIT 2

U.S. Patent No. RE47,720 – Lenovo

USTA Technology, LLC (“USTA”) provides evidence of infringement of the claims below of U.S. Patent No. RE47,720 (hereinafter “the ’720 patent”) by Lenovo. In support thereof, USTA provides the following claim charts.

“Accused Instrumentalities” as used herein refers to at least 802.11ac-compliant (including backwards compatible) access points made, used, offered for sale, sold and/or imported by Lenovo, including, but not limited to: Motorola B12, Motorola mb7220, mb7420, mb7621, mb8600, mb8611, mg7315, mg7540, mg7550, mg7700, mg8702, mg8725, mh7020, mh7021, mh7022, mh7023, mh7601, mh7603, ml2410, mr2600, mt7711, mt8733, Motorola Q11, Q14, Motorola R14, Motorola SB3100, SB6121 Modems and/or Routers, TP-Link AX5400 Ceiling Mount Dual-Band Wi-Fi 6 Access Point, TP-Link BE22000 Ceiling Mount Tri-Band Wi-Fi 7 Access Point, TP-Link BE22000 Tri-Band Whole Home Mesh WiFi 7 System (1 Pack), TP-Link BE11000 Ceiling Mount Tri-Band Wi-Fi 7 Access Point, TP-Link Archer A8 AC1900 Dual Band Gigabit WiFi Router, TP-Link Archer AX10 AX1500 Smart Dual Band Wi-Fi 6 Router, TP-Link EAP615-Wall Omada SDN AX1800 WiFi 6 in-Wall Access Point, TP-Link AX1800 Indoor/Outdoor Dual-Band Wi-Fi 6 Access Point, TP-Link Archer A54 AC1200 10/100 Mbps Dual Band WiFi Router, TP-Link EAP225-Outdoor Omada SDN AC1200 Outdoor WiFi Access Point, TP-Link AX3000 Ceiling Mount Dual-Band Wi-Fi 6 Access Point, TP-Link BE9300 Tri-Band Wi-Fi 7 Router and other access points with DL MU-MIMO capabilities; and at least 802.11ac-compliant (including backwards compatible) stations made, used, offered for sale, sold and/or imported by Lenovo, including, but not limited to: the moto E7, moto E7 plus, edge+, edge 5G UW, moto g 5G, moto g 5G 2023, moto g PLAY, moto g power 5G, moto g pure, moto g stylus, moto g stylus 5G, razr, razr+, razr 2023, Edge 30, Edge 40 ThinkPhone Smartphones, Tab P12/P12 Pro, IdeaPad Y700, IdeaPad 5G, and Phab 2 Pro along with associated hardware and/or software, and related 802.11ac-compliant services. This includes all Lenovo-branded smartphones compliant with 802.11ac and subsequent backwards-compatible versions of the 802.11 standard which were developed by Lenovo’s MBG, including Motorola, for use outside of the United States based on Lenovo’s use of those Lenovo-branded smartphones with DL MU-MIMO capable access points during development (including internal testing) in the United States.

These claim charts demonstrate Lenovo’s infringement by comparing each element of the asserted claims to corresponding components, aspects, and/or features of the Accused Instrumentalities. These claim charts are not intended to constitute an expert report on infringement. These claim charts include information provided by way of example, and not by way of limitation.

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 identifying 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, by itself or through its subsidiaries, partners and/or other agents, directly infringes the '720 patent in violation of 35 U.S.C. § 271(a) by using (including internal testing, compatibility testing, internal use, customer support, customer demonstrations), the Accused Instrumentalities and performing the infringing methods in the United States. The following exemplary analysis demonstrates that infringement. Lenovo uses and performs in the United States or has used and/or performed in the past, without authority, products, equipment, or services that infringe claims of the '720 patent, including without limitation, the Accused Instrumentalities and infringing methods in at least claims 53 and 95. USTA further contends, to the extent a party other than Lenovo performs any step of the asserted method claims, that such actions are attributable to Lenovo under the theory of joint infringement. Unless otherwise noted, USTA further contends that the evidence below supports a finding of indirect infringement under at least 35 U.S.C. §§ 271(b). Lenovo received notice of the '720 patent by at least November 23, 2022 and knowingly induced, and continues to induce, others (subsidiaries, partners, employees, customers and/or end users) to use in the United States, without authority products, equipment, or services that infringe, including without limitation, the Accused Instrumentalities and infringing methods.

Unless otherwise noted, USTA believes and contends that each element of the claim asserted herein is literally met through the use 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 claims. 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 the use of 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.

Note: Unless annotated in the evidence, any emphasis is added.

Claim	Accused Instrumentalities
53. A method for managing interference in a radio communications network, comprising the steps of:	The Accused Instrumentalities perform a method for managing interference in a radio communications network. For example, as evidenced below, Lenovo makes, uses, and sells 802.11ac-compliant access points (AP) (including, but not limited to Motorola Cable Modems and/or Routers, TP-Link access points, etc.) which, when operated by Lenovo (including its subsidiaries, partners, employees, customers and/or end users, etc.), require performance of a method for managing interference in a radio communications network (e.g., 802.11ac-compliant network). <u>Motorola B12</u>  • Ethernet Interface: One (1) 100/1000/2500 Gigabit Ethernet LAN port, with Auto-MDI/MDIX • Network Protocols: IPv4, IPv6, TCP, UDP, ARP, ICMP, DHCP, FTP, TFTP, SNMP, HTTPS • Application Protocol: SNMP v1/v2/v3 See, https://motorolanetwork.com/products/motorola-b12-advanced-compact-cable-modem-easily-pairs-with-any-wifi-router-supports-comcast-xfinity-cox-spectrum-2500-mbps-max-docsis-3-1-2-5-gbps-port?srltid=AfmBOoqmOQRDVan8qeSbyZcfUuMPvj9s_PYT9SycwnoypC_wCQVs5NeX.

Motorola mb8600



Cable Modem

- Super Fast DOCSIS 3.1 with fallback to 32x8 DOCSIS 3.0
- Supports the fastest available cable modem services, downloading 46 times faster than DOCSIS 2.0.
- Downstream speeds up to 3.8 Gbps when supported by your cable service speed and a router that can bond Ethernet ports
- Up to 1 Gbps upstream speeds
- Active Queue Management (AQM) significantly reduces Internet latency. AQM results in faster page loads for all Web traffic and greatly enhances interactive applications like online gaming and video conferencing.
- Includes Broadcom Full-Band Capture digital tuner to enhance speed and save energy.
- IPv6 next generation Internet addressing support
- One open and 3 masked 10/100/1000 Gigabit Ethernet (GigE) LAN ports allow connection of any SINGLE device with an Ethernet port including a router, Windows/Mac computer, HDTV, game station. The multiple Ethernet ports are not for connecting multiple devices; they allow connection to a router that can bond more than one Ethernet port to achieve speeds over 1Gbps when supported by your cable service.
- Works with any router, Windows® or Mac® computer, HDTV, or game station that has an Ethernet port
- Great for Netflix®, YouTube®, and other video streaming, high-speed gaming, Facebook®, web browsing, emails, and more.
- Works with DOCSIS 3.1, 3.0, 2.0, and 1.1 service
- Future proof, including DOCSIS 3.1, DOCSIS 3.0, 4 Ethernet ports, port bonding, and more
- Multi Processor Technology with ARM based Application Processor

See,

<https://www.motorola.com/us/mb8600/p?srsId=AfmBOoqapjRwEdGpKShdmv4tRVMpXPoMNlJxZbqbVzsD6vHhZpdjcN42>.

Motorola mg7700



mg7700

MG7700 24x8 Cable Modem plus AC1900 Dual Band WiFi Gigabit Router with Power Boost

This cable modem includes a built-in AC1900 3x3 wireless gigabit router that provides the range, wireless speeds and networking support need for multimedia, Internet video and high-performance networking in a home or office. Power Boost technology amplifies the wireless signal to the legal limit in the U.S. AnyBeam implicit beamforming at 2.4 GHz and 5 GHz focuses the wireless signal toward the wireless clients. Both Power Boost and AnyBeam extend range. Together, they provide the fastest and most robust connections over the largest possible range, for virtually all client types.

Built-in WiFi Gigabit Router

- High-speed AC1900 WiFi Gigabit Router with 4 Gigabit Ethernet ports
- 3 internal antennas support three send and three receive channels
- WiFi works with IEEE 802.11 n, ac, g, and b devices including smartphones, computers, tablets, Internet TV (e.g. Chromecast, Apple TV, Roku), HDTVs, game stations, and other Ethernet-capable devices.
- Wireless Power Boost adds high-performance WiFi power amplifiers to boost the wireless signals to the legal limit, giving a significant boost in speed and range.
- AnyBeam beamforming at 2.4 GHz and 5 GHz focuses the signal on wireless clients to allow better performance and range
- Comes with unique wireless security password for fast, easy setup (User can change the password easily)
- 4 Gigabit Ethernet (GigE) LAN ports for optional wired connections to computers, Internet TVs, HDTVs, tablets, game stations, and other Ethernet-capable devices
- Includes Configuration Manager with context-sensitive help
- Advanced firewall for added security
- Built-in Parental Control capability
- Guest network access gives visitors Internet services while protecting your local network's private information.
- Supports IPv4 and IPv6 for powerful, flexible network addressing
- Provides high-speed shared Internet for up to 253 wireless and Ethernet devices

See, <https://www.motorola.com/us/mg7700/p>.

Motorola mh7022



AC2200 Tri-Band Mesh WiFi

Provides extended range and optimal speeds, complete with 2x2 performance for both 2.4 and 5 GHz connections.

Intelligent Band Steering and Backhaul

Automatically redirects your devices towards the least congested WiFi band for a stronger, faster connection.

MU-MIMO Multi-User Technology

Allows for the use of multiple devices simultaneously, increasing your network's performance and efficiency.

Optimized WiFi Channel Selection

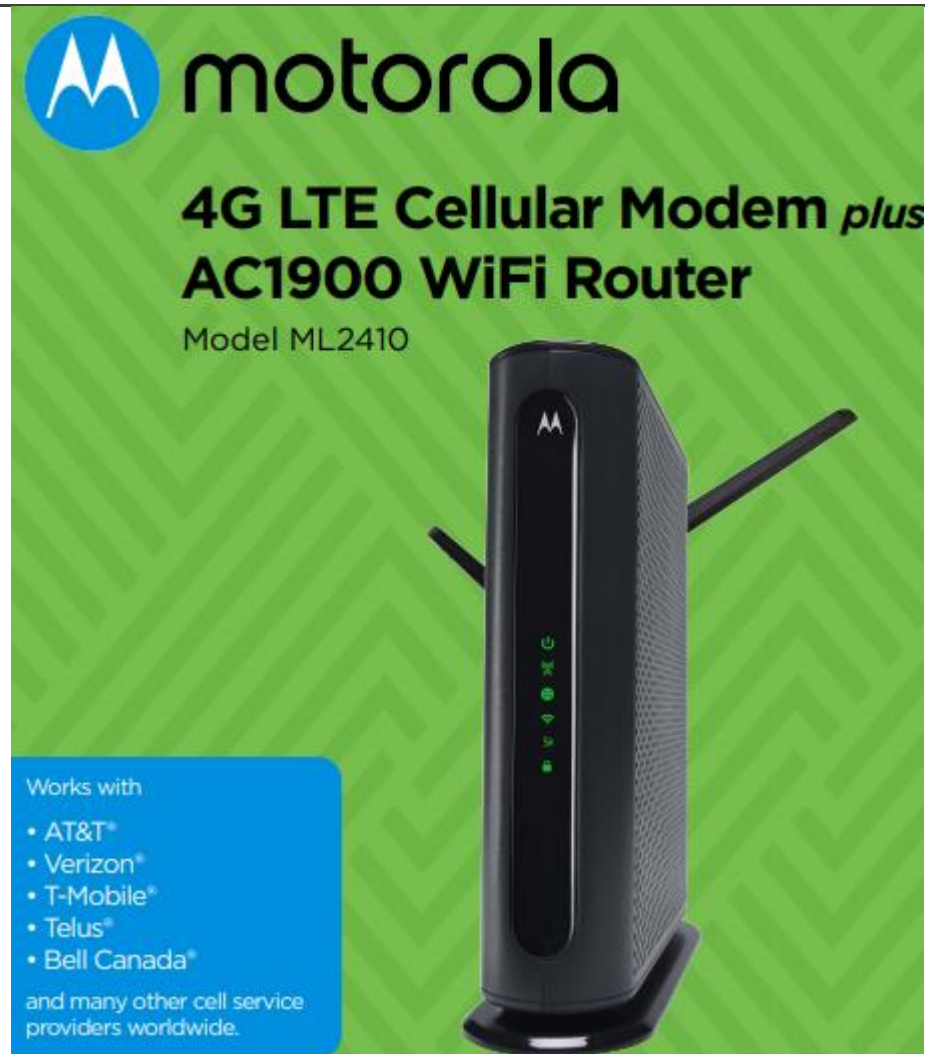
Seamlessly directs your web traffic to the best WiFi channel available to minimize buffering.

Network and Device-level Security

WPA2 security keeps your data secure. The mobile app provides security alerts, ad and malware blocks, and insights.

See, https://www.motorola.in/motorola-mh7022-whole-home-mesh-wifi-system/p?srltid=AfmBOoohHpeYktgllloHpBApO6rTS1tfWZnJ1uTdyU_Pv620nHXVIDHSV.

Motorola ml2410



WiFi Speed and Performance

- Simultaneous Dual Band radios
- Up to 600 Mbps* at 2.4 GHz
- Up to 1300 Mbps* at 5 GHz
- DFS (Dynamic Frequency Selection) allows the device to use frequencies that are generally reserved for radar when those are available.

Wireless Standards

- IEEE 802.11ac, n, g, b, and a

Networking and Security Features

- Stateful Packet Inspection (SPI)
- VPN: IPsec, OpenVPN, L2TP, PPTP
- Attack Protection
- MAC Filtering
- Wireless Functions: WMM/WME, Guest Network Access, WPS
- Wireless Security: WPA-PSK/WPA2-PSK, TKIP/AES
- Password protected system management

See, <https://en-us.support.motorola.com/ci/fattach/get/82900689/1703024743/redirect/1/filename/ML2410-DataSheet-14520.pdf>.

Motorola mr2600



Features

- Includes 4 external adjustable antennas for advanced WiFi performance. This results in extended range and high speed, with concurrent 4x4 performance for both 2.4 and 5 GHz connections.
- Plug the MR2600 into whatever cable modem, DSL modem, or other broadband modem you choose. This results in a high-speed Internet link via AC2600 dual band WiFi or Gigabit Ethernet for all your local WiFi and Ethernet devices - HDTVs, smartphones, game stations, computers, tablets, and more.
- Netflix®, YouTube®, Amazon™ Video, Hulu, the Web, and other streaming services can be delivered to many devices at the same time through the MR2600's 4 Gigabit Ethernet LAN ports and/or through WiFi.
- Enjoy high performance gaming with supercharged AC2600 WiFi, 4 Gigabit Ethernet ports, high-speed dual core router processor, automatic traffic prioritization, and more.
- 802.11ac Wave 2 MU-MIMO (Multi-User Multiple Input Multiple Output) technology dramatically speeds up your network, allowing high-speed communication with multiple WiFi devices.
- Implicit and explicit beamforming targets the WiFi signal to each of your WiFi devices resulting in blazing fast WiFi speeds and extended range.
- Smart QoS (Quality of Service) automatically prioritizes traffic

See, <https://www.motorola.com/us/mr2600/p?srsId=AfmBOoocyrO6MXWJl8fyL-5TbzfCqljK0Y2XrFLXOSE-qS3a2baVeWOI>.

Motorola mt7711



Built-in WiFi Gigabit Router

- High-speed AC1900 WiFi Gigabit Router with 4 Gigabit Ethernet ports
- 3 internal antennas support three send and three receive channels
- WiFi works with IEEE 802.11 n, ac, g, and b devices including smartphones, computers, notebooks, tablets, Internet TV (e.g. Chromecast, Apple TV, Roku, Amazon Fire TV), HDTVs, game stations, Amazon Echo, Google Home, and other Ethernet-capable devices.
- Wireless Power Boost adds high-performance WiFi power amplifiers to boost the wireless signals to the legal limit, giving a significant boost in speed and range.
- AnyBeam beamforming at 2.4 GHz and 5 GHz focuses the signal on wireless clients to allow better performance and range

See,

https://www.motorola.com/us/mt7711/p?srltid=AfmBOorRhioCv1OKeE4MfjrWimcdV1Udf283KVAIRw_RnG6Gjgso46iq.

Motorola Q11



AX3000 dual-band mesh WiFi

Multi-gigabit WiFi speeds up to 3 Gbps for over 100 wirelessly connected devices.

Optimized WiFi channel selection

Seamlessly directs your web traffic to the best WiFi channel available to minimize buffering.

MU-MIMO technology

Allows for the use of multiple devices simultaneously, increasing your network's performance and efficiency.

Network and device-level security

WPA3 security keeps your data secure. The motosync app provides security alerts, malware blocking, and adblocking

See, <https://www.motorola.com/us/q11-mesh-wifi-6-system-3-pack/p?srsId=AfmBOopvpojp9jJKFHL2lBeRudr23f8M3Aw6cV0lt01oUWHiuJvwsDps>.

Motorola R14

WiFi specs

- AX6000 WiFi 6 Dual-band 4x4 (802.11ax)
- Four (4) external dual-band detachable antennas
- IEEE 802.11 a/b/g/n/ac/ax, 4x4 MU-MIMO
- WiFi Performance (OFDMA, Beamforming, 1024-QAM)
- 802.11s compliant mesh capabilities
- Transmit Power (conducted):
 - 2.4GHz: up to 27dBm
 - 5GHz: up to 25 dBm

Ultra-Fast WiFi 6 Performance

- Supports Gigabit-plus Internet service* with a 2.5 Gbps WAN port. Delivers fast, secure WiFi for over 100 connected devices.

See, https://en-us.support.motorola.com/app/answers/detail/a_id/178013/~/specifications-%7C-motorola-r14.

Motorola SB3100



The General Instrument® SURFboard® SB3100 cable modem enables you to connect your home or business computer to a DOCSIS-compliant data network. It provides high-speed access to the Internet and other online services. The SB3100 transmits and receives data at much higher speeds than traditional telephone or ISDN modems.

See, https://armstrongonewire.com/Content/Documents/SB3100_manual.pdf.

TP-Link AX5400 Ceiling Mount Dual-Band Wi-Fi 6 Access Point

	TP-Link AX5400 Ceiling Mount Dual-Band Wi-Fi 6... \$134.99 Tech Specs Compare Similar Products Reviews Key Details: Blazing-Fast True Wi-Fi 6 Speeds: Designed with the latest wireless Wi-Fi 6 technology featuring 1024-QAM, HE60 and Long OFDM Symbol, the EAP670 boosts dual-band Wi-Fi speeds up to 5400 Mbps. <table> <tr> <td>Device Type</td><td>Wireless access point</td></tr> <tr> <td>Form Factor</td><td>Wall / ceiling mountable</td></tr> <tr> <td>Data Link Protocol</td><td>IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, IEEE 802.11ac, IEEE 802.11ax (Wi-Fi 6)</td></tr> </table> <table> <tr> <td>Features</td><td>Load balancing, Syslog support, E-mail alert, MAC address filtering, Quality of Service (QoS), reset button, rogue access point detection, Captive Portal, Transmit Power Control (TPC), MU-MIMO technology, beamforming technology, band steering, SSID to VLAN mapping, rate limit, Wireless Scheduler, Software Defined Networking (SDN), wireless SSID, VLAN management, LED on/off button, Extensive Access Control List (ACL) support, seamless roaming, Airtime Fairness, Zero-touch provisioning (ZTP), client isolation, schedule reboot, Omada Mesh technology, multi-site management</td></tr> </table> See https://www.lenovo.com/us/en/p/accessories-and-software/wireless-and-networking/networking-dual-band/78244035	Device Type	Wireless access point	Form Factor	Wall / ceiling mountable	Data Link Protocol	IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, IEEE 802.11ac, IEEE 802.11ax (Wi-Fi 6)	Features	Load balancing, Syslog support, E-mail alert, MAC address filtering, Quality of Service (QoS), reset button, rogue access point detection, Captive Portal, Transmit Power Control (TPC), MU-MIMO technology, beamforming technology, band steering, SSID to VLAN mapping, rate limit, Wireless Scheduler, Software Defined Networking (SDN), wireless SSID, VLAN management, LED on/off button, Extensive Access Control List (ACL) support, seamless roaming, Airtime Fairness, Zero-touch provisioning (ZTP), client isolation, schedule reboot, Omada Mesh technology, multi-site management
Device Type	Wireless access point								
Form Factor	Wall / ceiling mountable								
Data Link Protocol	IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, IEEE 802.11ac, IEEE 802.11ax (Wi-Fi 6)								
Features	Load balancing, Syslog support, E-mail alert, MAC address filtering, Quality of Service (QoS), reset button, rogue access point detection, Captive Portal, Transmit Power Control (TPC), MU-MIMO technology, beamforming technology, band steering, SSID to VLAN mapping, rate limit, Wireless Scheduler, Software Defined Networking (SDN), wireless SSID, VLAN management, LED on/off button, Extensive Access Control List (ACL) support, seamless roaming, Airtime Fairness, Zero-touch provisioning (ZTP), client isolation, schedule reboot, Omada Mesh technology, multi-site management								

<u>TP-Link BE22000 Ceiling Mount Tri-Band Wi-Fi 7 Access Point</u>	
Product Description	TP-Link Omada EAP783 V1.6 - wireless access point - Bluetooth, Wi-Fi 7 - cloud-managed
Device Type	Wireless access point
Form Factor	Wall / ceiling mountable
Ports Qty	2
Data Link Protocol	Bluetooth, IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, IEEE 802.11ac, IEEE 802.11be, IEEE 802.11ax (Wi-Fi 6)
Features	Load balancing, VLAN support, E-mail alert, firmware upgradable, Wi-Fi Multimedia (WMM) support, Auto Channel Select (ACS), Access Control List (ACL) support, Quality of Service (QoS), Multiple SSID support, reset button, dynamic IP mode, Captive Portal, MU-MIMO technology, beamforming technology, band steering, Wireless Scheduler, MAC address authentication, seamless roaming, Airtime Fairness, Zero-touch provisioning (ZTP), 4KV ESD Protector (contact discharge), 8KV ESD Protector (air-gap discharge), client isolation, schedule reboot, BSS Coloring, Private Pre-Shared Key (PPSK), Omada Mesh technology, secure guest network, rogue AP detection, LED control, uplink/downlink MU-MIMO, wireless radio enable/disable, Multi-Link Operation (MLO), 4KV lightning protection (common mode), SSID broadcast, Multiple Resource Unit (MRU)

See, <https://www.lenovo.com/us/en/dc/accessories-and-software/wireless-and-networking?visibleDatas=1008%3ATP-Link>

TP-Link BE22000 Tri-Band Whole Home Mesh WiFi 7 System (1 Pack)

Product Description	TP-Link Deco BE85 V1 - Wi-Fi system - Wi-Fi 7 - desktop
Device Type	Wi-Fi system - mesh
Enclosure Type	Desktop
Wi-Fi System Components	Router
WAN Ports Qty	2
Data Link Protocol	Ethernet, Fast Ethernet, Gigabit Ethernet, IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, IEEE 802.11ac, IEEE 802.11ax (Wi-Fi 6E), IEEE 802.11be

Features	NAT support, IGMP snooping, SPI, IPS, parental control, Access Point operational mode, DDos attack prevention, QoS, reset button, VPN Server, IGMP proxy, Tri-Band, VPN client, router mode, SSID to VLAN tagging, seamless roaming, 4x4 MU-MIMO technology, black list, bridge mode, schedule reboot, OFDMA, WPS button, TP-Link HomeShield, 4K QAM technology, Real-Time IoT Protection, Malicious Site Blocker, Home Network Scanner, AI-Driven Mesh, static route, MLO
Compliant Standards	IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, IEEE 802.11k, IEEE 802.11ac, IEEE 802.11r, IEEE 802.11v, IEEE 802.11ax, IEEE 802.11be, FCC, RoHS

See, <https://www.lenovo.com/us/en/p/accessories-and-software/wireless-and-networking/networking-wireless-tri-band/78804827>

TP-Link BE11000 Ceiling Mount Tri-Band Wi-Fi 7 Access Point

Product Description	TP-Link Omada EAP772 V1 - wireless access point - Bluetooth, Wi-Fi 7 - cloud-managed
Device Type	Wireless access point
Form Factor	Wall / ceiling mountable
Data Link Protocol	Ethernet, Fast Ethernet, Gigabit Ethernet, IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, IEEE 802.11ac, 2.5 Gigabit Ethernet, Bluetooth 5.2, IEEE 802.11be, IEEE 802.11ax (Wi-Fi 6)

See, <https://www.lenovo.com/us/lenovopro/en/p/accessories-and-software/wireless-and-networking/networking-wireless-tri-band/78804830>.

TP-Link Archer A8 AC1900 Dual Band Gigabit WiFi Router

Device Type	Wireless router - 4-port switch (integrated)
Enclosure Type	Desktop
WAN Ports Qty	1
Data Link Protocol	Ethernet, Fast Ethernet, Gigabit Ethernet, IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, IEEE 802.11ac Wave 2
Frequency Band	2.4 GHz / 5 GHz
Data Transfer Rate	1900 Mbps
Network / Transport Protocol	PPTP, L2TP, PPPoE, DHCP, DDNS, Bigpond
Routing Protocol	Static IP routing
Remote Management Protocol	DHCP
Features	DoS attack prevention, IPv6 support, parental control, WMM support, QoS, virtual server support, WPS, DHCP server, FTP server, port forwarding, UPnP Media Server, reset button, bandwidth control, IPv4 support, port triggering, SPIF, IP-MAC binding, 3T3R MIMO technology, DHCP client, VPN Server, MU-MIMO technology, beamforming technology, WDS bridge, Smart Connect, wireless SSID, guest access, Airtime Fairness, DMZ support, black list, white list, DynDNS, WPS button

See, https://www.lenovo.com/us/lenovopro/en/p/accessories-and-software/wireless-and-networking/wireless-router/78157050#tech_specs.

TP-Link Archer AX10 AX1500 Smart Dual Band Wi-Fi 6 Router

**TP-Link Archer
AX10 AX1500
Smart Dual Band
Wi-Fi 6 Router,
Beamforming,
OFDMA, MU-
MIMO**

★★★★★ 5.0 (1)

See, https://www.lenovo.com/us/lenovopro/en/p/accessories-and-software/wireless-and-networking/wireless-router/78017534#tech_specs.

TP-Link EAP615-Wall Omada SDN AX1800 WiFi 6 in-Wall Access Point

Product Description	TP-Link EAP615-Wall V1 - wireless access point - Wi-Fi 6
Device Type	Wireless access point
Form Factor	Wall mountable
Data Link Protocol	IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, IEEE 802.11ac, 802.11ax

Features	E-mail alert, firmware upgradable, Wi-Fi Multimedia (WMM) support, Access Control List (ACL) support, Quality of Service (QoS), RADIUS support, reset button, dynamic IP mode, rogue access point detection, Captive Portal, cloud managed, MU-MIMO technology, system log, beamforming technology, band steering, Wireless Scheduler, MAC address authentication, seamless roaming, Airtime Fairness, schedule reboot, Guest Network
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See, <https://www.lenovo.com/us/lenovopro/en/p/accessories-and-software/wireless-and-networking/networking-dual-band/78157064>.

TP-Link AX1800 Indoor/Outdoor Dual-Band Wi-Fi 6 Access Point

Product Description	TP-Link Omada EAP610-Outdoor - wireless access point - Wi-Fi 6 - cloud-managed
Device Type	Wireless access point

Data Link Protocol	IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, IEEE 802.11ac, 802.11ax
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Features	Syslog support, E-mail alert, Wi-Fi Multimedia (WMM) support, Quality of Service (QoS), reset button, weatherproof, rogue access point detection, Captive Portal, 15KV ESD Protector, 802.1x authentication, Transmit Power Control (TPC), MU-MIMO technology, beamforming technology, band steering, rate limit, Wireless Scheduler, Fast Roaming, seamless roaming, Airtime Fairness, Zero-touch provisioning (ZTP), dustproof, waterproof, 6KV lightning protection, schedule reboot, load balance network mode, Omada Mesh technology
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See, <https://www.lenovo.com/us/lenovopro/en/p/accessories-and-software/wireless-and-networking/networking-dual-band/78244033>.

TP-Link Archer A54 AC1200 10/100 Mbps Dual Band WiFi Router

- **Connect more devices simultaneously**

Archer A54 helps your devices achieve optimal performance by making communication more efficient with MU-MIMO technology. Two simultaneous data streams, allow all connected devices to achieve faster speeds than standard AC routers.

Device Type	Wireless router - 4-port switch (integrated)
Enclosure Type	Desktop
WAN Ports Qty	1
Data Link Protocol	Ethernet, Fast Ethernet, IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, IEEE 802.11ac
Frequency Band	2.4 GHz / 5 GHz
Performance	Maximum data rate (2.4 GHz): 300 Mbps Maximum data rate (5 GHz): 867 Mbps
Network / Transport Protocol	PPTP, L2TP, PPPoE, DHCP, DDNS, IPv4, IPv6
Routing Protocol	IGMP, static IP routing
Remote Management Protocol	DHCP
Features	Firewall protection, IGMP snooping, SPI, URL filtering, parental control, Access Point operational mode, ACL support, QoS, DHCP server, static IP mode, port forwarding, reset button, port triggering, dynamic IP mode, IP-MAC binding, DHCP client, tagged VLAN, IGMP proxy, wireless extender mode, beamforming technology, dual band, router mode, DMZ support, DynDNS, bridge mode, WPS button, Address Reservation, SIP ALG, Wi-Fi on/off button

See, <https://www.lenovo.com/us/lenovopro/en/p/accessories-and-software/wireless-and-networking/wireless-router/78157048>.

TP-Link EAP225-Outdoor Omada SDN AC1200 Outdoor WiFi Access Point

- **Superior Wi-Fi performance and long-range coverage**
Dedicated high-power amplifier and professional antennas along with the 802.11ac Wave 2 MU-MIMO technology, ensure superior Wi-Fi performance and long-range coverage over 2.4GHz and 5GHz wireless bands.

Product Description	TP-Link EAP225-Outdoor - wireless access point - Wi-Fi 5
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Features	Load balancing, E-mail alert, MAC address filtering, wall mountable, Wi-Fi Multimedia (WMM) support, Quality of Service (QoS), Multiple SSID support, pole mountable, weatherproof, rogue access point detection, Captive Portal, 802.1x authentication, Watch Dog Timer (WDT), Transmit Power Control (TPC), MU-MIMO technology, beamforming technology, scheduler, band steering, SSID to VLAN mapping, rate limit, Wireless Scheduler, VLAN management, Airtime Fairness
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See, <https://www.lenovo.com/us/lenovopro/en/p/accessories-and-software/wireless-and-networking/networking-dual-band/78015097>.

TP-Link AX3000 Ceiling Mount Dual-Band Wi-Fi 6 Access Point

Overview:

TP-Link EAP650 - Omada WiFi 6 AX3000 Wireless Gigabit
Ceiling Mount Access Point - Limited Lifetime Warranty -

Data Link Protocol	IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, IEEE 802.11ac, IEEE 802.11ax (Wi-Fi 6)
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	<table border="1"> <tr> <td data-bbox="657 191 1031 573">Features</td><td data-bbox="1031 191 1667 573">Load balancing, Syslog support, E-mail alert, MAC address filtering, Wi-Fi Multimedia (WMM) support, Auto Channel Select (ACS), Access Control List (ACL) support, Quality of Service (QoS), reset button, rogue access point detection, Captive Portal, Transmit Power Control (TPC), MU-MIMO technology, beamforming technology, band steering, SSID to VLAN mapping, rate limit, Wireless Scheduler, Software Defined Networking (SDN), VLAN management, LED on/off button, seamless roaming, Airtime Fairness, Zero-touch provisioning (ZTP), schedule reboot, 160MHz bandwidth support, Omada Mesh technology, secure guest network, multi-site management</td></tr> </table> See, https://www.lenovo.com/us/lenovopro/en/p/accessories-and-software/wireless-and-networking/networking-dual-band/78244034#tech_specs. TP-Link BE9300 Tri-Band Wi-Fi 7 Router <table border="1"> <tr> <td data-bbox="657 719 972 821">Product Description</td><td data-bbox="972 719 1606 821">TP-Link Archer BE550 V1.6 - wireless router - Wi-Fi 7 - desktop</td></tr> <tr> <td data-bbox="657 821 972 894">Device Type</td><td data-bbox="972 821 1606 894">Wireless router - 4-port switch (integrated)</td></tr> <tr> <td data-bbox="657 894 972 967">Enclosure Type</td><td data-bbox="972 894 1606 967">Desktop</td></tr> <tr> <td data-bbox="657 967 972 1040">WAN Ports Qty</td><td data-bbox="972 967 1606 1040">1</td></tr> <tr> <td data-bbox="657 1040 972 1190">Data Link Protocol</td><td data-bbox="972 1040 1606 1190">Ethernet, Fast Ethernet, Gigabit Ethernet, IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, IEEE 802.11ac, 2.5 Gigabit Ethernet, IEEE 802.11ax (Wi-Fi 6E), IEEE 802.11be</td></tr> </table> See, https://www.lenovo.com/us/lenovopro/en/p/accessories-and-software/wireless-and-networking/wireless-router/78804828#tech_specs.	Features	Load balancing, Syslog support, E-mail alert, MAC address filtering, Wi-Fi Multimedia (WMM) support, Auto Channel Select (ACS), Access Control List (ACL) support, Quality of Service (QoS), reset button, rogue access point detection, Captive Portal, Transmit Power Control (TPC), MU-MIMO technology, beamforming technology, band steering, SSID to VLAN mapping, rate limit, Wireless Scheduler, Software Defined Networking (SDN), VLAN management, LED on/off button, seamless roaming, Airtime Fairness, Zero-touch provisioning (ZTP), schedule reboot, 160MHz bandwidth support, Omada Mesh technology, secure guest network, multi-site management	Product Description	TP-Link Archer BE550 V1.6 - wireless router - Wi-Fi 7 - desktop	Device Type	Wireless router - 4-port switch (integrated)	Enclosure Type	Desktop	WAN Ports Qty	1	Data Link Protocol	Ethernet, Fast Ethernet, Gigabit Ethernet, IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, IEEE 802.11ac, 2.5 Gigabit Ethernet, IEEE 802.11ax (Wi-Fi 6E), IEEE 802.11be
Features	Load balancing, Syslog support, E-mail alert, MAC address filtering, Wi-Fi Multimedia (WMM) support, Auto Channel Select (ACS), Access Control List (ACL) support, Quality of Service (QoS), reset button, rogue access point detection, Captive Portal, Transmit Power Control (TPC), MU-MIMO technology, beamforming technology, band steering, SSID to VLAN mapping, rate limit, Wireless Scheduler, Software Defined Networking (SDN), VLAN management, LED on/off button, seamless roaming, Airtime Fairness, Zero-touch provisioning (ZTP), schedule reboot, 160MHz bandwidth support, Omada Mesh technology, secure guest network, multi-site management												
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Device Type	Wireless router - 4-port switch (integrated)												
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WAN Ports Qty	1												
Data Link Protocol	Ethernet, Fast Ethernet, Gigabit Ethernet, IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, IEEE 802.11n, IEEE 802.11ac, 2.5 Gigabit Ethernet, IEEE 802.11ax (Wi-Fi 6E), IEEE 802.11be												

“802.11ax radios are able to communicate with legacy 802.11a/b/g/n/ac radios. 802.11ax radios communicate with other 802.11ax radios using OFDMA and/or OFDMA. 802.11ax radios communicate with legacy radios using OFDM or HR-DSSS. When 802.11ax-only OFDMA conversations are occurring, RTS/CTS mechanisms are used to defer legacy transmissions.” See, <https://www.extremenetworks.com/wifi6/what-is-80211ax/>.

“Wi-Fi 7 ensures backward compatibility with earlier Wi-Fi generations across the 2.4 and 5 GHz legacy bands, as well as with Wi-Fi 6E within the 6 GHz band.” <https://www.extremenetworks.com/resources/blogs/what-is-wifi-7>.

“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. <u>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.</u> 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.
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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 must 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 can 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 can 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.
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	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.” Pages 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. For example, as evidenced below, Lenovo makes, uses, and sells 802.11ac-compliant access points (AP) which, when operated by Lenovo (including its subsidiaries, partners, employees, customers and/or end users), require performance of a method that includes receiving at a first node (e.g. first AP) in the radio communications network an instruction ([e.g. “Clear to Send”

(CTS) instruction or related/other instruction] transmitted from a second node (e.g. second AP) 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.

“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.

	<u>secondary 80 MHz channel:</u> 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.” Pages 161-163 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.
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- 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.”

Pages 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. <u>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</u> 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
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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.”

Pages 1313-1314 of 802.11-2016.

“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:

- 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.
- 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.”

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“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.”

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“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).”

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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

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filtering a transmission signal to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided;

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.

For example, as evidenced below Lenovo makes, uses, and sells 802.11ac-compliant access points (AP) which, when operated by Lenovo (including its subsidiaries, partners, employees, customers and/or end users), 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 or the related/other instruction).

“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) 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.
- b) 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.
- c) 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.
- d) Transmit a 20 MHz mask PPDU on the primary 20 MHz channel.
- e) 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.”

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“17.3.2.2 Overview of the PPDU encoding process

- e) 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.”

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:

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

Replace Figure 18-7 with the following:

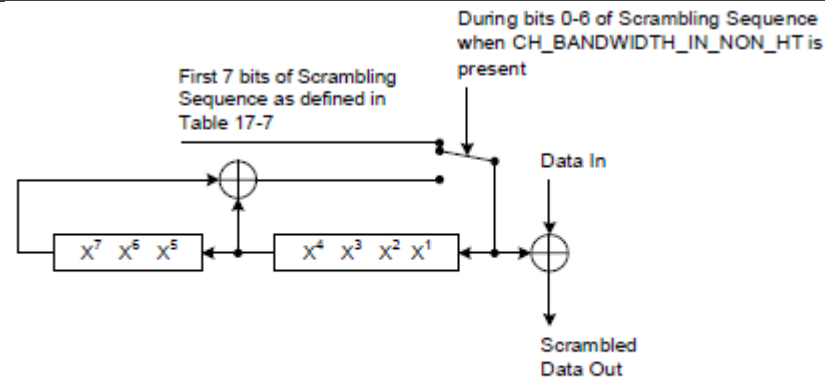


Figure 17-7—Data scrambler

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 1111111, 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 CH_BANDWIDTH_IN_NON_HT 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
- CH_BANDWIDTH_IN_NON_HT 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 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.”

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“21.3.17 VHT transmit specification

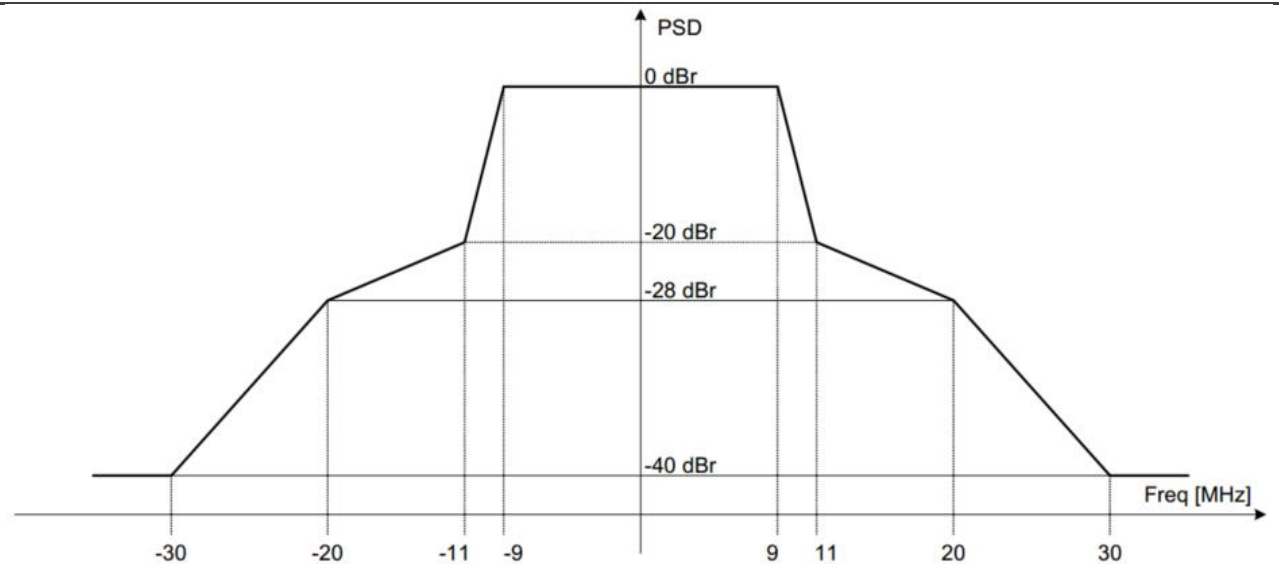
21.3.17.1 Transmit spectrum mask

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.

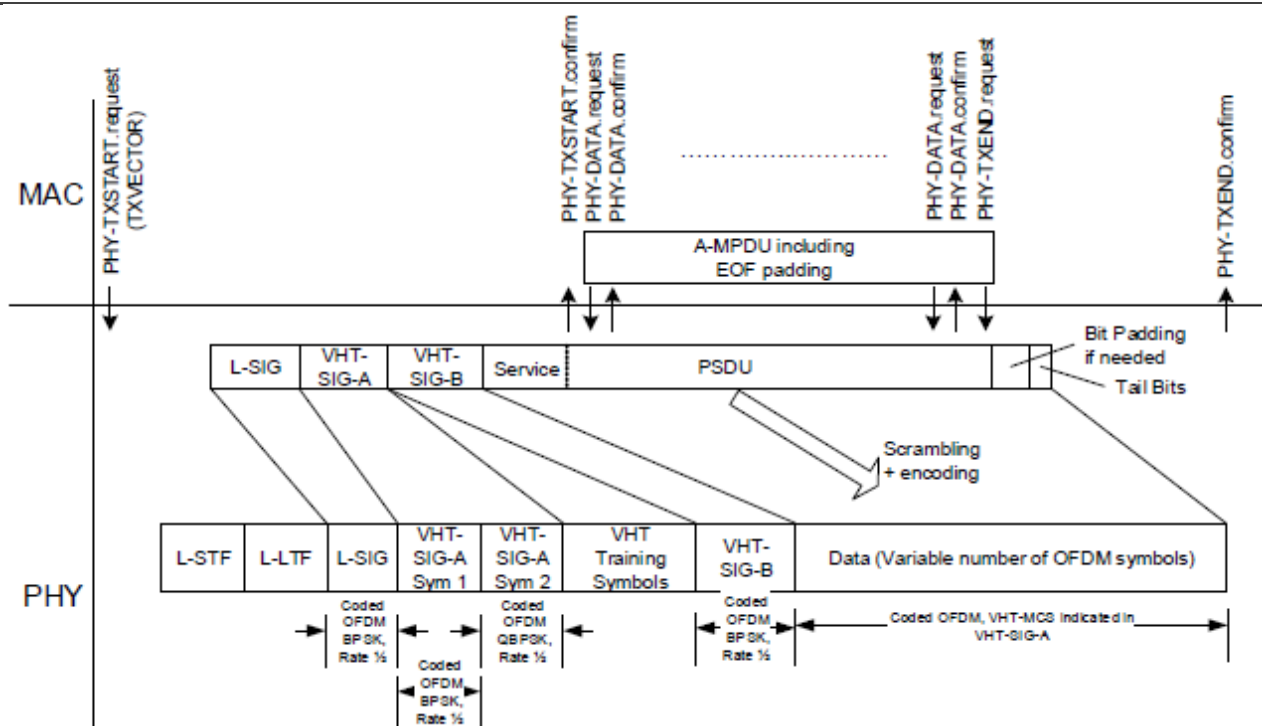
For a 20 MHz mask PPDU of non-HT, HT or VHT format, the interim transmit spectral mask shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth of 18 MHz, –20 dBr at 11 MHz frequency offset, –28 dBr at 20 MHz frequency offset, and –40 dBr at 30 MHz frequency offset and 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 PDU of non-HT, non-HT duplicate, 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 38 MHz, -20 dBr at 21 MHz frequency offset, -28 dBr at 40 MHz frequency offset, and -40 dBr 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 dBr spectrum level is above -56 dBm/MHz.”

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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. For example, as evidenced below Lenovo makes, uses, and/or sells 802.11ac-compliant access points (AP) which, when operated by Lenovo (including its subsidiaries, partners, employees, customers and/or end users), require performance of a method that includes transmitting the filtered transmission signal to the second node. “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.
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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.”

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“21.3.17 VHT transmit specification

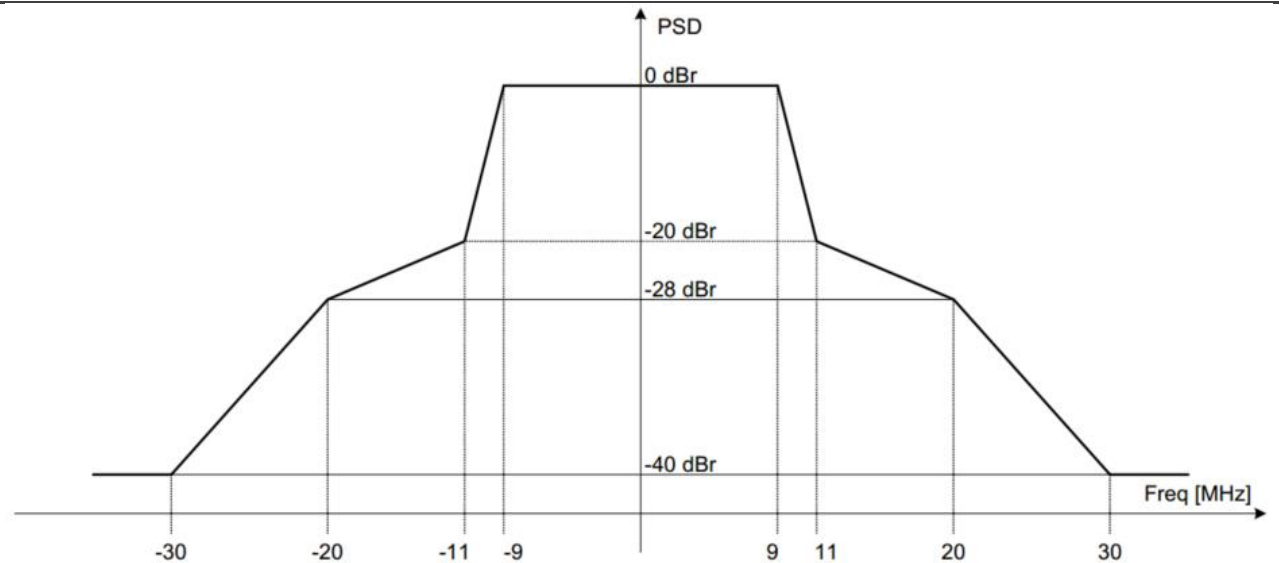
21.3.17.1 Transmit spectrum mask

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 dBr (dB relative to the maximum spectral density of the signal) bandwidth of 38 MHz, -20 dBr at 21 MHz frequency offset, -28 dBr at 40 MHz frequency offset, and -40 dBr 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. Figures 21-30 shows an example of the resulting overall spectral mask when the -40 dBr spectrum level is above -56 dBm/MHz.”

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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 step 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. The Accused Instrumentalities perform the step of 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. For example, as evidenced below, Lenovo makes, uses, and sells 802.11ac-compliant access points (AP) which, when operated by Lenovo (including its subsidiaries, partners, employees, customers and/or end users), 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 second VHT NDP sounding PPDU) sent from the first node to the third node. 21.3.11.2 Beamforming <u>Feedback Matrix</u> V <u>“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.</u> The beamformee shall generate the beamforming feedback matrices with the number of rows (N_r) equal to the N_{STS} of the NDP. <u>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 $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may</u>
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	calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1} \dots, Q_{k,N_{user}-1}]$ using $V_{k,u}$ and $SNR_{k,u}$ ($0 \leq u \leq N_{user}-1$) in order to suppress crosstalk between participating beamformees. The method used by the beamformer to calculate the steering matrix 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. <u>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.</u> 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.
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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.”

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“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.” Pages 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 step of decompressing the compressed first feedback resulting in a decompressed first feedback; and decompressing the compressed second feedback resulting in a decompressed second feedback. For example, as evidenced below Lenovo makes, uses, and sells 802.11ac-compliant access points (AP) which, when operated by Lenovo (including its subsidiaries, partners, employees, customers and/or end users), 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. “19.3.12.3.6 <u>Compressed beamforming feedback matrix</u> 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; and further comprising:	The Accused Instrumentalities perform the prior steps listed above, 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. For example, as evidenced below Lenovo makes, uses, and sells 802.11ac-compliant access points (AP) which, when operated by Lenovo (including its subsidiaries, partners, employees, customers and/or end users), 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: 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, <u>where k is one of the subcarriers</u>, 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.

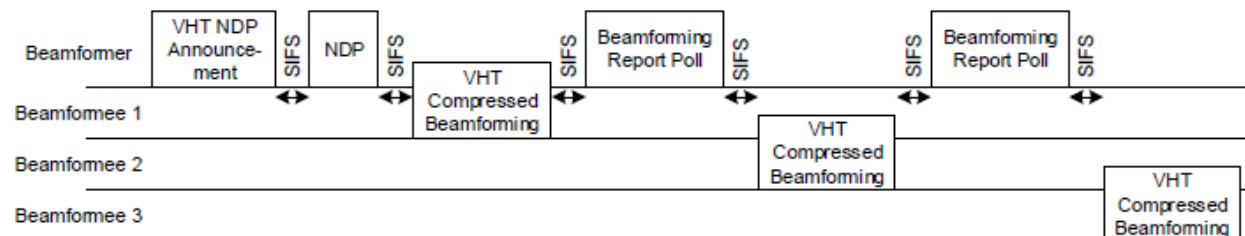


Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

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“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 $x_k = [x_{k,0}^T, x_{k,1}^T, \dots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \dots, x_{k,N_{STS,u}-1}]^T$ 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 $N_{RXu} \times N_{TX}$

N_{RXu} 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

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)."

Pages 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, 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. For example, as evidenced below Lenovo makes, uses, and sells 802.11ac-compliant access points (AP) which, when operated by Lenovo (including its subsidiaries, partners, employees, customers and/or end users), 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). Note: See evidence cited earlier in this independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): • 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, <u>where k is one of the subcarriers</u>, 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.

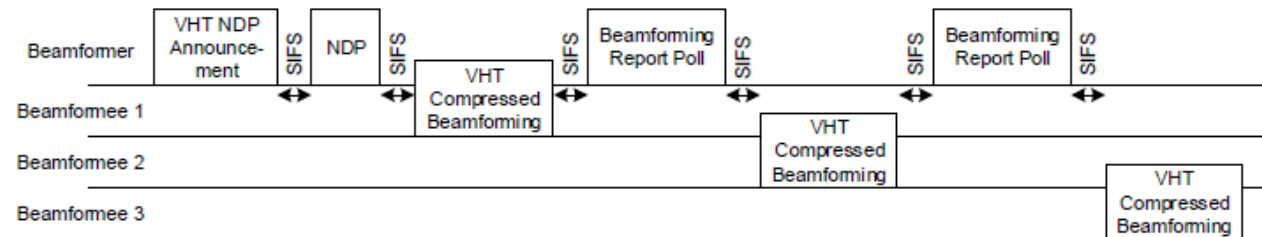


Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

Pages 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 $x_k = [x_{k,0}^T, x_{k,1}^T, \dots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \dots, x_{k,N_{STS,u}-1}]^T$ 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

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)."

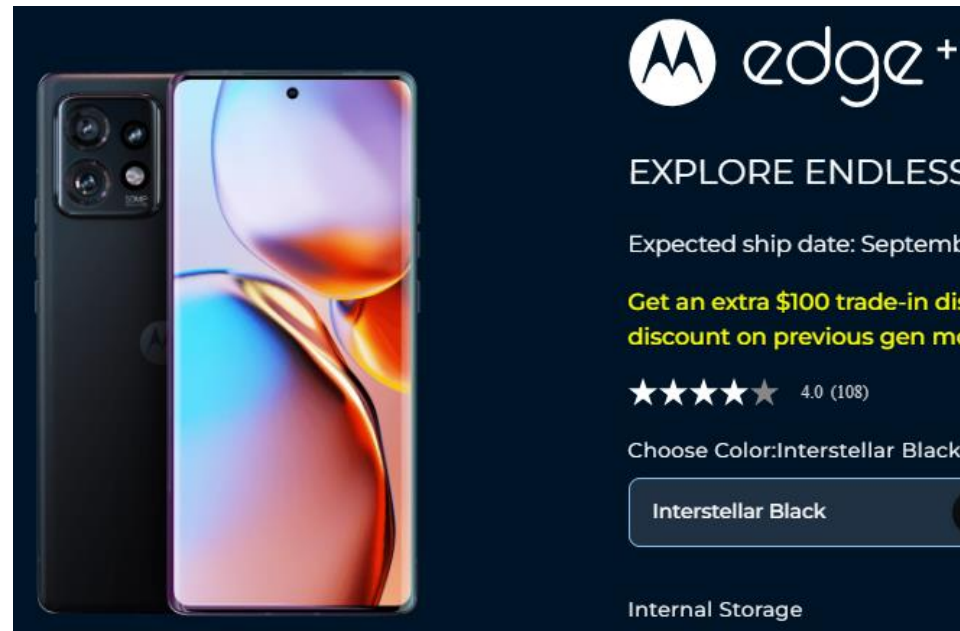
Pages 2578-2579 of 802.11-2016.

“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.													
95. A method for managing interference in a radio communications network, comprising the steps of:	The Accused Instrumentalities perform a method for managing interference in a radio communications network. For example, as evidenced below, Lenovo makes, uses, offers for sale and/or sells 802.11ac-compliant stations (STA) (including, but not limited to tablets, smartphones, etc.) which, when operated by Lenovo (including its subsidiaries, partners, employees, customers and/or end users), require performance of a method for managing interference in a radio communications network (e.g., a 802.11ac-compliant network). <u>Motorola moto E7</u> <table><tr><td rowspan="6">COMMS</td><td>WLAN</td><td>Wi-Fi 802.11 b/g/n</td></tr><tr><td>Bluetooth</td><td>5.0, A2DP, LE</td></tr><tr><td>Positioning</td><td>GPS, GLONASS, GALILEO</td></tr><tr><td>NFC</td><td>No</td></tr><tr><td>Radio</td><td>FM radio</td></tr><tr><td>USB</td><td>USB Type-C 2.0</td></tr></table> See, https://www.gsmarena.com/motorola_moto_e7-10511.php.	COMMS	WLAN	Wi-Fi 802.11 b/g/n	Bluetooth	5.0, A2DP, LE	Positioning	GPS, GLONASS, GALILEO	NFC	No	Radio	FM radio	USB	USB Type-C 2.0
COMMS	WLAN		Wi-Fi 802.11 b/g/n											
	Bluetooth		5.0, A2DP, LE											
	Positioning		GPS, GLONASS, GALILEO											
	NFC		No											
	Radio		FM radio											
	USB	USB Type-C 2.0												

Motorola edge+



Enhanced connections

Strengthen your wireless connection with Wi-Fi 6E³. And be ready for the networks of tomorrow with Wi-Fi 7³ compatibility.

Wi-Fi

Wi-Fi 802.11 a/b/g/n/ac/ax/k/v/r 2.4 GHz | 5 GHz | 6GHz Wi-Fi 6E, Wi-Fi 7 ready³ Wi-Fi hotspot

See, <https://www.motorola.com/us/smartphones-motorola-edge-plus-gen-3/p?skuId=893>.

Motorola moto g 5G



connectivity	Networks + Bands 5G: NR band n2/n5/n7/n12/n14/n25/n26/n29/n30/n41/n48/n66/n70/n71/n77/n78 4G: LTE band 1/2/3/4/5/7/8/12/13/14/17/18/20/25/26/28/29/30/38/39/40/41/48/66/71 3G: WCDMA band 1/2/4/5/8 2G: GSM band 2/3/5/8	Bluetooth Technology Bluetooth® 5.1
	NFC Yes ¹²	Wi-Fi Wi-Fi 802.11 a/b/g/n/ac 2.4GHz & 5GHz Wi-Fi hotspot
		Location Services GPS, A-GPS, LTEPP, GLONASS, Galileo, SUPL

See, <https://www.motorola.com/us/smartphones-moto-g-5g-gen-3/p?srsId=AfmBOoqARSrP6W5gmuetvKFTkxGMgO3QzFPYHCAPZ5ntSuFb-pDcwLoi&skuld=1071>.

Motorola razr



connectivity

Networks + Bands

5G | 4G: LTE | 3G: UMTS / HSPA+ | 2G: GSM / EDGE

3G: GSM850/900/1800/1900; W1/2/4/5/8

4G:

B1/2/3/4/5/7/8/12/13/14/17/18/19/20/25/26/28/29/30/38/39/40/41/46/48/66/71

5G sub-6: N1/2/3/5/7/12/14/20/25/26/28/29/30/38/40/41/48/66/70/71/77/78

NFC

Yes

Wi-Fi

WiFi 5G, WiFi 6/6E, WiFi 7

802.11 a/b/g/n/ac/ax/be

2.4GHz & 5GHz & 6GHz (specific regions only)

Wi-Fi hotspot

Bluetooth Technology

Bluetooth® 5.4

Location Services

GPS, A-GPS, LTEPP, SUPL, GLONASS, Galileo, Beidou

See, <https://www.motorola.com/us/smartphones-razr-plus-gen-2/p?skuId=1132>.

Motorola Edge 30

Wi-Fi

Wi-Fi 802.11 a/b/g/n/ac/ax 2.4 GHz | 5 GHz |
6E⁵ Wi-Fi hotspot

See <https://www.motorola.com/we/smartphones-motorola-edge-30/p?skuId=448>

Motorola Edge 40

Wi-Fi

Wi-Fi 802.11 a/b/g/n/ac/ax
2.4 GHz | 5 GHz | 6 GHz
Wi-Fi 6E, Wi-Fi 7 ready³
Wi-Fi hotspot

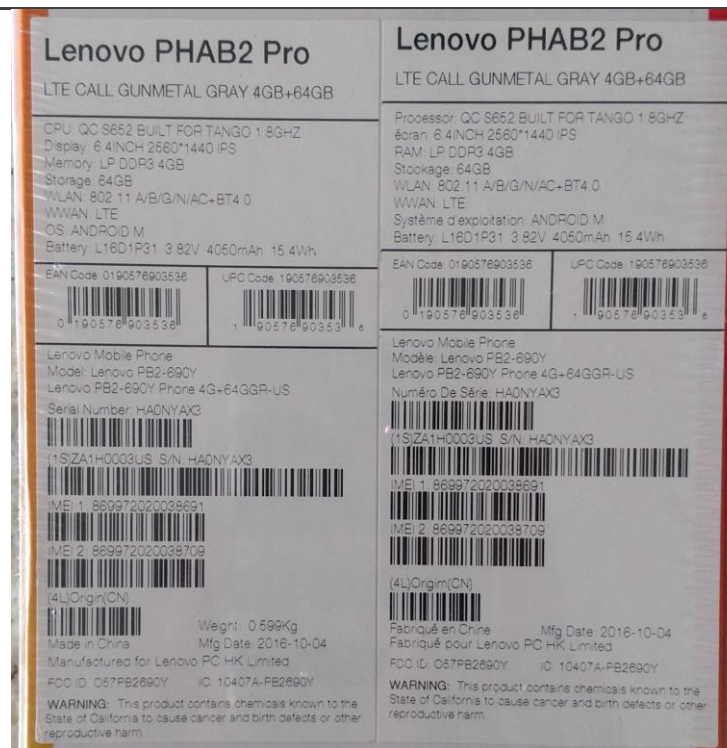
See <https://www.motorola.com/we/smartphones-motorola-edge-40-pro/p?skuId=511>

Motorola ThinkPhone

connectivity		Bluetooth Technology
Networks + Bands 5G: n1/2/5/7/14/41/66/71/77/78 4G LTE: B1/2/3/4/5/7/8/12/13/14/18/26/38/39/40/41/48/66/71 3G: B1/2/4/5/8/19 2G: B2/3/5/8		Bluetooth® 5.3
NFC Yes	Wi-Fi Wi-Fi 802.11 a/b/g/n/ac/ax 2.4 GHz 5 GHz 6GHz Wi-Fi 6E Wi-Fi hotspot	Location Services GPS, AGPS, LTEPP, SUPL, Glonass, Galileo

See, https://www.motorola.com/us/smartphones-thinkphone/p?srsId=AfmBOoofFC9_VAoka1jITq4yhCYeIkEovOnYTpQybAVpqel693Ce-rcL&skuId=869.

	<u>Lenovo Tab P12/P12 Pro, IdeaPad Y700, IdeaPad 5G</u> <table><tr><td>Wireless</td><td> • WiFi 6 802.11AX (2 x 2) • Bluetooth® 5.1 </td></tr></table> (https://www.lenovo.com/us/en/p/tablets/android-tablets/lenovo-tab-series/lenovo-tab-p12/len103l0018#tech_specs.) Network Ethernet No onboard Ethernet WLAN + Bluetooth® 802.11ac 2x2 Wi-Fi® + Bluetooth 5.0 (https://psref.lenovo.com/syspool/Sys/PDF/IdeaPad/IdeaPad_5G_14Q8X05/IdeaPad_5G_14Q8X05_Spec.pdf.) <u>Lenovo Phab 2 Pro</u>	Wireless	• WiFi 6 802.11AX (2 x 2) • Bluetooth® 5.1
Wireless	• WiFi 6 802.11AX (2 x 2) • Bluetooth® 5.1		



See U.S. Trademark Registration Number: 5182522 Specimen from Statement of Use. See also <https://www.amazon.com/Lenovo-ZA1H0003US-Unlocked-Android-Smartphone/dp/B01M4LBRTG?th=1>.¹

“802.11ax radios are able to communicate will legacy 802.11a/b/g/n/ac radios. 802.11ax radios communicate with other 802.11ax radios using OFDMA and/or OFDMA. 802.11ax radios

¹ USTA includes the foregoing because Lenovo had previously represented that no Lenovo-branded phones are sold in the United States. Lenovo’s statement of use and submission of specimens indicates otherwise. Moreover, to the extent that any Lenovo phones were developed in the United States, internal testing of the Wi-Fi functionality would result in performance of the claimed methods and infringe the claims of the ’720 patent.

communicate with legacy radios using OFDM or HR-DSSS. When 802.11ax-only OFDMA conversations are occurring, RTS/CTS mechanisms are used to defer legacy transmissions.” See, <https://www.extremenetworks.com/wifi6/what-is-80211ax/>.

“Wi-Fi 7 ensures backward compatibility with earlier Wi-Fi generations across the 2.4 and 5 GHz legacy bands, as well as with Wi-Fi 6E within the 6 GHz band.” <https://www.extremenetworks.com/resources/blogs/what-is-wifi-7>.

“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. <u>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.</u> 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.
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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
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	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.” Pages 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. For example, as evidenced below, Lenovo makes, uses, and sells 802.11ac-compliant stations (STA) which, when operated by Lenovo (including its subsidiaries, partners, employees, customers and/or end users), 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 or related/other 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.

“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.

	<u>secondary 80 MHz channel</u>: 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.” Pages 161-163 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
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	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
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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.”

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“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.”

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“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.”

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“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:

- 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.
- 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.”

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“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.”

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“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).”

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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

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filtering a transmission signal to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided;

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.

For example, as evidenced below Lenovo makes, uses, and sells 802.11ac-compliant stations (STA) which, when operated by Lenovo (including its subsidiaries, partners, employees, customers and/or end users), 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 or the related/other instruction).

“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:

- f) 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.
- g) 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.
- h) 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.
- i) Transmit a 20 MHz mask PPDU on the primary 20 MHz channel.
- j) 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.”

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“17.3.2.2 Overview of the PPDU encoding process

- f) 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.

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“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:

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

Replace Figure 18-7 with the following:

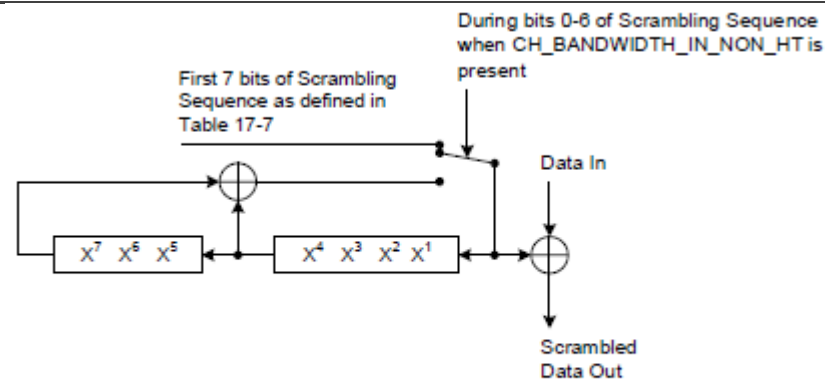


Figure 17-7—Data scrambler

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 1111111, 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 CH_BANDWIDTH_IN_NON_HT 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
- CH_BANDWIDTH_IN_NON_HT 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 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.”

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“21.3.17 VHT transmit specification

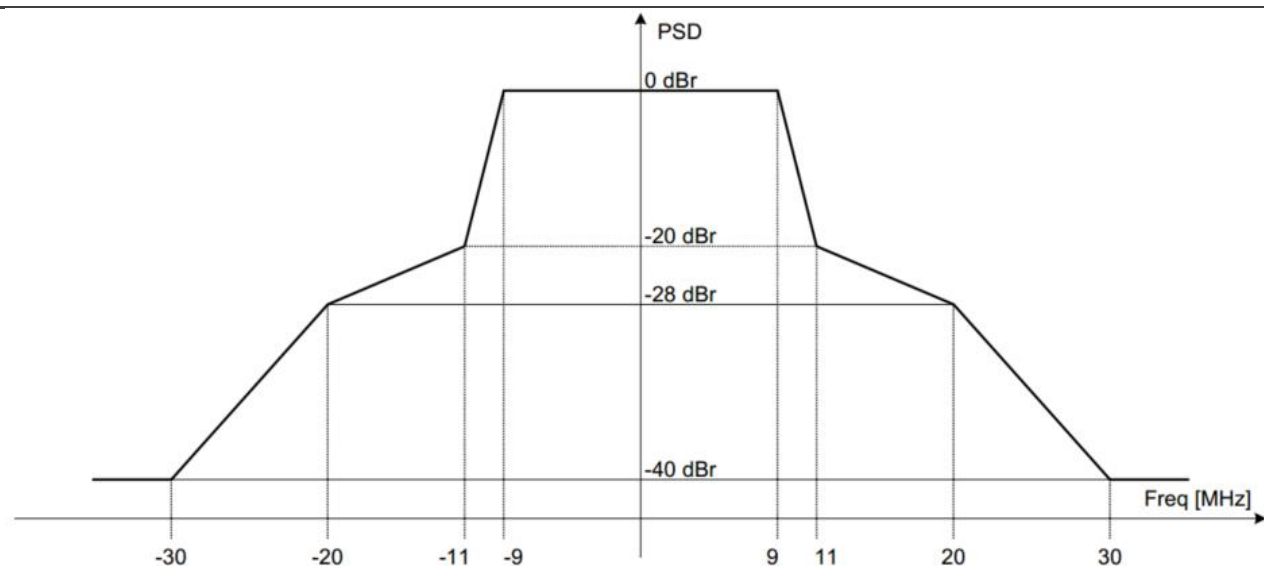
21.3.17.1 Transmit spectrum mask

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 PDU of non-HT, non-HT duplicate, 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 38 MHz, -20 dBr at 21 MHz frequency offset, -28 dBr at 40 MHz frequency offset, and -40 dBr 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 dBr spectrum level is above -56 dBm/MHz.”

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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.

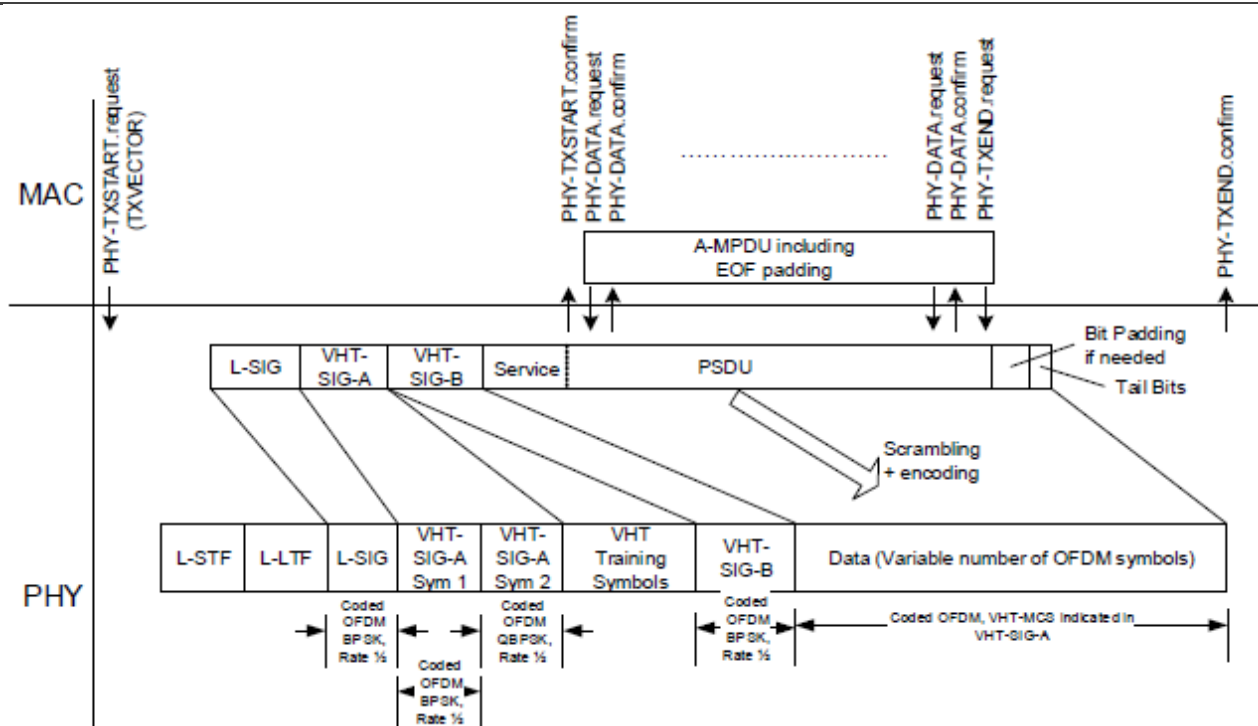
For example, as evidenced below Lenovo makes, uses, and sells 802.11ac-compliant stations (STA) which, when operated by Lenovo (including its subsidiaries, partners, employees, customers and/or end users), require performance of a method that includes transmitting the filtered transmission signal to the second node.

“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 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.”

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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.”

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“**21.3.17 VHT transmit specification**

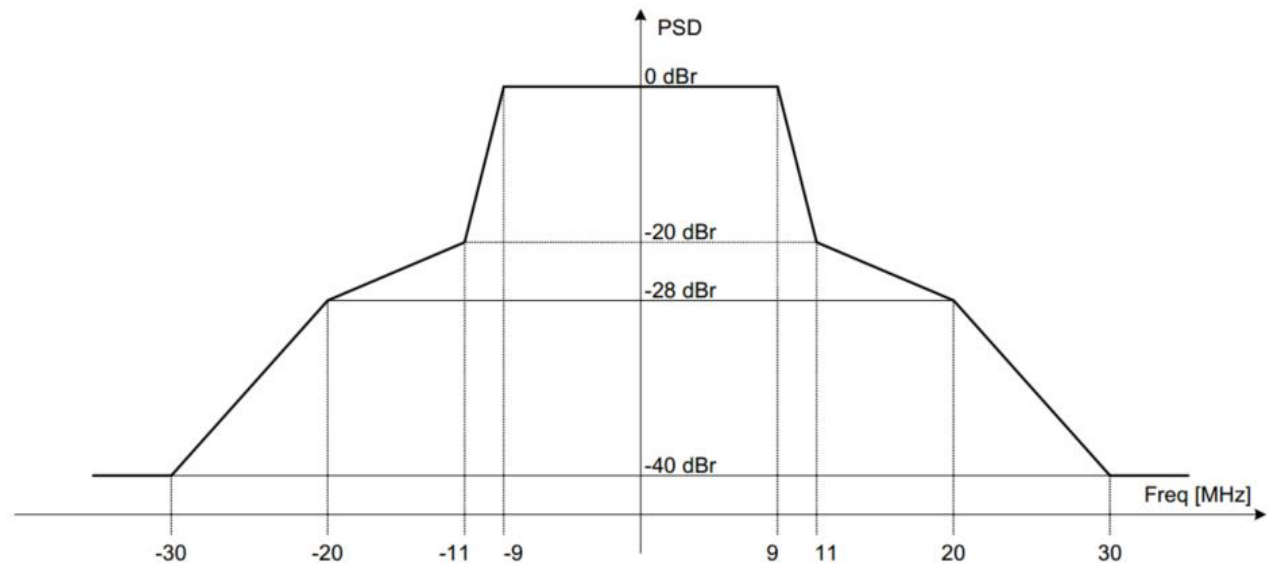
21.3.17.1 Transmit spectrum mask

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 dBr (dB relative to the maximum spectral density of the signal) bandwidth of 38 MHz, -20 dBr at 21 MHz frequency offset, -28 dBr at 40 MHz frequency offset, and -40 dBr 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 dBr spectrum level is above -56 dBm/MHz.” Pages 2582-2583 of 802.11-2016.
separately from the receipt of the instruction, receiving a particular signal at the first node that is transmitted from the second node;	The Accused Instrumentalities perform the step of, separately from the receipt of the instruction, receiving a particular signal at the first node that is transmitted from the second node. Note: See evidence cited earlier in this independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): 21.3.11.2 Beamforming <u>Feedback Matrix</u> V “<u>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.</u>

	The beamformee shall generate the beamforming feedback matrices with the number of rows (N_r) equal to the N_{STS} of the NDP. <u>After receiving the angle information, $\varphi(k, v)$ and $\psi(k, u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79).</u> For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1} \dots, Q_{k,N_{user}-1}]$ using $V_{k,u}$ and $SNR_{k,u}$ ($0 \leq u \leq N_{user}-1$) in order to suppress crosstalk between participating beamformees. The method used by the beamformer to calculate the steering matrix 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. <u>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.</u> 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.
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	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 <u>VHT Compressed Beamforming Report field</u> <u>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.</u> 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
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	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.” Pages 764-765 of 802.11-2016. “Calculating the feedback matrix can only begin after receiving the NDP from the beamformer. Once the NDP is received, each OFDM subcarrier is processed independently in its own matrix that describes the performance of the subcarrier between each transmitter antenna element and each receiver antenna element. The contents of the matrix are based on the received power and phase shifts between each pair of antennas.” See, https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html.
generating a feedback based on a received power and one or more frequencies via which the particular signal is received;	The Accused Instrumentalities perform the step of generating a feedback based on a received power and one or more frequencies via which the particular signal is received. Note: See evidence cited earlier in this independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): 21.3.11.2 Beamforming <u>Feedback Matrix</u> V “<u>Upon receipt of a VHT NDP sounding PPDU</u>, the beamformee shall remove the space-time stream CSD in Table 21-11 from the measured channel before <u>computing a set of matrices for</u>

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, $\phi(k,v)$ 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 (N_r) equal to the N_{STS} of the NDP.

After receiving the angle information, $\phi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix Q_k . For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1} \dots, Q_{k,N_{user}-1}]$ using $V_{k,u}$ and $SNR_{k,u}$ ($0 \leq u \leq N_{user}-1$) in order to suppress crosstalk between participating beamformees. The method used by the beamformer to calculate the steering matrix 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.

“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.”

Pages 764-765 of 802.11-2016.

9.4.1.27 MIMO Control field

The MIMO Control field is used to manage the exchange of MIMO channel state or transmit beamforming feedback information. It is used in the CSI (see 9.6.12.6), Noncompressed Beamforming (see 9.6.12.7), and Compressed Beamforming (see 9.6.12.8) frames.

The MIMO Control field is 6 octets in length and is defined in Figure 9-94.

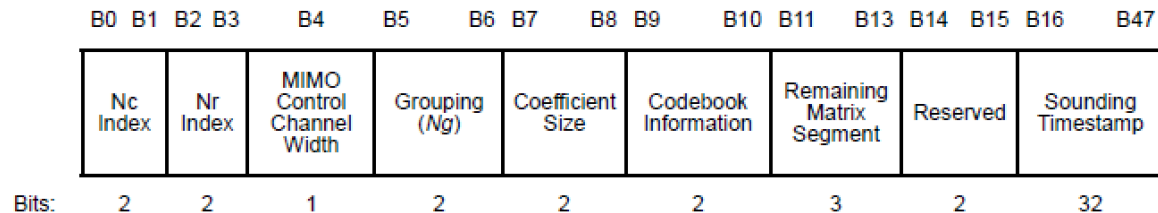


Figure 9-94—MIMO Control field

Page 745 of 802.11-2016.

	“Calculating the feedback matrix can only begin after receiving the NDP from the beamformer. Once the NDP is received, each OFDM subcarrier is processed independently in its own matrix that describes the performance of the subcarrier between each transmitter antenna element and each receiver antenna element. The contents of the matrix are based on the received power and phase shifts between each pair of antennas.” See, https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html.
compressing the feedback; and	The Accused Instrumentalities perform the step of compressing the feedback. “19.3.12.3.6 <u>Compressed beamforming feedback matrix</u> 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.
transmitting the compressed feedback from the first node to the second node, for use by the second node in determining a transmit power with which the second node transmits to the first node via at least one antenna of a plurality of antennas, while	The Accused Instrumentalities perform the step of transmitting the compressed feedback from the first node to the second node, for use by the second node in determining a transmit power with which the second node transmits to the first node via at least one antenna of a plurality of antennas, while simultaneously transmitting to one or more other nodes. <u>Note:</u> See evidence cited earlier in this independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):

simultaneously transmitting to one or more other nodes;	21.3.11.2 Beamforming <u>Feedback Matrix</u> 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 <u>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.</u> The beamformee shall generate the beamforming feedback matrices with the number of rows (N_r) equal to the N_{STS} of the NDP. <u>After receiving the angle information, $\varphi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79).</u> For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1} \dots, Q_{k,N_{user}-1}]$ using $V_{k,u}$ and $SNR_{k,u}$ ($0 \leq u \leq N_{user}-1$) in order to suppress crosstalk between participating beamformees. The method used by the beamformer to calculate the steering matrix 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
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	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. <u>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.</u> 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.
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“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,

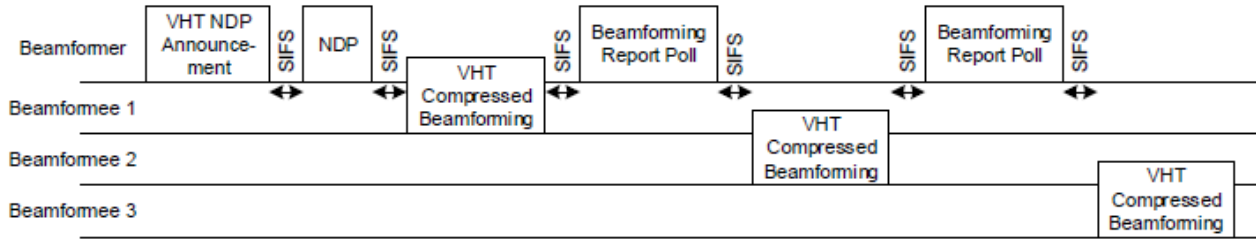
N_c is the number of columns in a compressed beamforming feedback matrix determined by the N_c Index field of the VHT MIMO Control field,

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.”

Pages 764-765 of 802.11-2016.

“Calculating the feedback matrix can only begin after receiving the NDP from the beamformer. Once the NDP is received, each OFDM subcarrier is processed independently in its own matrix that describes the performance of the subcarrier between each transmitter antenna element and each receiver antenna element. The contents of the matrix are based on the received power and phase shifts between each pair of antennas.”

See, <https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html>.

wherein the filtered transmission signal is transmitted to the second node using an 802.11-based orthogonal frequency-division multiplexing (OFDM) protocol;	The Accused Instrumentalities perform the prior steps listed above, wherein the filtered transmission signal is transmitted to the second node using an 802.11-based orthogonal frequency-division multiplexing (OFDM) protocol. Note: See evidence cited earlier in this independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): • 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, <u>where k is one of the subcarriers</u>, 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 Pages 1490-2579 of 802.11-2016.
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“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 $x_k = [x_{k,0}^T, x_{k,1}^T, \dots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \dots, x_{k,N_{STS,u}-1}]^T$ 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> Pages 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.
wherein an update of the compressed feedback is	The Accused Instrumentalities perform the prior steps listed above, wherein an update of the compressed feedback is repeatedly generated, compressed, and transmitted at time periods of less

repeatedly generated, compressed, and transmitted at time periods of less than one second; so that the transmit power is repeatedly updated based thereupon at time periods of less than one second.	than one second; so that the transmit power is repeatedly updated based thereupon at time periods of less than one second. Note: See evidence cited earlier in this independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): “$Q_{k,0}$ 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> Pages 2578-2579 of 802.11-2016. “a good rule of thumb is that channel measurement must occur on significantly shorter time scales to be effective—probably along the lines of 10 ms instead of the 100 ms that is acceptable in single-user beamforming. At such a short time scale, devices carried at walking speed will be able to move less than an inch (about 1.75 cm) between measurements.” See, https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html.
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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.