U.S. Patent No. RE47,720 – AT&T

USTA Technology, LLC ("USTA") provides evidence of infringement of the claims below of U.S. Patent No. RE47,720 (hereinafter "the '720 patent") by AT&T. In support thereof, USTA provides the following claim charts.

"Accused Instrumentalities and Services" 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 AT&T, including, but not limited to:~~ AT&T AirCard 781S, AirCard 779S,~~ AirTies access points and devices (e.g., 4960, 4980, 4971, ~~AirTies~~ 4920, 4921, 4991, 4981), Arris/Vantiva access points and devices, ~~Business Wi-Fi with Aruba Central, Business Wi-Fi with Cisco Meraki,~~ Optical Network Terminal (ONT) with Wi-Fi, ~~Internet Air, Internet Air for Business 5G, Internet for AT&T Fiber, Global Network Client, Wireless Internet, Fixed Wireless Internet, U-verse,~~ CGW452, CGW450, Turbo Hotspot 2, Turbo Hotspot 3, ~~Cell Booster, Cell Bosster Pro, Wireless Internet, Unite Express,~~ Unite Express 2, Unite Explore, Smart Wi-Fi Extender, All-Fi Booster, All-Fi Hub, BGW210, BGW320 (including BGW320-500, BGW320-505), BGW530, ~~Netgear 6200, Netgear 7550,~~ Nighthawk LTE Mobile Hotspot, Nighthawk 5G Mobile Hotspot, Nighthawk 5G Mobile Hotspot Pro, Nighthawk M6 Pro, Nighthawk M7 Pro, Franklin A50, Cradle~~el~~point access points (e.g., E100, E300, E320, ~~Cradlepoint~~ E~~e~~3000, IBR900, IBR1700, IBR1900, AER2200, X10-5GC, R2105), HPE/Aruba access points, ~~NVG510, NVG589,~~ NVG599, Inseego Wavemaker 5G indoor cellular router FG2000, Inseego MiFi X PRO, Inseego M2000, Inseego MiFi8000, Advantech B&B Advantech B&B Smartworx ICR-3200 LTE Gateway, Meraki access points (e.g., MR28, CW9162I, CW9164I, CW9166I, MR36, MR44, MR46, MR56, MR76, MR36), HPE/Aruba access points, ~~2Wire 2701, 2Wire3600, 2Wire 3800, 2Wire 3801, 2Wire i38, Pace 4111, Pace 5031, Pace 5168,~~ Pace 5268, RT410 hotspot, ~~Westell 327, Westell F90, Westell 6100, Motorola 2210, Motorola 3360, Siemens 4100, 4100b, 5100,~~ ZTE Max Connect MF928, ~~and Speedstream 4100, 5100 Networking, Gateway, and Hotspot Devices,~~ AT&T's Wi-Fi services (e.g., AT&T Nationwide Wi-Fi Hotspots, FirstNet, AT&T Hot Zones, AT&T Internet Air (including for Business), All-Fi, Fixed Wireless Access, AT&T Internet, AT&T Business Internet, AT&T Wi-Fi Services, AT&T Managed LAN Service, AT&T SD-WAN with Wi-Fi Feature, Business Wi-Fi with Aruba Central, Business Wi-Fi with Cisco Meraki, AT&T Managed Services, AT&T Hosting Enhanced Services, Managed Wireless WAN, AT&T Mobile Services, AT&T IoT Wireless Service, etc.), and at least 802.11ac-compliant stations (including backwards compatibility) made, used, offered for sale, sold and/or imported by AT&T, including, but not limited to: AT&T Propel 2 5G, Motivate 3, Motivate 4, Motivate Pro 5G, Vista, Vista 2, Verge, iPropel 5G, Calypso 4, Cingular Flex 2, amigo Jr. Tab, Primetime, Trek HD, Trek 2 HD, Modio LTE case for iPad mini, iPhone 15, iPhone 15 Plus, iPhone 15 Pro, iPhone 15 Pro Max, iPhone 16, iPhone 16 Pro, iPhone 16 Pro Max~~, Galaxy S24, Galaxy S24 Ultra, Galaxy S24 FE, Galaxy S24+, Galaxy Z Flip5, Galaxy Z Flip6, Galaxy Z Fold5, Galaxy Z Fold6~~, razr, razr+, ~~Galaxy S23 FE,~~ moto g stylus 5G, iPhone SE, ~~Galaxy A35 5G, Galaxy A15 5G,~~ iPhone 14, iPhone 13, TCL, ~~Galaxy XCover6 Pro,~~

XP10, XP3plus, and Motorola edge Phone Devices, along with associated hardware and/or software, and related 802.11ac-compliant services.[1]

These claim charts demonstrate AT&T's infringement by comparing each element of the asserted claims to corresponding components, aspects, and/or features of the Accused Instrumentalities and Services. 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 AT&T has not yet provided any non-public information. An analysis of AT&T's (or other third parties') technical documentation and/or software source code may assist in fully identify all infringing features and functionality. Accordingly, USTA reserves the right to supplement this infringement analysis once such information is made available to USTA. Furthermore, USTA reserves the right to revise this infringement analysis, as appropriate, upon issuance of a court order construing any terms recited in the asserted claims.

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

Unless otherwise noted, USTA contends that AT&T directly infringes the '720 patent in violation of 35 U.S.C. § 271(a) by using (including internal testing, provisioning of AT&T Wi-Fi services (e.g., AT&T Nationwide Wi-Fi Hotspots, FirstNet, AT&T Hot Zones, AT&T Internet Air, All-Fi, Fixed Wireless Access, AT&T Internet, AT&T ~~Businss~~Business Internet, AT&T employees Wi-Fi services, etc.), provisioning of AT&T Wi-Fi access points, internal use of AT&T Wi-Fi services while conducting business, installation and maintenance/servicing of AT&T Internet services with Wi-Fi for business and residential customers, compatibility testing, providing services for Fixed Wireless, AT&T Internet Air, AT&T Internet Air for Business, FirstNet, Nationwide Wi-Fi Hotspot network, and other Wi-Fi service offerings by AT&T, etc.) the Accused Instrumentalities and Services and performing the claimed methods in the United States. The following exemplary analysis demonstrates that infringement. AT&T 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 Services, and infringing methods.

USTA further contends, to the extent a party other than AT&T performs any step of the asserted method claims, that such actions are attributable to AT&T under the theory of joint infringement. AT&T contracts with numerous third parties to provide the Accused Instrumentalities and Services and provides detailed instructions to those third parties related to the same. For example,

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[1] For the avoidance of doubt, Samsung and Google branded devices are not Accused Instrumentalities.

AT&T contracts with third parties to offer Wi-Fi services utilizing access points, including with suppliers of such access points, businesses utilizing access points, and companies testing access points and other IoT devices (for example, AT&T requires device compatibility testing and certification by AT&T for use on AT&T's networks).[2]

~~AT&T also requires device compatability testing and certification by AT&T for use on AT&T's networks.~~ 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). AT&T induces others to use in the United States, or has induced others to use in the past, without authority products, equipment, or services that infringe, including without limitation, the Accused Instrumentalities and Services, and infringing methods. AT&T provides detailed instructions regarding the use of AT&T Wi-Fi devices and services, including site design, installation, customer support, and maintenance, and induces its customers to practice the claimed methods as a result. AT&T has induced such infringement at least since becoming aware of the '720 patent after receiving notice from USTA on or around November 8, 2022 through a letter dated November 7, 2022 directed to Mr. David McAtee, Senior Executive Vice President and General Counsel for AT&T from Mr. Andrew Gordon, Manager for USTA. That letter provided specific evidence including a claim chart for claim 53 demonstrating infringement. Since at least that time, AT&T has actively induced infringement of the '720 patent.

On information and belief, since at least the time AT&T received notice, AT&T has induced and continue to induce others to infringe the '720 patent under 35 U.S.C. § 271(b) by, among other things, and with specific intent or willful blindness, actively aiding and abetting others to infringe, including but not limited to AT&T's partners, clients, customers, and end users, whose use of the Accused Instrumentalities constitutes direct infringement of the '720 patent.[3]

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[2] *See, e.g.*, https://www.att.com/gen/general?pid=7462; https://www.boingo.com/press-releases/att-expands-wi-fi-roaming-agreement-with-boingo/; https://www.business.att.com/collateral/sd-wan-aruba.html; https://www.att.com/legal/terms.smartWiFiEULA.html; https://about.att.com/story/att_wi_fi_small_site_for_business.html; https://www.business.att.com/content/dam/businesscenter/pdf/legal/att-enterprise-additional-service-equipment-related-terms.pdf; https://www.att.com/support/article/wireless/KM1103818/; https://www.corp.att.com/cpetesting/testing-services/; http://serviceguidenew.att.com; https://web.archive.org/web/20171122213124/https://www.business.att.com/solutions/Portfolio/wifi/; https://www.business.att.com/legal/att-business-wifi-with-cisco-meraki-terms-of-service.html.

[3] *See* https://www.corp.att.com/agnc/wp-content/uploads/sites/45/2024/11/Windows_adminguide_10.9.pdf.

For example, AT&T's actions that aid and abet others such as its partners, customers, clients, and end users to infringe include advertising and distributing the Accused Instrumentalities and providing instruction materials, training, and services regarding the Accused Instrumentalities and software automatically connecting their customers to Wi-Fi networks.[4]

For example, on information and belief, AT&T operates a nationwide network of Wi-Fi hotspots for its customers and other end-users that includes Accused Instrumentalities which practice one or more claims of the '720 patent when used by AT&T.[5] AT&T encourages customers and other end-users to utilize its nationwide Wi-Fi network.[6] On information and belief, AT&T further provides managed Wi-Fi services for its customers that include site planning, deployment/installation, operation and maintenance of Accused Instrumentalities that practice one or more claims of the '720 patent when used by AT&T or its customers.[7] On information and belief, AT&T further conducts internal testing of the Accused Instrumentalities which includes practicing one or more claims of the '720 patent.[8] On information and belief, AT&T further provides numerous services related to Wi-Fi including setting up, testing, operating, maintaining, and/or upgrading its customers' Wi-Fi networks, including using the Accused Instrumentalities to practice one or more claims of the '720 patent.[9] On information and belief, AT&T further offers Wi-Fi services at several locations, including its

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[4] *See* https://www.att.com/legal/terms.smartWiFiEULA.html ("Automatic Wi-Fi Connections"); https://www.business.att.com/learn/articles/benefits-of-the-new-standards-for-network-reliability.html (AT&T provides network consulting experts); https://www.business.att.com/learn/articles/do-i-need-a-network-upgrade.html; https://www.business.att.com/content/dam/businesscenter/pdf/legal/att-business-passport.pdf (passport feature); https://www.corp.att.com/agnc/wp-content/uploads/sites/45/2023/05/Windows_usersguide_10.8.pdf (AT&T Global Network Client utilized to connect to AT&T Wi-Fi locations); https://www.corp.att.com/agnc/.

[5] *See* https://www.attsavings.com/internet/wireless-internet-buyers-guide ("AT&T gives you free access to more than 30,000 Wi-Fi hotspots nationwide.").

[6] *See* https://www.business.att.com/content/dam/attbusiness/briefs/att-business-wi-fi-product-brief.pdf.

[7] *See* https://www.business.att.com/content/dam/attbusiness/briefs/att-business-wi-fi-product-brief.pdf ("If you prefer a capex model, you can purchase the equipment, and AT&T will manage it at a reduced monthly fee per access point."); https://serviceguidenew.att.com/sg_CustomPreviewer?attachmentId=00PPV00000SeyF92AJ; https://serviceguidenew.att.com/sg_CustomPreviewer?attachmentId=00PPV00000R3PC52AN; https://www.business.att.com/portfolios/networking.html.

[8] *See* https://iotdevices.att.com/devices.aspx.

[9] *See* https://www.youtube.com/watch?v=CODnk8k54Rw&list=PLxP2-8eHxebXqKMteRdxs1vEdTxt1-iEP&index=16; https://serviceguidenew.att.com/sg_CustomPreviewer?attachmentId=00PPV00000SfDFk2AN.

retail stores, to customers with qualifying data plans, and the provision of such Wi-Fi services infringes one or more claims of the ’720 patent.[10] Furthermore, AT&T’s Wi-Fi services may be accessed via mobile phones, laptops and/or tablets sold by AT&T.

Unless otherwise noted, USTA believes and contends that each element of the claim asserted herein is literally met through AT&T’s provisioning of the Accused Instrumentalities and Services. However, to the extent that AT&T 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 and Services, USTA did not identify any substantial differences between the elements of the patent claim and the corresponding features of the Accused Instrumentalities and Services, as set forth herein. In each instance, the identified feature of the Accused Instrumentalities and Services 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 and Services, USTA asserts that, on information and belief, any similarly-functioning instrumentalities also infringe the charted claim. USTA reserves the right to amend this infringement analysis based on other products made, used, sold, imported, or offered for sale by AT&T. USTA also reserves the right to amend this infringement analysis by citing other claims of the ’720 patent, not listed in the claim chart, that are infringed by the Accused Instrumentalities and Services. USTA further reserves the right to amend this infringement analysis by adding, subtracting, or otherwise modifying content in the “Accused Instrumentalities and Services” column of the chart.

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[10] See https://www.att.com/support/article/wireless/KM1103818/; https://www.attsavings.com/internet/wireless-internet-buyers-guide.

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

Claim	Accused Instrumentalities and Services
19. A method for managing interference in a radio communications network, comprising the steps of:	The Accused Instrumentalities and Services perform a method for managing interference in a radio communications network. For example, as evidenced below, AT&T makes, uses, or sells 802.11ac-compliant access points (AP) (including, but not limited to Networking, Gateway, and Hotspot Devices, etc.) which, when operated by AT&T (e.g., employees conducting regular business activities, design and installation teams, maintenance support, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet with Wi-Fi, etc.) and/or AT&T's agents or customers, require performance of a method for managing interference in a radio communications network (e.g., a 802.11ac-compliant network including backwards compatible 802.11ax and 802.11be APs).

AT&T Fiber® with AT&T All-Fi™

Powerful Wi-Fi you can rely on

Our next-generation Wi-Fi® delivers more coverage to more corners of your home than ever before.

Compatible gateway with Wi-Fi 6 subject to availability. Optimal performance requires Wi-Fi 6 enabled devices. Whole-home Wi-Fi connectivity may require AT&T Smart Wi-Fi® Extenders for an additional monthly charge.

AT&T All-Fi

A top-of-the-line Wi-Fi experience

Complete Wi-Fi coverage without dead zones

Up to 5,000 sq. ft. with mesh extender technology.

$10/mo. for up to five extenders. Number of extenders determined at the sole discretion of AT&T.

Speeds up to 5 GIG

Enjoy our fastest speeds, so you can enjoy more of what you love—on more devices.

Ltd. avail/areas. Speeds based on wired connection Actual speeds may vary. Single device wired speed maximum 4.7Gbps. For more info, go to www.att.com/speed101.

AT&T ActiveArmor℠

24/7 security that helps block threats before they reach your devices.

Guards against known threats only. AT&T Smart Home Manager app required. Security features must be enabled.

Easy 1-2-3 self-installation

If you qualify for an easy self-install kit, no technician is needed.

①

Unpack the AT&T Wi-Fi gateway

Plug the AT&T Wi-Fi gateway into an outlet.

②

Make the connection

Connect your AT&T Wi-Fi gateway to your computer using the provided cables.

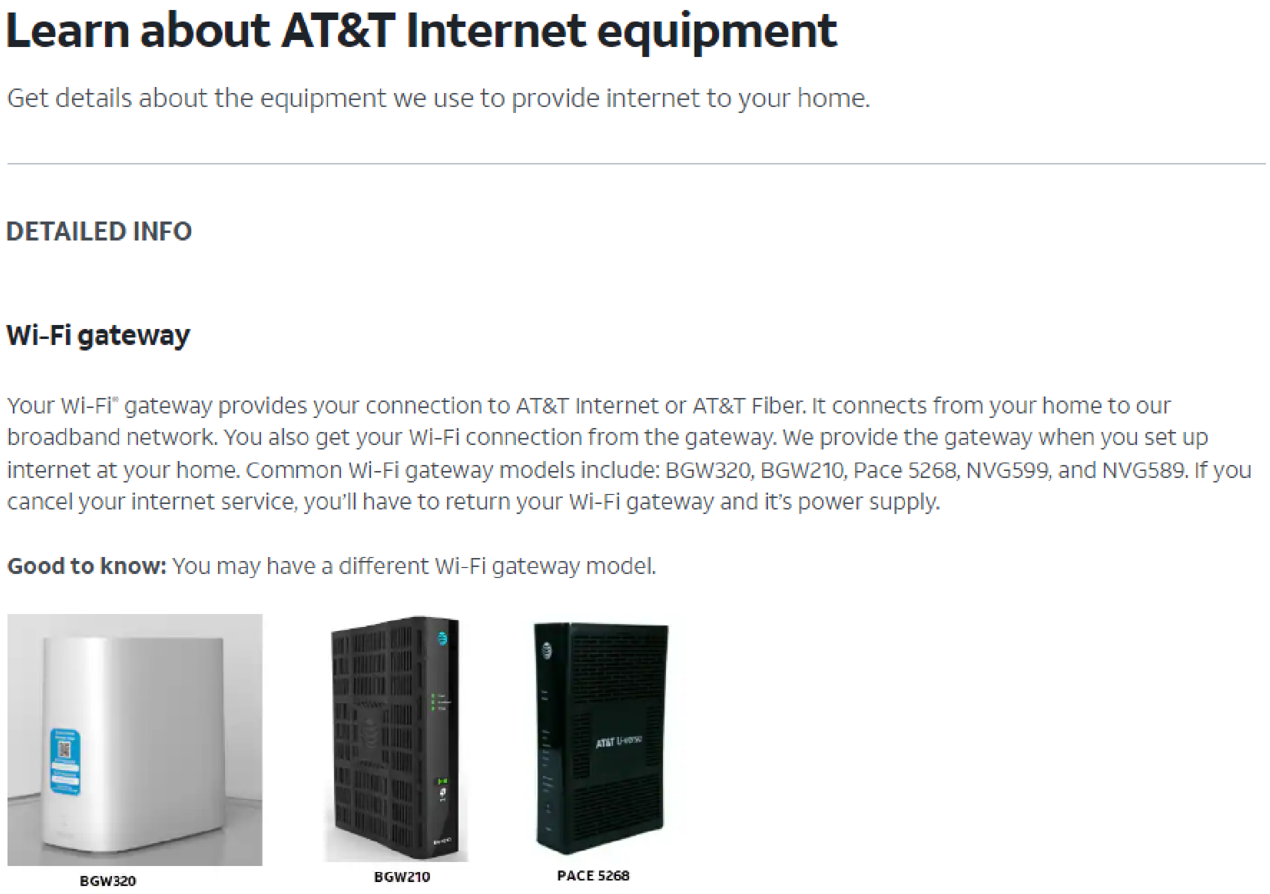
③

Sign in, register & get online

Follow the easy on-screen steps—and you're good to go.

If you are unable to install the AT&T Wi-Fi Gateway, call 800.288.2020 to schedule a technician for a professional installation.

https://www.att.com/wi-fi/



Learn about AT&T Internet equipment

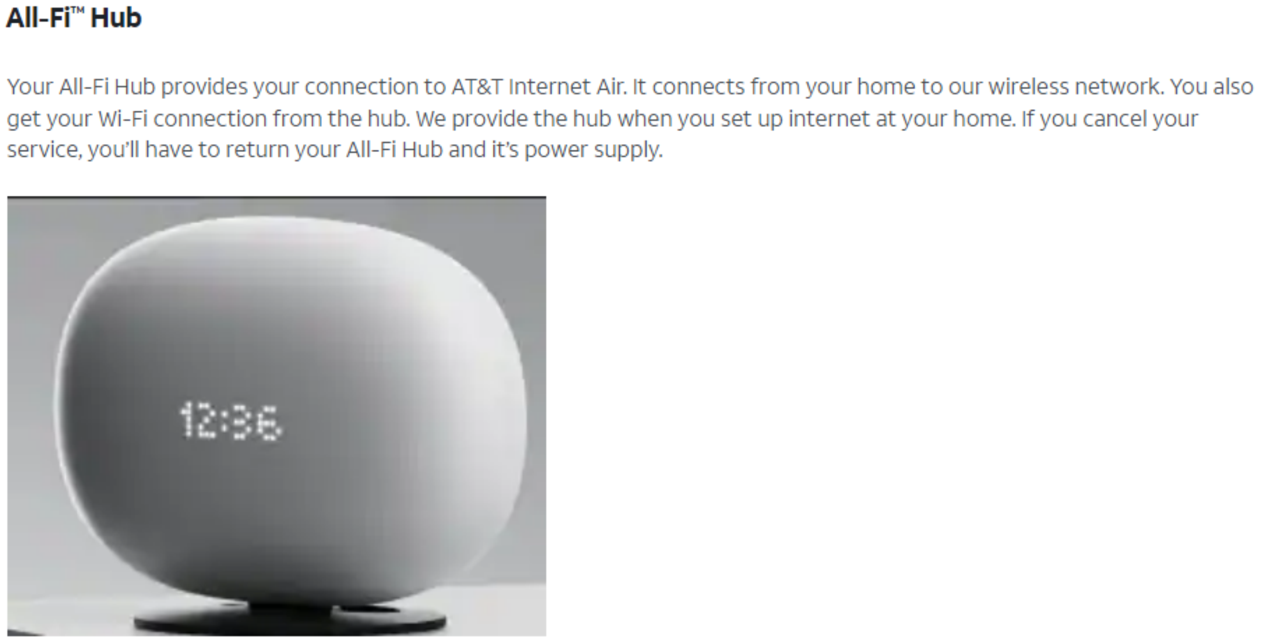
Get details about the equipment we use to provide internet to your home.

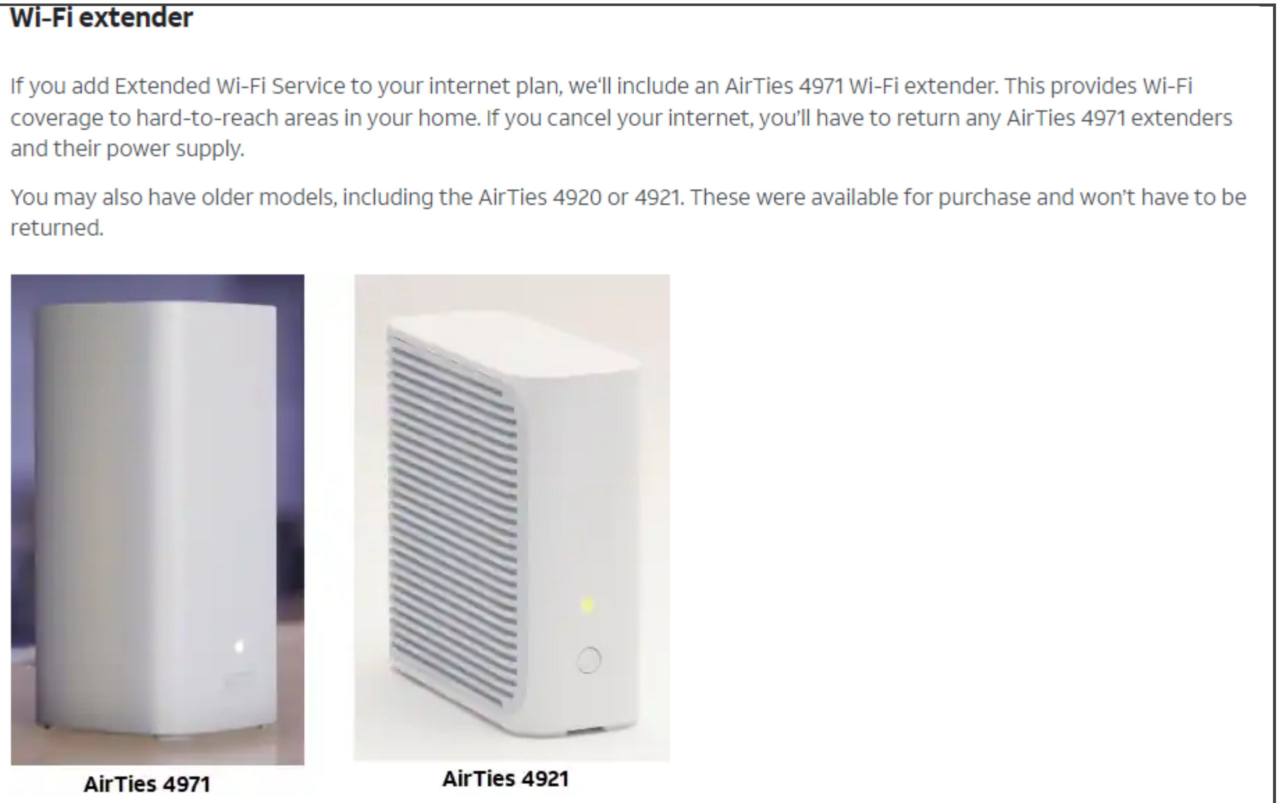
DETAILED INFO

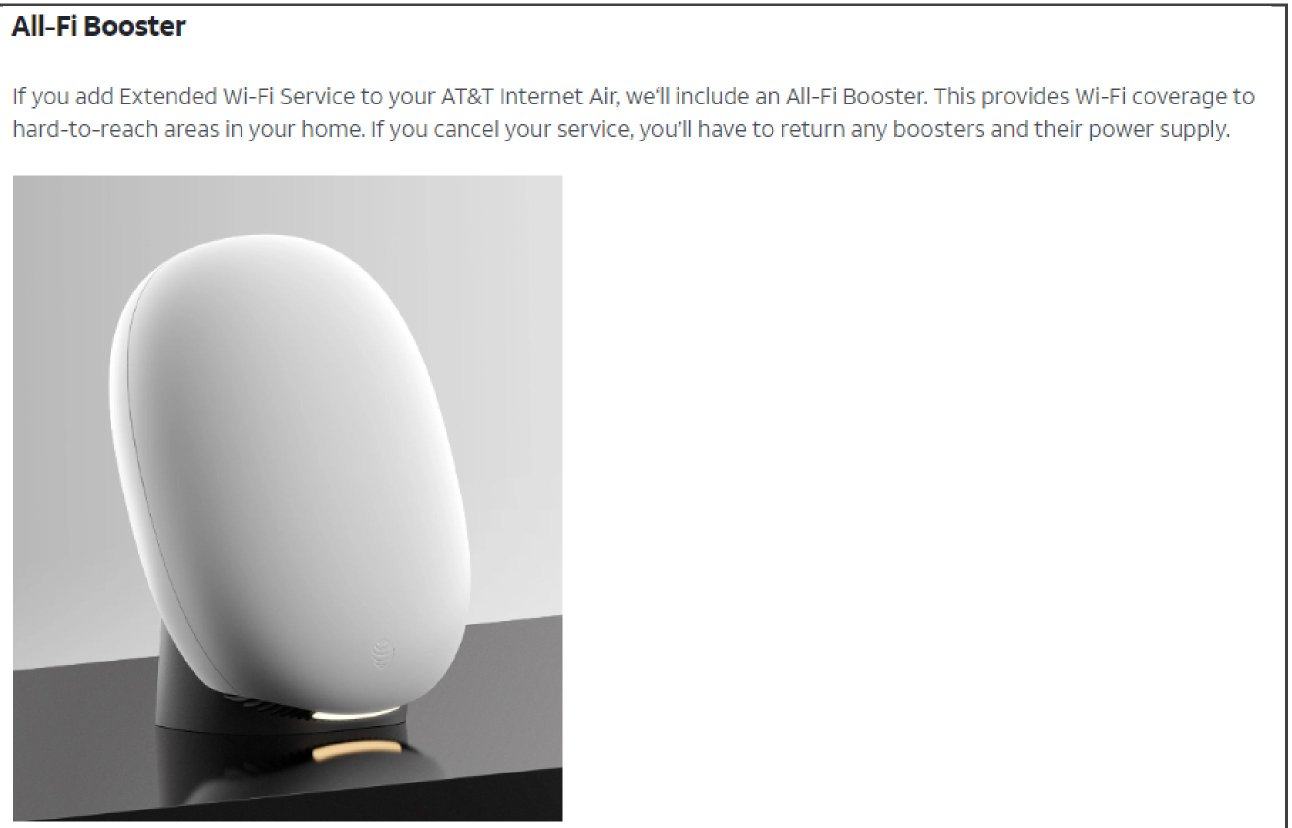
Wi-Fi gateway

Your Wi-Fi® gateway provides your connection to AT&T Internet or AT&T Fiber. It connects from your home to our broadband network. You also get your Wi-Fi connection from the gateway. We provide the gateway when you set up internet at your home. Common Wi-Fi gateway models include: BGW320, BGW210, Pace 5268, NVG599, and NVG589. If you cancel your internet service, you'll have to return your Wi-Fi gateway and it's power supply.

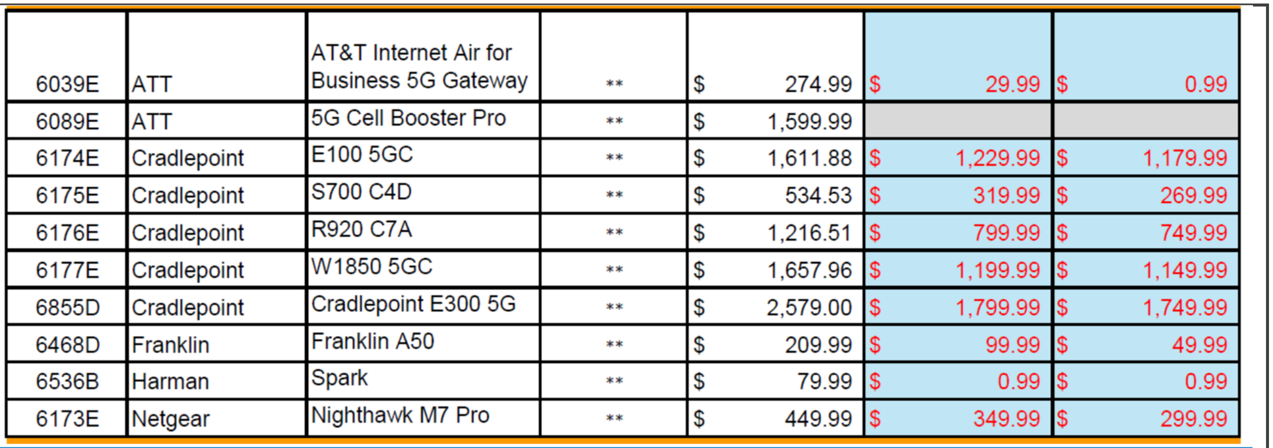
Good to know: You may have a different Wi-Fi gateway model.

	 **All-Fi™ Hub** Your All-Fi Hub provides your connection to AT&T Internet Air. It connects from your home to our wireless network. You also get your Wi-Fi connection from the hub. We provide the hub when you set up internet at your home. If you cancel your service, you'll have to return your All-Fi Hub and it's power supply.

	 **Wi-Fi extender** If you add Extended Wi-Fi Service to your internet plan, we'll include an AirTies 4971 Wi-Fi extender. This provides Wi-Fi coverage to hard-to-reach areas in your home. If you cancel your internet, you'll have to return any AirTies 4971 extenders and their power supply. You may also have older models, including the AirTies 4920 or 4921. These were available for purchase and won't have to be returned.

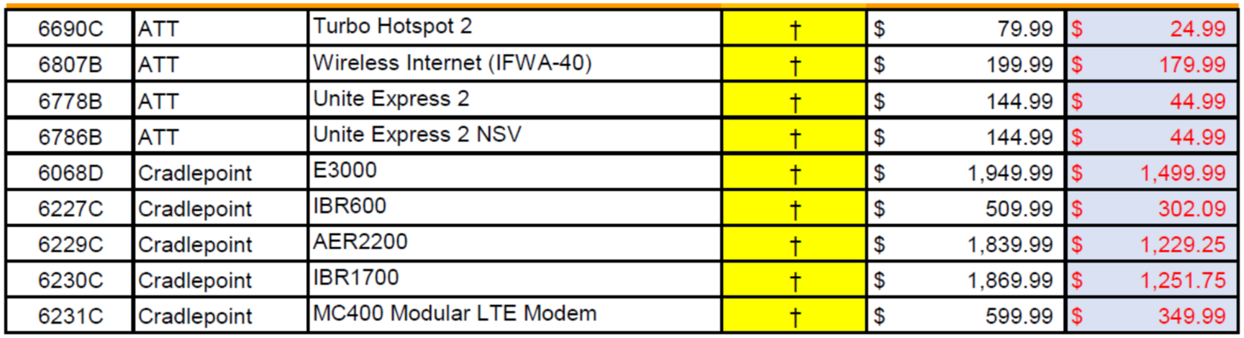
	 **All-Fi Booster** If you add Extended Wi-Fi Service to your AT&T Internet Air, we'll include an All-Fi Booster. This provides Wi-Fi coverage to hard-to-reach areas in your home. If you cancel your service, you'll have to return any boosters and their power supply. https://www.att.com/support/article/u-verse-high-speed-internet/KM1011652/

	 https://about.att.com/story/2024/integrated-gateway.html "In addition to being a modem, the new device [CGW452] will also function as a Wi-Fi 6E router." https://www.cnet.com/tech/mobile/atts-new-fiber-modem-can-connect-to-5g-if-your-wired-internet-is-out/  All-Fi Hub (CGW450) AT&T All·Fi https://www.att.com/scmsassets/support/internet/what-do-my-all-fi-hub-lights-mean-cgw450.pdf

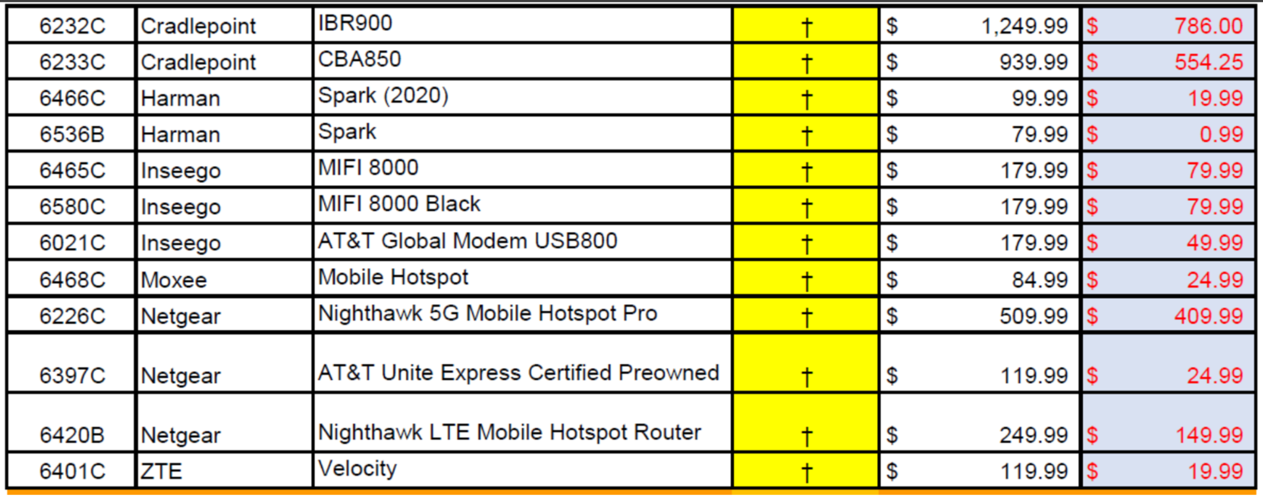


6039E	ATT	AT&T Internet Air for Business 5G Gateway	**	$ 274.99	$ 29.99	$ 0.99
6089E	ATT	5G Cell Booster Pro	**	$ 1,599.99		
6174E	Cradlepoint	E100 5GC	**	$ 1,611.88	$ 1,229.99	$ 1,179.99
6175E	Cradlepoint	S700 C4D	**	$ 534.53	$ 319.99	$ 269.99
6176E	Cradlepoint	R920 C7A	**	$ 1,216.51	$ 799.99	$ 749.99
6177E	Cradlepoint	W1850 5GC	**	$ 1,657.96	$ 1,199.99	$ 1,149.99
6855D	Cradlepoint	Cradlepoint E300 5G	**	$ 2,579.00	$ 1,799.99	$ 1,749.99
6468D	Franklin	Franklin A50	**	$ 209.99	$ 99.99	$ 49.99
6536B	Harman	Spark	**	$ 79.99	$ 0.99	$ 0.99
6173E	Netgear	Nighthawk M7 Pro	**	$ 449.99	$ 349.99	$ 299.99

https://www.business.att.com/content/dam/businesscenter/pdf/legal/att-business-equipment-list.pdf



6690C	ATT	Turbo Hotspot 2	†	$ 79.99	$ 24.99
6807B	ATT	Wireless Internet (IFWA-40)	†	$ 199.99	$ 179.99
6778B	ATT	Unite Express 2	†	$ 144.99	$ 44.99
6786B	ATT	Unite Express 2 NSV	†	$ 144.99	$ 44.99
6068D	Cradlepoint	E3000	†	$ 1,949.99	$ 1,499.99
6227C	Cradlepoint	IBR600	†	$ 509.99	$ 302.09
6229C	Cradlepoint	AER2200	†	$ 1,839.99	$ 1,229.25
6230C	Cradlepoint	IBR1700	†	$ 1,869.99	$ 1,251.75
6231C	Cradlepoint	MC400 Modular LTE Modem	†	$ 599.99	$ 349.99



6232C	Cradlepoint	IBR900	†	$ 1,249.99	$ 786.00
6233C	Cradlepoint	CBA850	†	$ 939.99	$ 554.25
6466C	Harman	Spark (2020)	†	$ 99.99	$ 19.99
6536B	Harman	Spark	†	$ 79.99	$ 0.99
6465C	Inseego	MIFI 8000	†	$ 179.99	$ 79.99
6580C	Inseego	MIFI 8000 Black	†	$ 179.99	$ 79.99
6021C	Inseego	AT&T Global Modem USB800	†	$ 179.99	$ 49.99
6468C	Moxee	Mobile Hotspot	†	$ 84.99	$ 24.99
6226C	Netgear	Nighthawk 5G Mobile Hotspot Pro	†	$ 509.99	$ 409.99
6397C	Netgear	AT&T Unite Express Certified Preowned	†	$ 119.99	$ 24.99
6420B	Netgear	Nighthawk LTE Mobile Hotspot Router	†	$ 249.99	$ 149.99
6401C	ZTE	Velocity	†	$ 119.99	$ 19.99

https://web.archive.org/web/20220325180150/https:/www.business.att.com/content/dam/businesscenter/pdf/legal/att-business-equipment-list.pdf

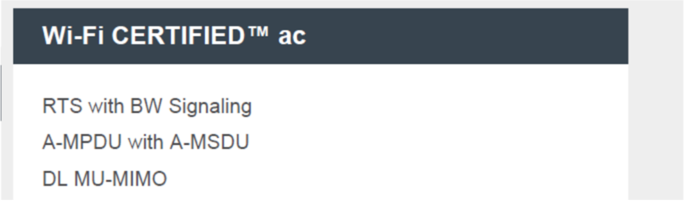
Wi-Fi CERTIFIED™ Certificate

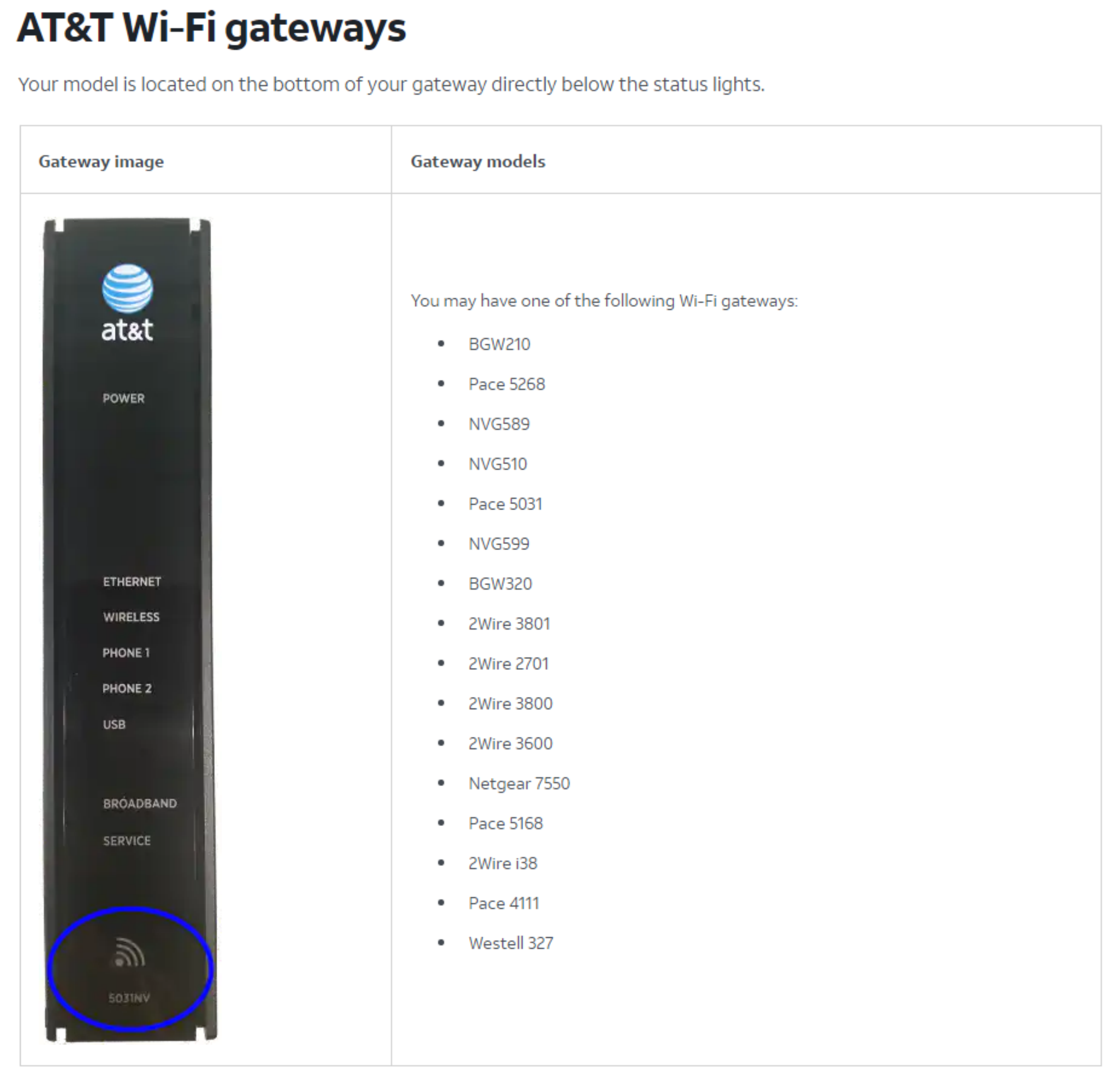
This certificate lists the features that have successfully completed Wi-Fi Alliance interoperability testing. Learn more: www.wi-fi.org/certification/programs

Certification ID: WFA128414

Product Info

Date of Certification	November 17, 2023
Company	CradlePoint, Inc.
Product Name	E100-5GC
Product Model Variant	Updating Modem to 5GC
Model Number	S5A352A
Category	Routers
Sub-category	Access Point for Home or Small Office (Wireless Router)

	 **Wi-Fi CERTIFIED™ ac** RTS with BW Signaling A-MPDU with A-MSDU DL MU-MIMO https://api.cert.wi-fi.org/api/certificate/download/public?variantId=128208; *see also* https://api.cert.wi-fi.org/api/certificate/download/public?variantId=126272 (E300-5GB Wi-Fi CERTIFIED ac for DL MU-MIMO); https://api.cert.wi-fi.org/api/certificate/download/public?variantId=16366 (E3000 certified for DL MU-MIMO); https://api.cert.wi-fi.org/api/certificate/download/public?variantId=105088 (E3000-5GB same); https://api.cert.wi-fi.org/api/certificate/download/public?variantId=66247 (IPR1700 same); https://api.cert.wi-fi.org/api/certificate/download/public?variantId=66248 (AER2200 same); https://api.cert.wi-fi.org/api/certificate/download/public?variantId=13087 (IBR900 same).

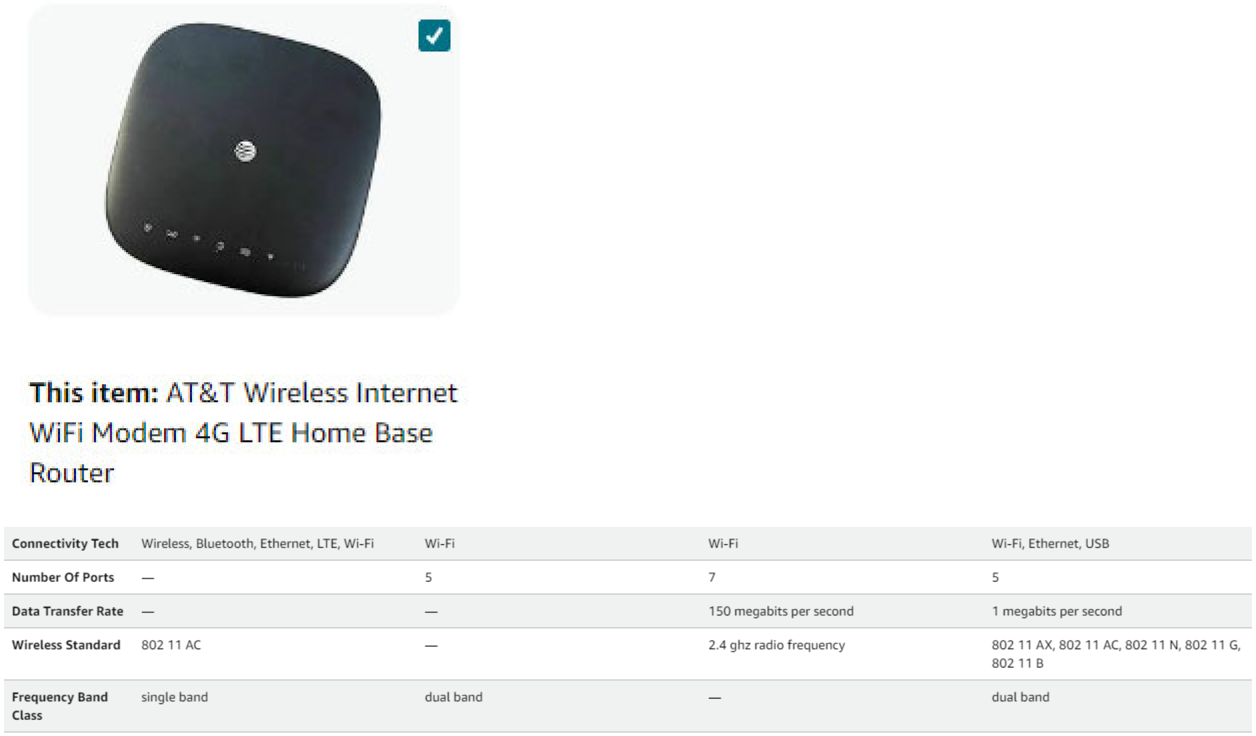


AT&T Wi-Fi gateways

Your model is located on the bottom of your gateway directly below the status lights.

Gateway image	**Gateway models**
	You may have one of the following Wi-Fi gateways: • BGW210 • Pace 5268 • NVG589 • NVG510 • Pace 5031 • NVG599 • BGW320 • 2Wire 3801 • 2Wire 2701 • 2Wire 3800 • 2Wire 3600 • Netgear 7550 • Pace 5168 • 2Wire i38 • Pace 4111 • Westell 327

https://www.att.com/support/article/dsl-high-speed/KM1047050/



This item: AT&T Wireless Internet WiFi Modem 4G LTE Home Base Router

Connectivity Tech	Wireless, Bluetooth, Ethernet, LTE, Wi-Fi	Wi-Fi	Wi-Fi	Wi-Fi, Ethernet, USB
Number Of Ports	—	5	7	5
Data Transfer Rate	—	—	150 megabits per second	1 megabits per second
Wireless Standard	802 11 AC	—	2.4 ghz radio frequency	802 11 AX, 802 11 AC, 802 11 N, 802 11 G, 802 11 B
Frequency Band Class	single band	dual band	—	dual band

https://www.amazon.com/Wireless-Internet-Hotspot-Antenna-AT/dp/B075JB968D?source=ps-sl-shoppingads-lpcontext&ref_=fplfs&psc=1&smid=A24OVZW9214RO6

Moxee mobile hotspot https://www.att.com/ecms/dam/att/devicesupport/EMB-Moxee-K779HSDL-UserManual-051220.pdf

ZTE wireless internet MF279 https://www.att.com/ecms/dam/att/devicesupport/5000-5499/5174/ATT-WirelessInternet-MF279.pdf

ATT MiFi 8000 https://www.att.com/device-support/index/9006088/Inseego/InseegoMiFi8000

	Att turbo hotspot 3 https://www.att.com/scmsassets/support/wireless/qsg-turbo-hotspot-3-wingtech-att-20231022.pdf IFWA-40-ATT https://www.att.com/ecms/dam/att/devicesupport/IFWA-40-ATT-UserGuide.pdf https://www.att.com/wi-fi/extender/ (“The AT&T Wi-Fi extender is designed to be compatible with the BGW320, BGW210, or 5268AC AT&T Wi-Fi Gateways. These Wi-Fi Gateways feature Wi-Fi 6 technology, a more advanced wireless transmission standard that allows more devices to be connected without any loss in connection speed.”) https://www.att.com/internet/smart-home/ (“All features available with BGW320, BGW210, 5268AC and NVG599 Wi-Fi gateways.”) https://www.attsavings.com/internet/wireless-internet-buyers-guide (“AT&T gives you free access to more than 30,000 Wi-Fi hotspots nationwide.”) https://www.firstnet.com/coverage/firstnet-megarange.html Nextivity® SHIELD MegaFi (Mobile Kit) Nextivity® SHIELD MegaFi 2 (Mobile Kit) Nextivity® SHIELD MegaFi 2 (Fixed Kit) Nextivity® SHIELD MegaFi (Fixed Kit) Nextivity® SHIELD MegaGo (integrated Wi-Fi hotspot) Nextivity® SHIELD MegaGo 2 (integrated Wi-Fi hotspot) https://www.firstnet.com/devices/accessories/sonim-rdk3.html https://www.business.att.com/content/dam/businesscenter/pdf/legal/att-business-connected-school-bus-brief.pdf (Cradlepoint R920 (4G) or R1900 (5G) ▪ Peplink MAX BR1 Pro Cat 20 or 5G ▪ MegaRange HPUE (for rural routes) ▪ All IP54/64 and SAEJ1455 MIL STD 810G)

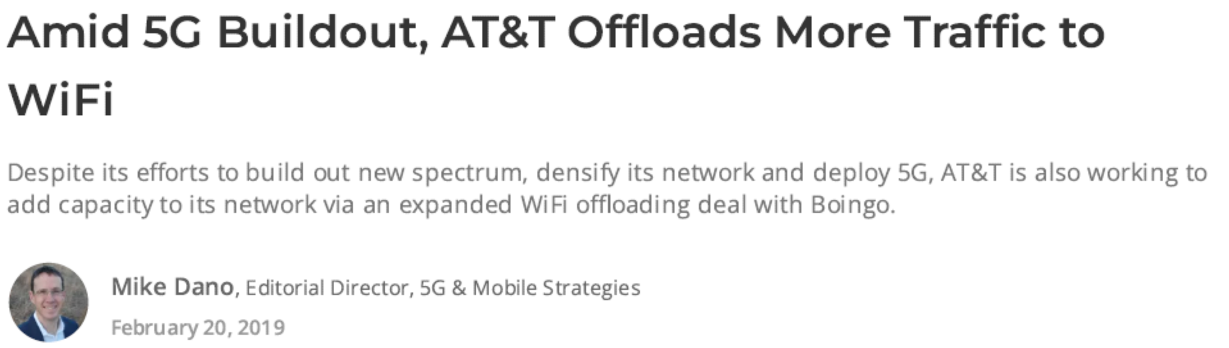
	“AT&T All-Fi is complimentary to all AT&T Fiber customers, regardless of their fiber internet speed plan . . . Everyone with All-Fi gets the AT&T Wi-Fi Gateway” https://www.att.com/internet/what-is-all-fi/#storyoffer7; *see also* https://www.att.com/legal/terms.wiFiServices.html “AT&T All-Fi Hub and All-Fi Booster are devices that . . . are actually related to AT&T’s wireless internet service—AT&T Internet Air—which allows Wi-Fi service through AT&T’s cellular network.” https://www.att.com/internet/what-is-all-fi/#storyoffer7 AT&T charges significant sum and invests significant resources to test and confirm 802.11 protocol compatibility within its networks, including up to or more than $50,000 per device. https://iotdevices.att.com/certified-devices.aspx; https://iotdevices.att.com/networkready.aspx; https://iotdevices.att.com/devices.aspx#:~:text=For%20chipset%2Dbased%20device%20designs,while%20ensuring%20ongoing%20network%20compatibility. “AT&T’s most recent generation of Wi-Fi equipment generally supports Wi-Fi 6 (IEEE 802.11ax) standard and is compatible with older Wi-Fi (IEEE 802.11 a/b/g/n/ac) standards . . . AT&T reserves the right to manage remotely any ~~equiprement~~equipment used to access any Internet Servic e, whether that equipment is connected via a wired or wireless connection . . . Access to AT&T’s nationwide network of Wi-Fi Hot Spots may be available to use as part of the Service . . . .” https://www.att.com/legal/terms.consumerserviceagreement.html “AT&T provides a router and management for as little as $1 a day.” https://www.business.att.com/products/att-dedicated-internet.html “AT&T provides Wi-Fi access at more than 18,000 hot spots in 42 countries globally (including company-owned and roaming locations).” https://www.att.com/gen/general?pid=7462 “Get unlimited access at more than 30,000 AT&T Wi-Fi Hot Spots nationwide.” https://www.att.com/plans/tethering/

	“Nationwide Wi-Fi Hotspot Service. AT&T's mass market Wi-Fi broadband internet access service is designed to provide customers with the highest speed available from the network at any given point in time, subject to the many different factors discussed above that can affect network performance. AT&T's Wi-Fi services generally support the IEEE 802.11n/ac standard . . . .” https://about.att.com/sites/broadband/performance#:~:text=Nationwide%20Wi%2DFi%20Hotspot%20Service,access%20services%2C%20please%20click%20here. “These Terms of Service & Acceptable Use Policy (the “Terms”) govern your use of the AT&T Wi-Fi Services (“Service”) provided to you through premises operators pursuant to contracts with AT&T or delivered to you directly by AT&T. . . The Service is provided by AT&T Wi-Fi Services, an affiliate of AT&T Corp. (“AT&T”). In order to provide the Service to Customers, AT&T contracts with owners and operators of popular establishments and businesses who purchase the Service to provide it to their employees, patrons, and invited guests at specific sites or locations (Locations). AT&T also offers the Service for the benefit of AT&T Mobility, AT&T DSL and U-verse subscribers for use in select public venues and for certain events, for example, in a city park or performance concert (“AT&T Hot Zones”) . . . The Service is designed to provide you with the highest speed available from the network at any given point in time, subject to the many different factors discussed above that can affect network performance. The Service generally supports the IEEE 802.11n/ac standard . . . .” https://www.att.com/legal/terms.wiFiServices.html “AT&T Business Wi-Fi helps you deliver a connected full-service experience. Our highly secure solution delivers a fully-integrated, managed Wi-Fi service that connects and protects your business and consumers . . . Professional and self-installation options are available, based on your needs. Select from three flexible management options for equipment and services. If you prefer a capex model, you can purchase the equipment, and AT&T will manage it at a reduced monthly fee per access point . . . AT&T is a preeminent provider of Wi-Fi services, delivering highly reliable and scalable connectivity, **with 24/7 support for both your end users and your employees. We can handle a variety of deployment types and support a wide array of applications. We’ll take care of everything from network design to installation.** Get the high-quality service you want, from a company you trust. AT&T..” https://www.business.att.com/content/dam/attbusiness/briefs/att-business-wi-fi-product-brief.pdf

	"Use AT&T Wi-Fi Hot Spots to connect your mobile device or laptop to high-speed internet. You can find them in public places like coffee shops, airports, and restaurants. They're available nationwide . . . Your device automatically connects to our Wi-Fi network when you're at an AT&T Wi-Fi Hot Spot location." https://www.att.com/support/article/wireless/KM1103818/ "Enjoy a fully managed Wi-Fi service with a robust Day 0, 1, and 2 support model. From site design to professional installation to ongoing care, we have you covered . . . Choose which equipment option will best suit your needs (Cisco Meraki, Aruba, or Mist). Then decide whether you would like AT&T to professionally install the equipment or you would like to self-install . . .No matter which equipment option you choose, all come with Wi-Fi 6 compatible devices. . . . AT&T offers a robust support model with Day 0, 1, and 2 support available. AT&T offers professional services to conduct site surveys, design networks, install equipment, and provide ongoing care and maintenance." https://www.business.att.com/products/business-wifi.html "AT&T Wireless LAN Service - WLAN is an extension of MLAN that includes IEEE 802.11 compliant wireless LAN controllers, Wi-Fi access points and their communication with compatible edge devices. WLAN requires that the Customer's wired LAN also be under AT&T management. AT&T provides design, implementation and remote in band monitoring and management of a Customer's Wi-Fi LAN infrastructure from one of AT&T's Management centers." https://serviceguidenew.att.com/sg_CustomPreviewer?attachmentId=00PPV00000Iw3842AB "AT&T offers a wide variety of AT&T Wi-Fi Services as defined herein. The following Services are available under this Service Guide: • AT&T Wi-Fi Connect Link Base Service (CLB) • AT&T Wi-Fi Connect Link Total Service (CLT) • AT&T Wi-Fi Connect Link Select Service (CLS) • AT&T Wi-Fi Small Site Service (AWSS) • AT&T Business Wi-Fi (formerly known as AT&T Wi-Fi Enterprise) (ABW)" https://serviceguidenew.att.com/sg_CustomPreviewer?attachmentId=00PPV00000Iw3JN2AZ "All AT&T Equipment and Customer Premises Equipment (CPE) that is part of the Wi-Fi Network may be referred to as "Equipment." Equipment may be installed by AT&T to deliver the Service. The Equipment can be either AT&T Equipment or Purchased Equipment. Equipment

ownership for a particular Service or installation is specified herein or in an applicable Pricing Schedule. For AT&T Equipment, AT&T grants Customer a limited, non-exclusive, non-transferable license to use the Service during the Term of the Pricing Schedule. For Purchased Equipment, Customer will obtain by its purchase from AT&T a software license for certain third-party software needed for the operation of the Service."
https://serviceguidenew.att.com/sg_CustomPreviewer?attachmentId=00PPV00000Iw3JN2AZ

For example, as evidenced below, AT&T has entered into contracts with Boingo to add capacity to its mobile network via the use of Passpoint technology, which allows AT&T to offload its mobile network traffic onto Wi-Fi networks:

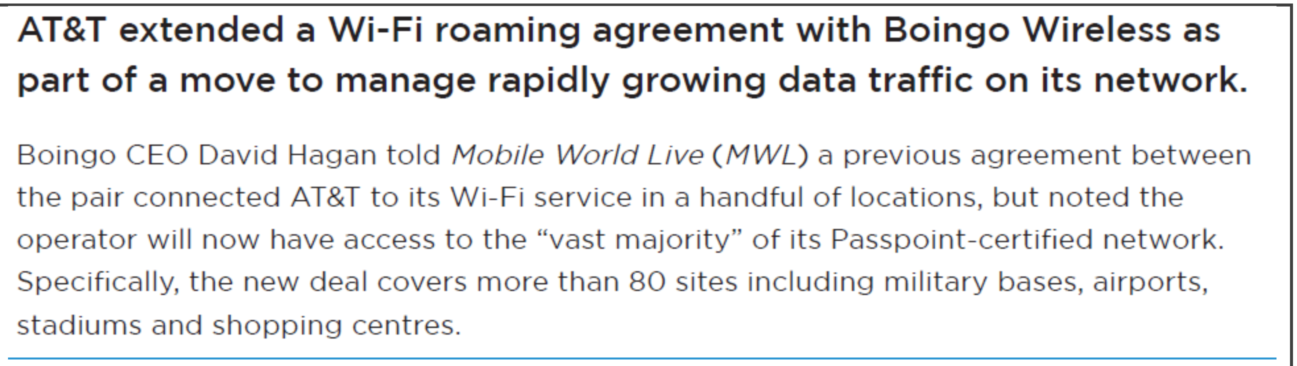


Amid 5G Buildout, AT&T Offloads More Traffic to WiFi

Despite its efforts to build out new spectrum, densify its network and deploy 5G, AT&T is also working to add capacity to its network via an expanded WiFi offloading deal with Boingo.

Mike Dano, Editorial Director, 5G & Mobile Strategies
February 20, 2019

(https://www.lightreading.com/wifi/amid-5g-buildout-at-t-offloads-more-traffic-to-wifi.)



AT&T extended a Wi-Fi roaming agreement with Boingo Wireless as part of a move to manage rapidly growing data traffic on its network.

Boingo CEO David Hagan told *Mobile World Live* (*MWL*) a previous agreement between the pair connected AT&T to its Wi-Fi service in a handful of locations, but noted the operator will now have access to the "vast majority" of its Passpoint-certified network. Specifically, the new deal covers more than 80 sites including military bases, airports, stadiums and shopping centres.

(https://www.mobileworldlive.com/att/att-boosts-wi-fi-offload-with-boingo/.)

Other evidence:

- https://www.business.att.com/content/dam/attbusiness/briefs/att-business-wi-fi-product-brief.pdf ("If you prefer a capex model, you can purchase the equipment, and AT&T will manage it at a reduced monthly fee per access point.");
- https://www.youtube.com/watch?v=yfqlGQEK_-8&t=8s;
- https://www.youtube.com/watch?v=69WNpYDIdGg ("AT&T Business Wi-Fi, helping to meet your business needs while providing the best Wi-Fi coverage and connection speeds available.");
- https://iotdevices.att.com/Uploaded_Docs/get_certified_checklist_20190111070751200.pdf (for certification testing);
- https://www.youtube.com/playlist?list=PLxP2-8eHxebXqKMteRdxs1vEdTxt1-iEP;
- https://www.youtube.com/watch?v=CODnk8k54Rw&list=PLxP2-8eHxebXqKMteRdxs1vEdTxt1-iEP&index=16 ("Sign in and Smart Home Manager will automatically run a number of diagnostics on your home network. Once the quick diagnostic is complete, you will be shown your homepage with special For You cards that provide recommendations to improve the health of your home network if needed. ");
- https://www.youtube.com/watch?v=FmpS2xalLdU&list=PLxP2-8eHxebXqKMteRdxs1vEdTxt1-iEP&index=3;

	- https://www.youtube.com/watch?v=h5i8SEH-f84&list=PLxP2-8eHxebXqKMteRdxs1vEdTxt1-iEP&index=23; - https://www.youtube.com/watch?v=hycUxRIbKOw (BGW320 WiFi gateway); - https://www.youtube.com/watch?v=Am3HmjBtYOs (how to configure private wifi); - https://www.youtube.com/watch?v=m0n59YwPVIM&list=PLxP2-8eHxebUNOD5oZUNe895wM_csi0Ph (Learn How to use on Guest Wifi Your Inseego MiFi 8000); - https://www.youtube.com/watch?v=nIDsQJ1Le0o; - https://www.youtube.com/watch?v=1XENrj7Actg ("Learn how to set up AirTies 4971 Wi-Fi Extender"); - https://www.youtube.com/watch?v=Am3HmjBtYOs ("AT&T Business Wi-Fi: How to configure your private Wi-Fi") - https://www.youtube.com/watch?v=DFjowxyv1Ac ("AT&T Business Wi-Fi: How to configure your Public Wi-Fi"); - https://www.business.att.com/learn/articles/benefits-of-the-new-standards-for-network-reliability.html ("Our network consulting experts will assess your internal evaluation and help you determine where to prioritize your network needs."); - https://www.business.att.com/learn/articles/do-i-need-a-network-upgrade.html; - https://www.business.att.com/content/dam/businesscenter/pdf/legal/att-business-passport.pdf; - https://www.business.att.com/industries/partner-solutions/att-alliance-channel.html; - https://www.business.att.com/products/business-wifi.html; - https://www.business.att.com/portfolios/business-internet.html; - https://www.business.att.com/content/dam/attbusiness/briefs/att-business-wifi-with-cisco-meraki-product-brief.pdf; - https://www.business.att.com/products/business-wifi.html#equipment-options; - https://www.business.att.com/content/dam/attbusiness/briefs/att-managed-wireless-wan.pdf; - https://www.business.att.com/portfolios/networking.html; - https://www.business.att.com/legal/att-business-wifi-with-cisco-meraki-terms-of-service.html; - https://www.business.att.com/collateral/business-wifi-with-aruba-central.html;

	- https://www.business.att.com/content/dam/attbusiness/briefs/att-business-wifi-with-aruba-central-product-brief.pdf; - https://www.business.att.com/content/dam/attbusiness/briefs/att-sd-wan-with-vmware-product-brief.pdf "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 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." 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. An RTS/CTS exchange by VHT STAs also performs fast collision inference on the secondary 20

	MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel and helps the VHT STA transmitting the RTS to determine the available bandwidth at the responder. Another advantage of the RTS/CTS mechanism occurs where multiple BSSs utilizing the same channel overlap. The medium reservation mechanism works across the BSS boundaries. The RTS/CTS mechanism might also improve operation in a typical situation in which all STAs are able to receive from the AP, but might not be able to receive from all other STAs in the BSA. Except for MPDUs transmitted via the GCR service, the RTS/CTS mechanism cannot be used for MPDUs with a group addressed immediate destination because there are multiple recipients for the RTS frame, and thus potentially multiple concurrent senders of the CTS frame in response. For MPDUs transmitted via the GCR service, an RTS frame may be used if it is directed to a STA within the GCR group (see 10.22.2.11.2 and 10.24.10). The RTS/CTS mechanism is not used for every Data frame transmission. Because the additional RTS and CTS frames add overhead inefficiency, the mechanism is not always justified, especially for short Data frames. The use of the RTS/CTS mechanism is under control of dot11RTSThreshold. This attribute may be set on a per-STA basis. This mechanism allows STAs to be configured to initiate RTS/CTS either always, never, or only on frames longer than a specified length. NOTE—A STA configured not to initiate the RTS/CTS mechanism updates its virtual CS mechanism with the duration information contained in a received RTS or CTS frame, and responds to an RTS frame addressed to it with a CTS frame if permitted by medium access rules. All non-DMG STAs that are members of a BSS are able to receive and transmit at all of the data rates in the BSSBasicRateSet parameter of the MLME-START.request primitive or BSSBasicRateSet parameter of the SelectedBSS parameter of the MLME-JOIN.request primitive; see 6.3.4.2.4 and 6.3.11.2.4. NOTE—A STA's operational rate set does not necessarily contain all the mandatory rates. However a STA has to be capable of receiving using a mandatory rate (as required by the rules in 10.7) even if it is not present in this set.

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

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

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

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

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

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

Pages 1303-1305 of 802.11-2016

"**10.3.2.7 CTS and DMG CTS procedure**

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

A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a bandwidth signaling TA and that has the RXVECTOR parameter DYN_BANDWIDTH_IN_NON_HT equal to Static behaves as follows:

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

A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a bandwidth signaling TA and that has the RXVECTOR parameter DYN_BANDWIDTH_IN_NON_HT equal to Dynamic behaves as follows:

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

A non-VHT STA that is addressed by an RTS frame or a VHT STA that is addressed by an RTS frame carried in a non-HT or non-HT duplicate PPDU that has a nonbandwidth signaling TA or a

	VHT STA that is addressed by an RTS frame in a format other than non-HT or non-HT duplicate behaves as follows: — If the NAV indicates idle, the STA shall respond with a CTS frame after a SIFS. — Otherwise, the STA shall not respond with a CTS frame. The RA field of the CTS frame shall be set to the nonbandwidth signaling TA obtained from the TA field of the RTS frame to which this CTS frame is a response. The Duration field in the CTS frame shall be the duration field from the received RTS frame, adjusted by subtraction of aSIFSTime and the number of microseconds required to transmit the CTS frame at a data rate determined by the rules in 10.7. After transmitting an RTS frame, the STA shall wait for a CTSTimeout interval with a value of aSIFSTime + aSlotTime + aRxPHYStartDelay. This interval begins when the MAC receives a PHY-TXEND.confirm primitive. If a PHY-RXSTART.indication primitive does not occur during the CTSTimeout interval, the STA shall conclude that the transmission of the RTS frame has failed, and this STA shall invoke its backoff procedure upon expiration of the CTSTimeout interval. If a PHY-RXSTART.indication primitive does occur during the CTSTimeout interval, the STA shall wait for the corresponding PHY-RXEND.indication primitive to determine whether the RTS frame transmission was successful. The recognition of a valid CTS frame sent by the recipient of the RTS frame, corresponding to this PHY-RXEND.indication primitive, shall be interpreted as successful response, permitting the frame exchange sequence to continue (see Annex G). The recognition of anything else, including any other valid frame, shall be interpreted as failure of the RTS frame transmission. In this instance, the STA shall invoke its backoff procedure at the PHY-RXEND.indication primitive and may process the received frame. A DMG STA follows the procedure defined in this subclause, except that it uses a DMG CTS frame instead of a CTS frame. A non-DMG STA does not transmit DMG CTS frames.” Pages 1313-1314 of 802.11-2016
receiving at a first node in the radio communications network an instruction transmitted from a	The Accused Instrumentalities and Services 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.

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, AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method that includes receiving at a first node (e.g. first STA) in the radio communications network an instruction [e.g. "Clear to Send" (CTS) instruction 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. **secondary 80 MHz channel**: In a 160 MHz or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 80 MHz channel not including the primary 20 MHz channel, that together with the primary 80 MHz channel forms the 160 MHz or 80+80 MHz channel of the 160 MHz or 80+80 MHz VHT BSS. **secondary access category (AC)**: An access category (AC) that is not associated with the enhanced distributed channel access function (EDCAF) that gains channel access. NOTE—Traffic associated with a secondary AC can be included in a multi-user (MU) physical layer (PHY) protocol data unit (MU PPDU) that includes traffic associated with the primary AC. There could be multiple secondary ACs at a given time." 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.
- 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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“**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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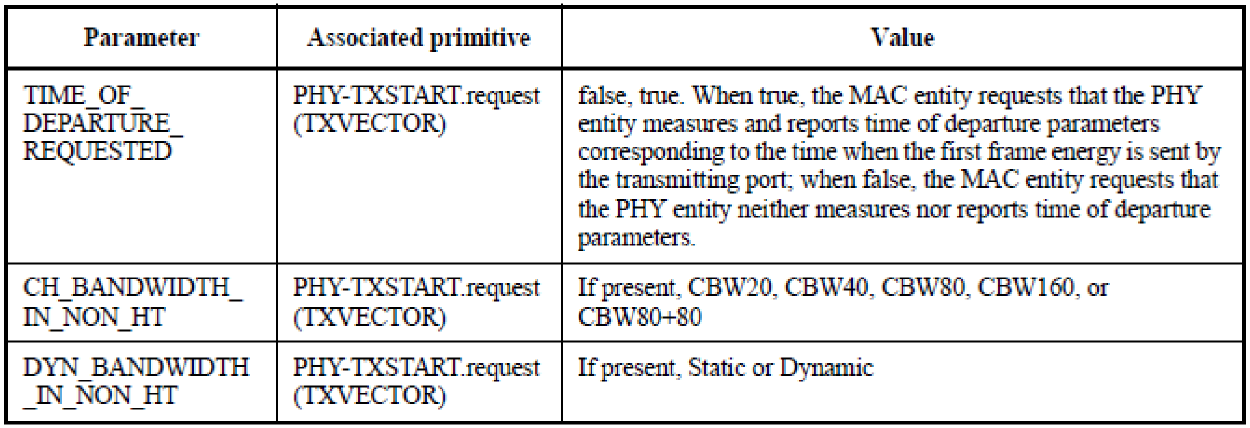
"17.2.2.1 General

. . .

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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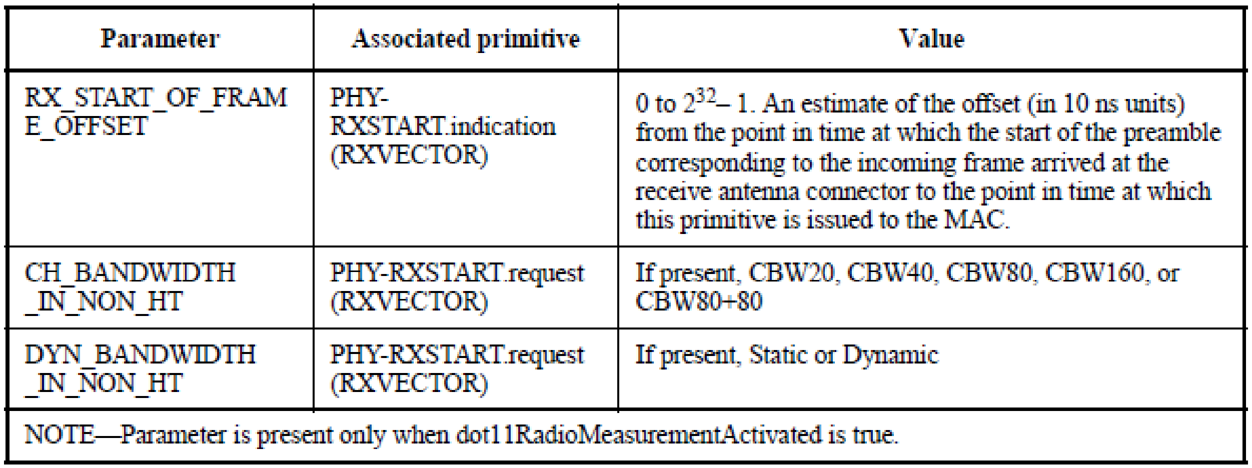
"**17.2.3.1 General**

. . .

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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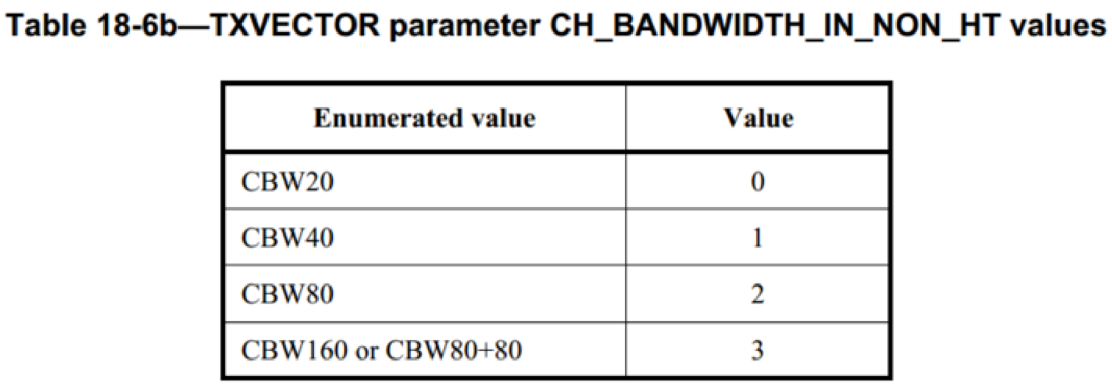


Table 18-6b—TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

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

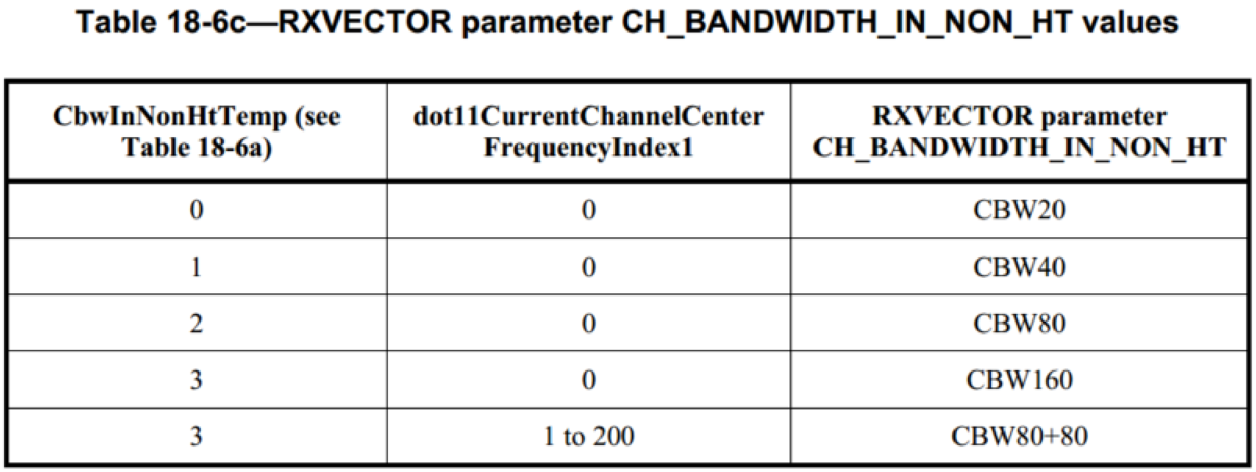
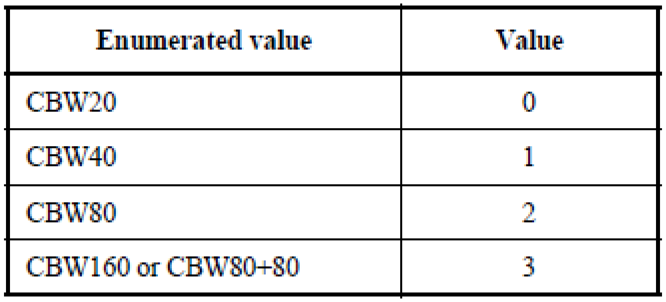


Table 18-6c—RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

CbwInNonHtTemp (see Table 18-6a)	dot11CurrentChannelCenterFrequencyIndex1	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

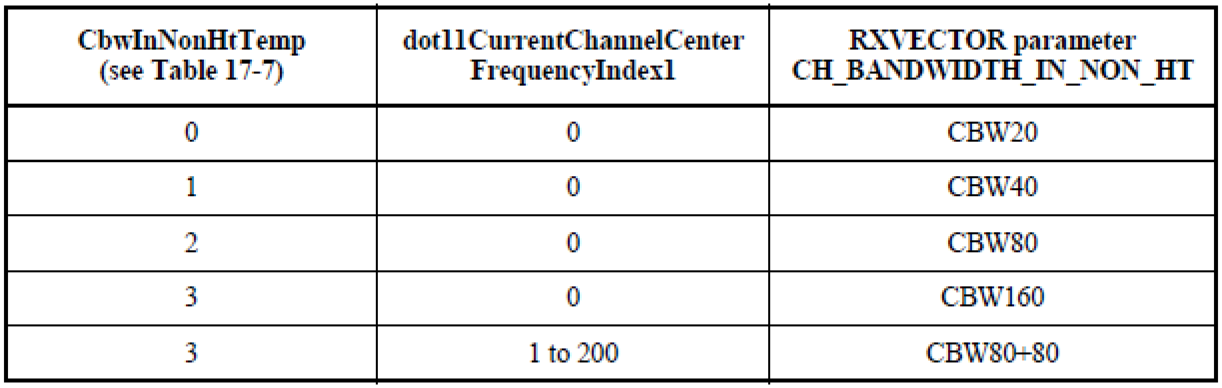
Table 17-8—TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values



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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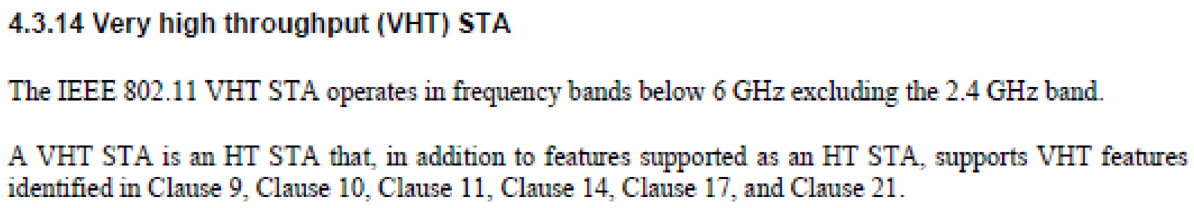
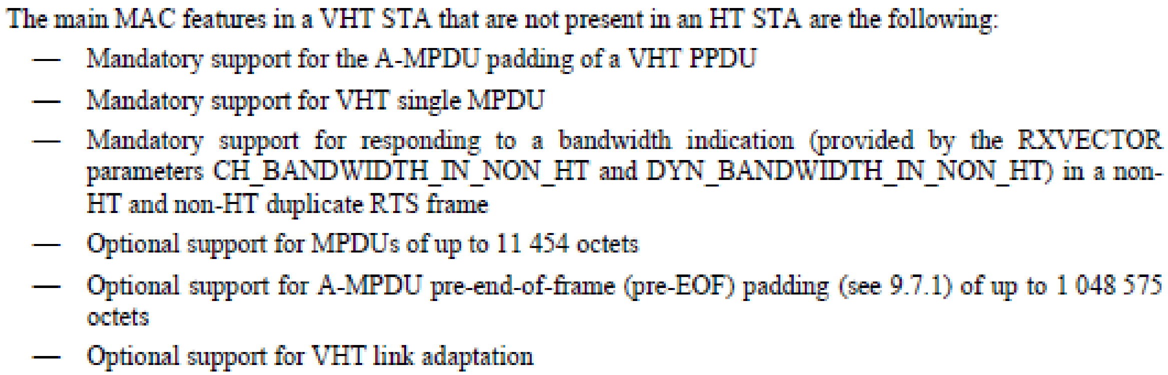


4.3.14 Very high throughput (VHT) STA

The IEEE 802.11 VHT STA operates in frequency bands below 6 GHz excluding the 2.4 GHz band.

A VHT STA is an HT STA that, in addition to features supported as an HT STA, supports VHT features identified in Clause 9, Clause 10, Clause 11, Clause 14, Clause 17, and Clause 21.

. . .



The main MAC features in a VHT STA that are not present in an HT STA are the following:

- Mandatory support for the A-MPDU padding of a VHT PPDU
- Mandatory support for VHT single MPDU
- Mandatory support for responding to a bandwidth indication (provided by the RXVECTOR parameters CH_BANDWIDTH_IN_NON_HT and DYN_BANDWIDTH_IN_NON_HT) in a non-HT and non-HT duplicate RTS frame
- Optional support for MPDUs of up to 11 454 octets
- Optional support for A-MPDU pre-end-of-frame (pre-EOF) padding (see 9.7.1) of up to 1 048 575 octets
- Optional support for VHT link adaptation

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9.3.1.2 RTS frame format

The frame format for the RTS frame is as defined in Figure 9-20.

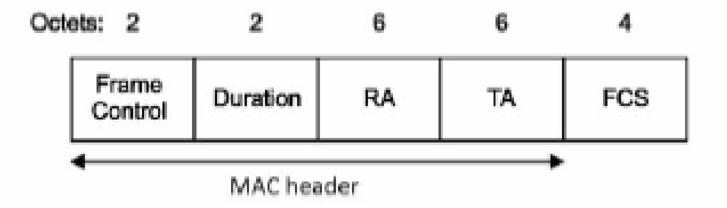
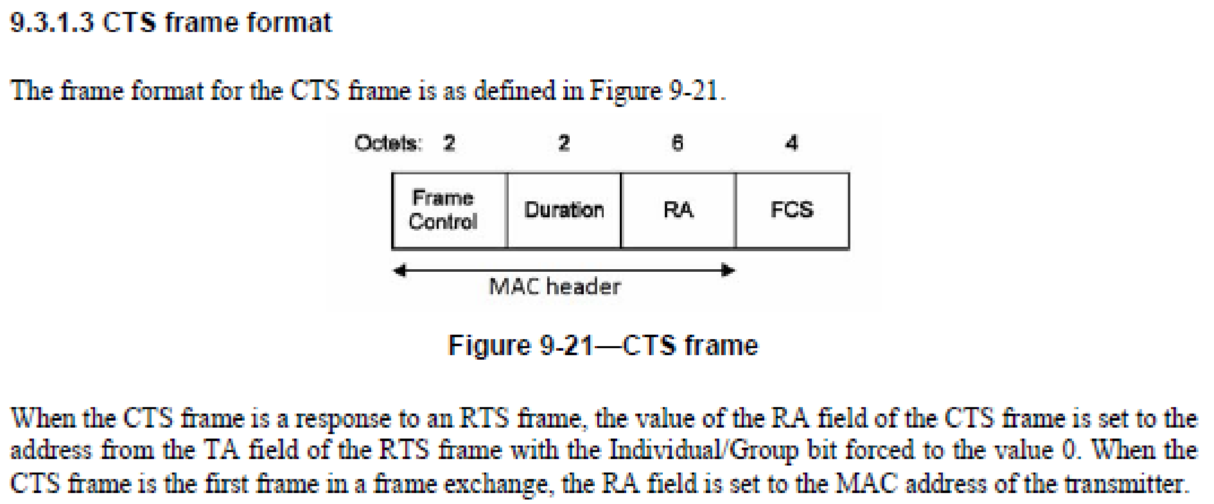


Figure 9-20—RTS frame

The RA field value of the RTS frame is the address of the STA, on the WM, that is the intended immediate recipient of the pending individually addressed Data, Management, or Control frame.

The TA field value is the address of the STA transmitting the RTS frame or the bandwidth signaling TA of the STA transmitting the RTS frame. In an RTS frame transmitted by a VHT STA in a non-HT or non-HT duplicate format and where the scrambling sequence carries the TXVECTOR parameters CH_BANDWIDTH_IN_NON_HT and DYN_BANDWIDTH_IN_NON_HT (see 10.3.2.6), the TA field is a bandwidth signaling TA.



9.3.1.3 CTS frame format

The frame format for the CTS frame is as defined in Figure 9-21.

Octets:	2	2	6	4
	Frame Control	Duration	RA	FCS

MAC header

Figure 9-21—CTS frame

When the CTS frame is a response to an RTS frame, the value of the RA field of the CTS frame is set to the address from the TA field of the RTS frame with the Individual/Group bit forced to the value 0. When the CTS frame is the first frame in a frame exchange, the RA field is set to the MAC address of the transmitter.

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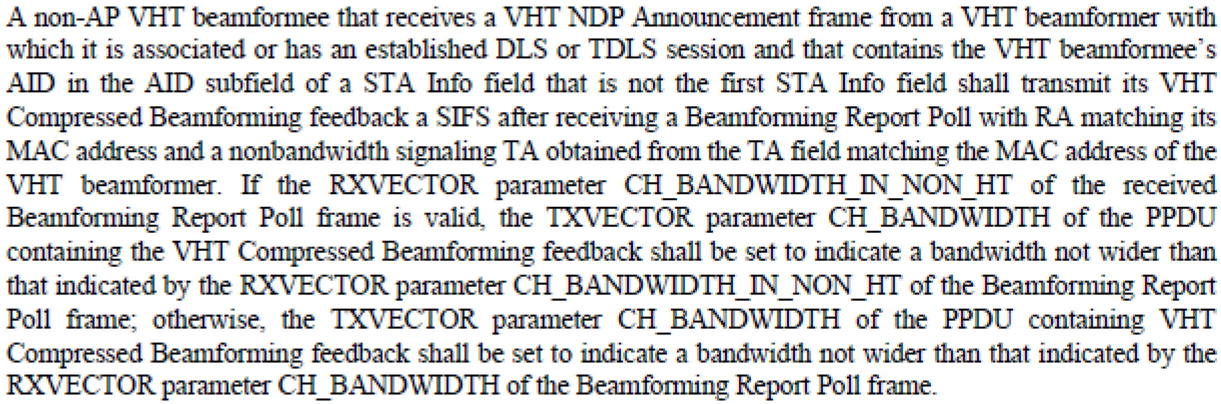
10.34.5.2 Rules for VHT sounding protocol sequences



A non-AP VHT beamformee that receives a VHT NDP Announcement frame from a VHT beamformer with which it is associated or has an established DLS or TDLS session and that contains the VHT beamformee's AID in the AID subfield of a STA Info field that is not the first STA Info field shall transmit its VHT Compressed Beamforming feedback a SIFS after receiving a Beamforming Report Poll with RA matching its MAC address and a nonbandwidth signaling TA obtained from the TA field matching the MAC address of the VHT beamformer. If the RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT of the received Beamforming Report Poll frame is valid, the TXVECTOR parameter CH_BANDWIDTH of the PPDU containing the VHT Compressed Beamforming feedback shall be set to indicate a bandwidth not wider than that indicated by the RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT of the Beamforming Report Poll frame; otherwise, the TXVECTOR parameter CH_BANDWIDTH of the PPDU containing VHT Compressed Beamforming feedback shall be set to indicate a bandwidth not wider than that indicated by the RXVECTOR parameter CH_BANDWIDTH of the Beamforming Report Poll frame.

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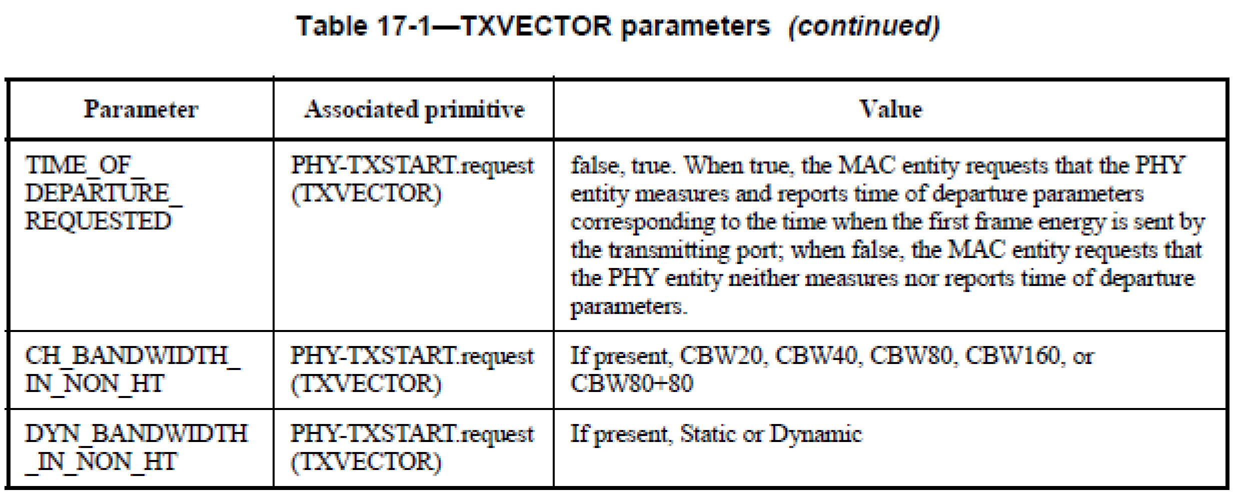
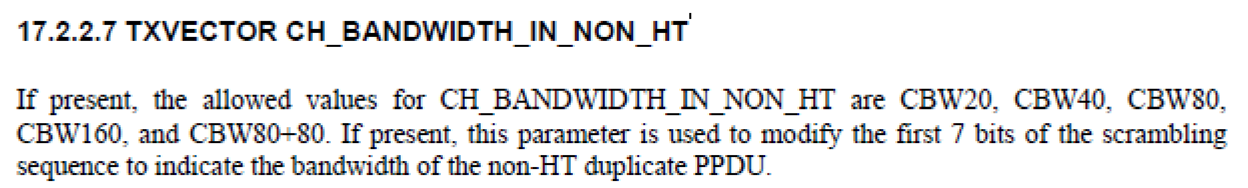


Table 17-1—TXVECTOR parameters *(continued)*

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



17.2.2.7 TXVECTOR 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, this parameter is used to modify the first 7 bits of the scrambling sequence to indicate the bandwidth of the non-HT duplicate PPDU.

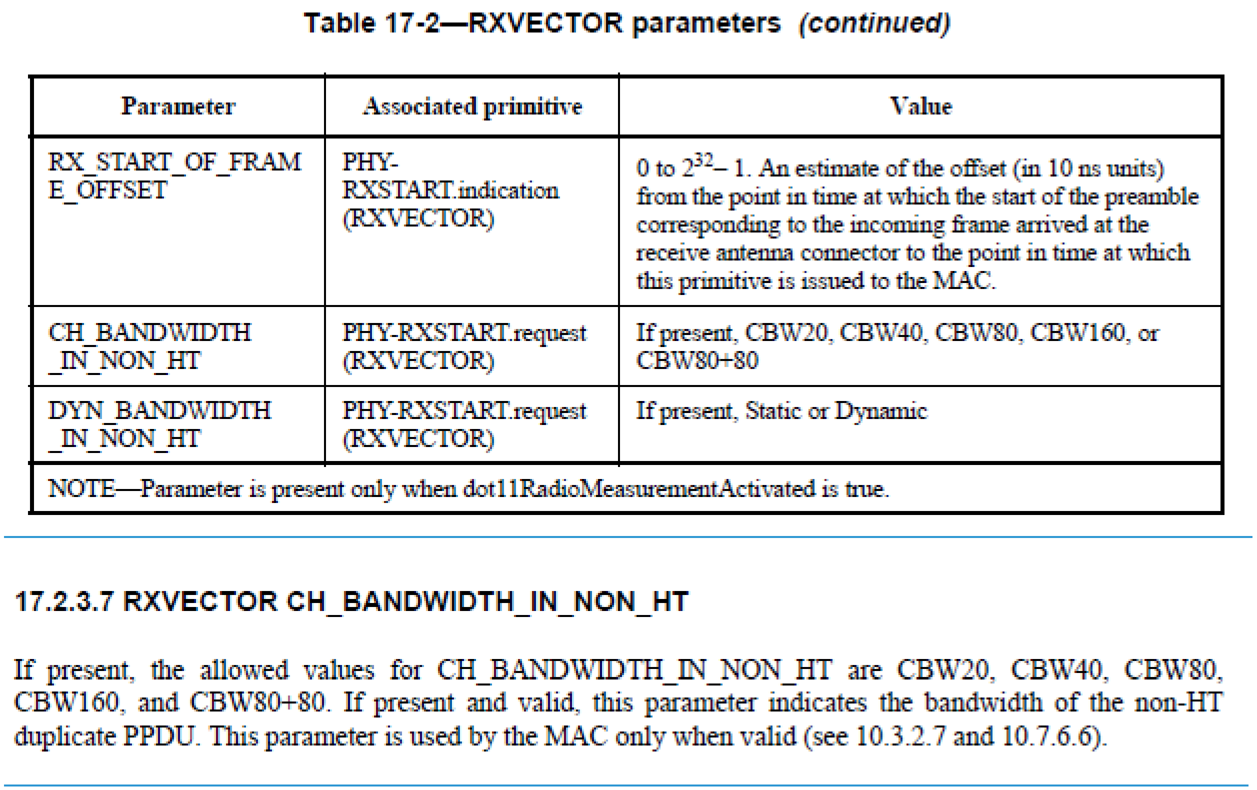


Table 17-2—RXVECTOR parameters *(continued)*

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).

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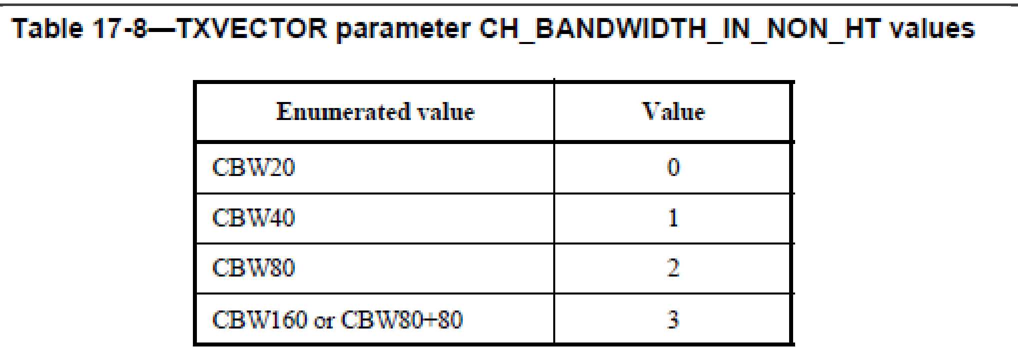

Table 17-8—TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

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

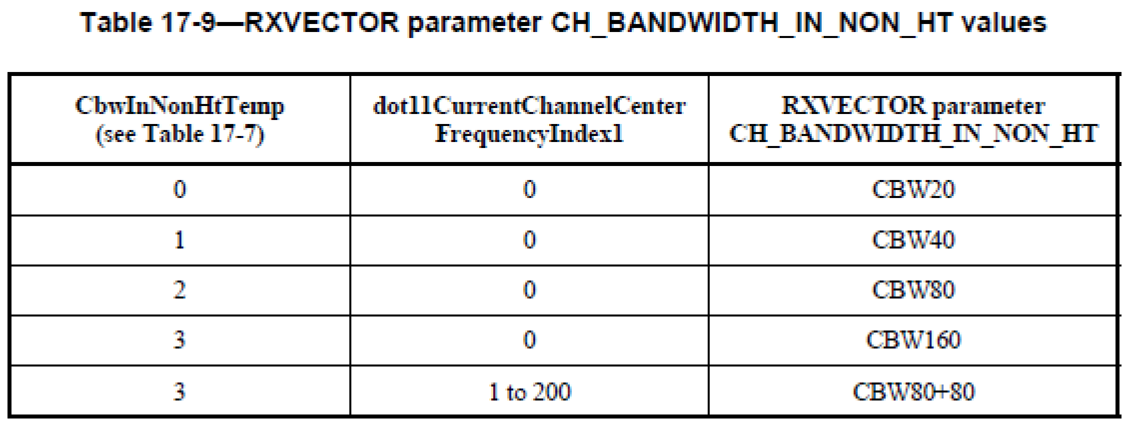

Table 17-9—RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

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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	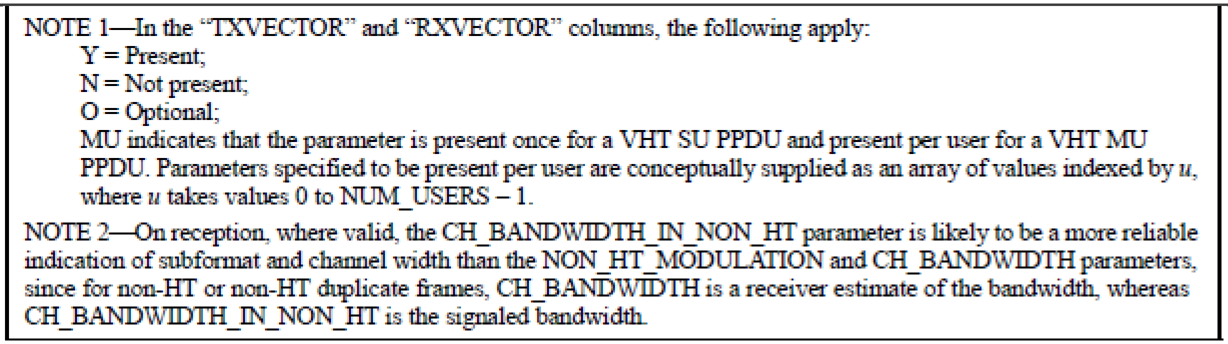 NOTE 1—In the “TXVECTOR” and “RXVECTOR” columns, the following apply: Y = Present; N = Not present; O = Optional; MU indicates that the parameter is present once for a VHT SU PPDU and present per user for a VHT MU PPDU. Parameters specified to be present per user are conceptually supplied as an array of values indexed by *u*, where *u* takes values 0 to NUM_USERS – 1. NOTE 2—On reception, where valid, the CH_BANDWIDTH_IN_NON_HT parameter is likely to be a more reliable indication of subformat and channel width than the NON_HT_MODULATION and CH_BANDWIDTH parameters, since for non-HT or non-HT duplicate frames, CH_BANDWIDTH is a receiver estimate of the bandwidth, whereas CH_BANDWIDTH_IN_NON_HT is the signaled bandwidth. Page 2633 of 802.11-2016
filtering a transmission signal to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided; and	The Accused Instrumentalities and Services 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 AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T’s provisioning of Wi-Fi and/or Hotspots, AT&T’s provisioning of business and residential Internet, etc.) and/or AT&T’s agents or customers, require performance of a method that includes filtering a transmission signal (e.g. via a mask PPDU and resulting scrambling, and/or another filtering that results in power (that was used or could be used) being removed, etc.) to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided (e.g. based on the CTS instruction 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.

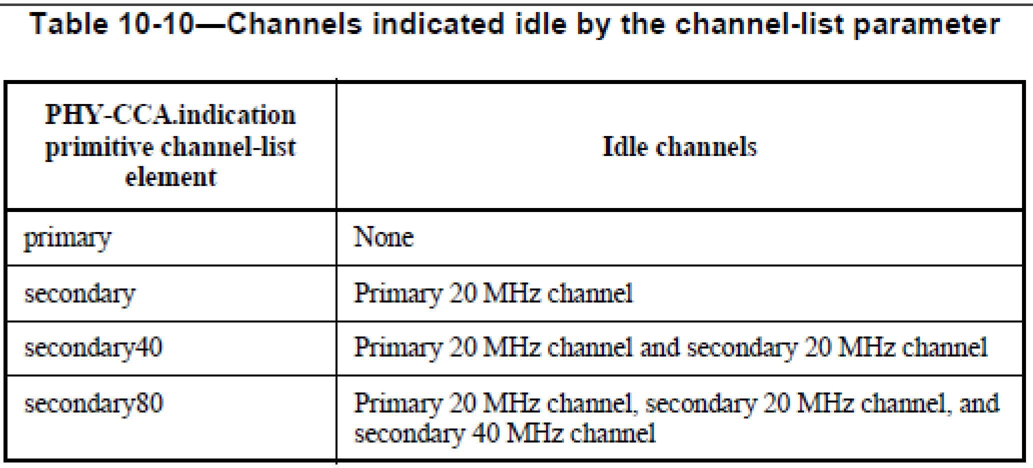

Table 10-10—Channels indicated idle by the channel-list parameter

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.

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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:

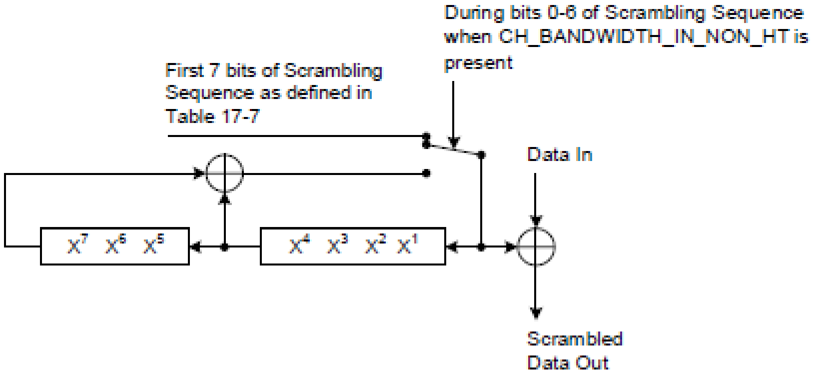

Figure 17-7—Data scrambler

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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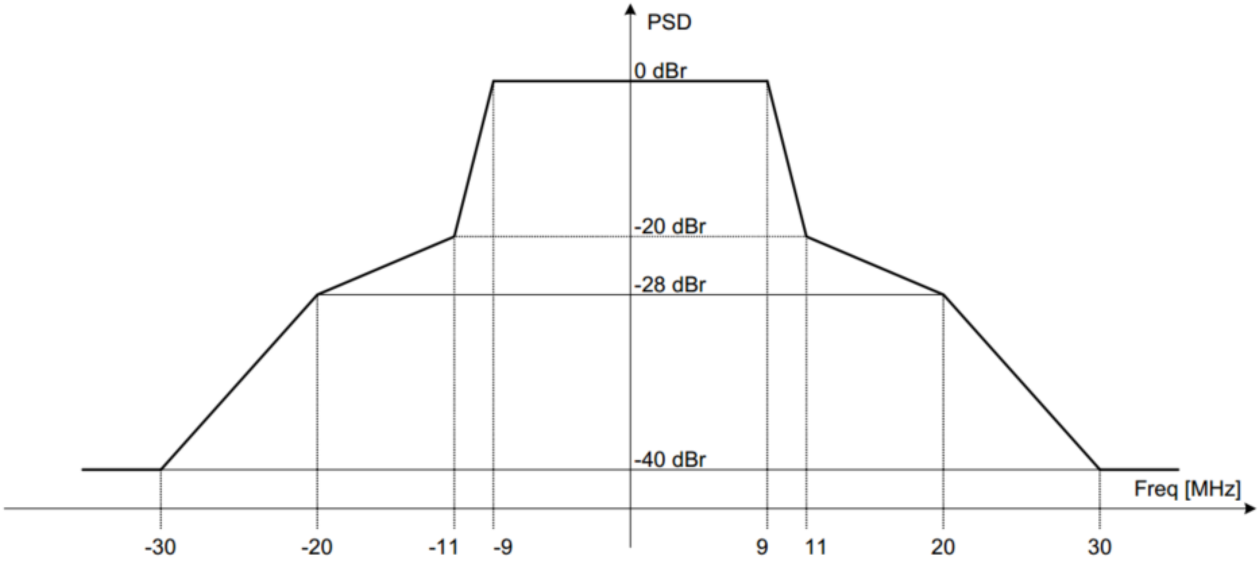
"**21.3.17 VHT transmit specification**

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 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
transmitting the filtered transmission signal to the second node;	The Accused Instrumentalities and Services perform the step of transmitting the filtered transmission signal to the second node.

For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, 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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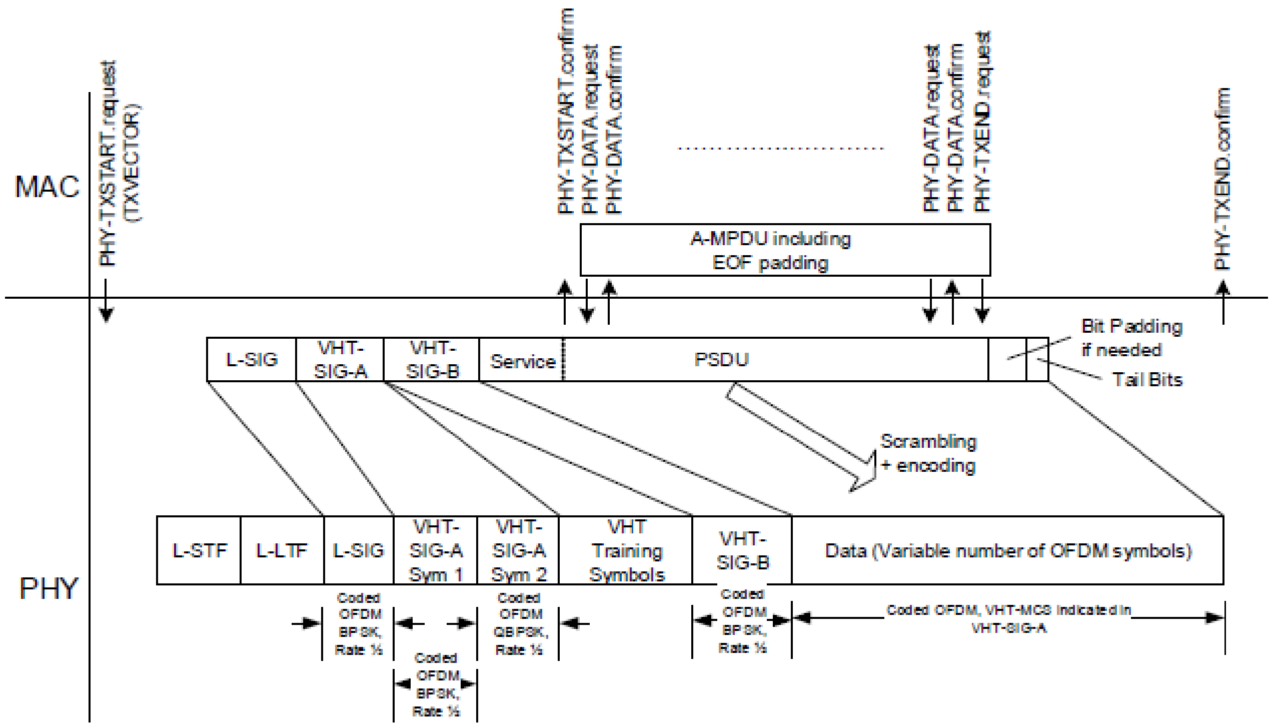

NOTE—This procedure does not describe the operation of optional features, such as MU-MIMO, LDPC or STBC.

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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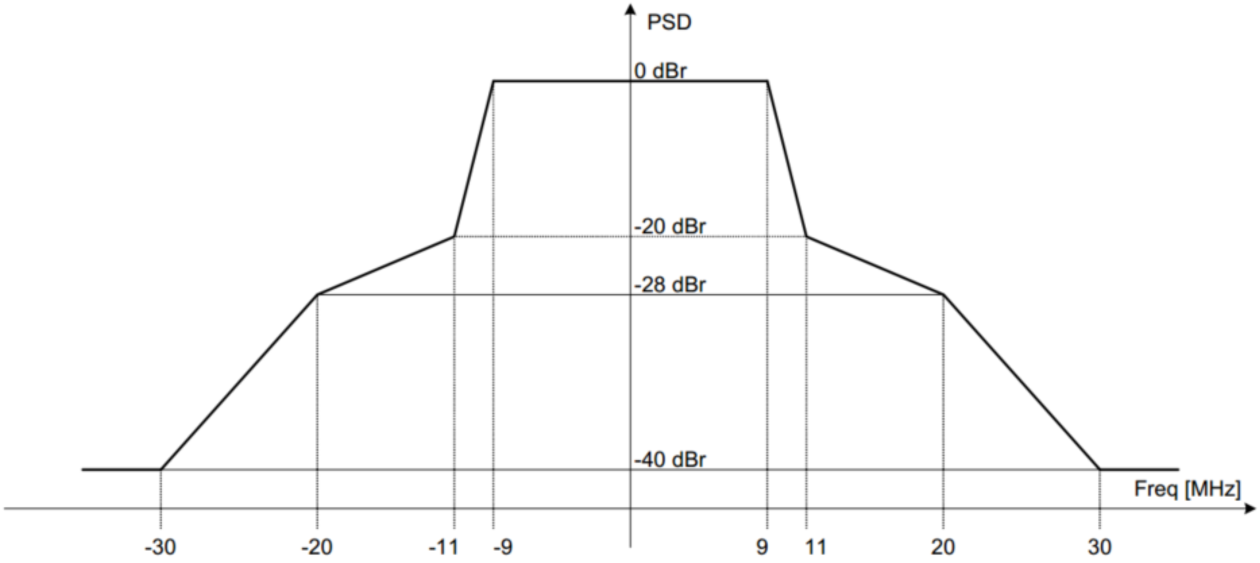
“21.3.17 VHT transmit specification

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."

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~~AT&T also makes, uses, offers to sell and sells, and induces others to use, Wi-Fi extenders with Wi-Fi gateways as a mesh network.[11] third party~~

~~[11] *See, e.g.,* https://www.att.com/wi-fi/extender/.~~

separately from the receipt of the instruction, receiving a compressed first feedback from the second node that is based on a received power and one or more frequencies of a first signal transmitted from the first node to the second node; separately from the receipt of the instruction, receiving a compressed second feedback from a third node that is based on a received power and one or more frequencies of a second signal transmitted from the first node to the third node;	The Accused Instrumentalities and Services perform the step of, separately from the receipt of the instruction, receiving a compressed first feedback from the second node that is based on a received power and one or more frequencies of a first signal transmitted from the first node to the second node. The Accused Instrumentalities and Services perform the step of, separately from the receipt of the instruction, receiving a compressed second feedback from a third node that is based on a received power and one or more frequencies of a second signal transmitted from the first node to the third node. For example, as evidenced below, AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method that includes receiving a compressed first feedback (e.g. a first feedback matrix) from the second node that characterizes receipt of a first signal (e.g. a first VHT NDP sounding PPDU) sent from the first node to the second node; and receiving a compressed second feedback (e.g. a second feedback matrix) from a third node that characterizes receipt of a second signal (e.g. a second VHT NDP sounding PPDU) sent from the first node to the third 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 Feedback Matrix *V*** "Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in Table 21-11 from the measured channel before computing a set of matrices for feedback to the beamformer. The beamforming feedback matrix, $V_{k,u}$, found by the beamformee u for subcarrier k shall be compressed in the form of angles using the method described in 19.3.12.3.6. The angles, $\varphi(k,v)$ and $\psi(k,u)$, are quantized according to Table 9-68. The number of bits for quantization is chosen by the beamformee, based on the indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DLMU- MIMO

beamforming. The compressed beamforming feedback using 19.3.12.3.6 is the only Clause 21 beamforming feedback format defined.

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

After receiving the angle information, $\varphi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1]$ 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.”

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“**10.34.5 VHT sounding protocol**

10.34.5.1 General

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

If dot11VHTSUBeamformerOptionImplemented is true, a STA shall set the SU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTSUBeamformeeOptionImplemented is true, a STA shall set the SU Beamformee Capable field in the VHT Capabilities element to 1.

If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set the MU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set the MU Beamformee Capable field in the VHT Capabilities element to 1.

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

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

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

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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, *Nc* is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field, *Nr* is the number of rows in a compressed beamforming feedback matrix determined by the Nr 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." https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html
decompressing the compressed first feedback resulting in a decompressed first feedback; decompressing the compressed second feedback resulting in a decompressed second feedback;	The Accused Instrumentalities and Services 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 AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents

	or customers, require performance of a method that includes: decompressing the compressed first feedback (e.g. the first feedback matrix) resulting in a decompressed first feedback; and decompressing the compressed second feedback (e.g. the second feedback matrix) resulting in a decompressed second feedback. "**19.3.12.3.6 Compressed beamforming feedback matrix** In compressed beamforming feedback matrix, the beamformee shall remove the space-time stream CSD in Table 19-10 from the measured channel before computing a set of matrices for feedback to the beamformer. The beamforming feedback matrices, *V(k)*, found by the beamformee are compressed in the form of angles, which are sent to the beamformer. The beamformer might use these angles to decompress the matrices and determine the steering matrices Q_k. The matrix per tone shall be compressed as follows: The N_r x 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
generating one or more data structures based on the decompressed first feedback and the decompressed second feedback;	The Accused Instrumentalities and Services perform the step of generating one or more data structures based on the decompressed first feedback and the decompressed second feedback. For example, as evidenced below, AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method that includes generating one or more data structures based on the decompressed first feedback and the decompressed second feedback. **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 Feedback Matrix *V*

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

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

After receiving the angle information, $\varphi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix Q_{k}. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,N_{user}}-1]$ using $V_{k,u}$ and $SNR_{k,u}$ $(0 \le u \le N_{user}-1)$ 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."

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"**10.34.5 VHT sounding protocol**

10.34.5.1 General

Transmit beamforming and DL-MU-MIMO require knowledge of the channel state to compute a steering matrix that is applied to the transmitted signal to optimize reception at one or more

	receivers. The STA transmitting using the steering matrix is called the VHT beamformer, and a STA for which reception is optimized is called a VHT beamformee. An explicit feedback mechanism is used where the VHT beamformee directly measures the channel from the training symbols transmitted by the VHT beamformer and sends back a transformed estimate of the channel state to the VHT beamformer. The VHT beamformer then uses this estimate, perhaps combining estimates from multiple VHT beamformees, to derive the steering matrix. If dot11VHTSUBeamformerOptionImplemented is true, a STA shall set the SU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTSUBeamformeeOptionImplemented is true, a STA shall set the SU Beamformee Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set the MU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set the MU Beamformee Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set dot11VHTSUBeamformerOptionImplemented to true. If dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set dot11VHTSUBeamformeeOptionImplemented to true. A STA is a VHT SU-only beamformer if it sets the SU Beamformer Capable field to 1 but sets the MU Beamformer Capable field to 0 in transmitted VHT Capabilities elements. A STA is an SU-only beamformee if it sets the SU Beamformee Capable field to 1 but sets the MU Beamformee Capable field to 0 in transmitted VHT Capabilities elements. If dot11VHTSUBeamformerOptionImplemented is false, a STA shall not act in the role of a VHT beamformer. If dot11VHTSUBeamformeeOptionImplemented is false, a STA shall not act in the role of a VHT beamformee. “ Page 1488 of 802.11-2016

	“9.4.1.49 VHT Compressed Beamforming Report field The VHT Compressed Beamforming Report field is used by the VHT Compressed Beamforming feedback (see 9.6.23.2) to carry explicit feedback information in the form of angles representing compressed beamforming feedback matrices *V* for use by a transmit beamformer to determine steering matrices *Q*, as described in 10.32.3 and 19.3.12.3. The size of the VHT Compressed Beamforming Report field depends on the values in the VHT MIMO Control field. The VHT Compressed Beamforming Report field contains VHT Compressed Beamforming Report information or successive (possibly zero-length) portions thereof in the case of segmented VHT Compressed Beamforming feedback (see 10.34.5). VHT Compressed Beamforming Report information is always included in the VHT Compressed Beamforming feedback. The VHT Compressed Beamforming Report information contains the channel matrix elements indexed, first, by matrix angles in the order shown in Table 9-67 and, second, by data subcarrier index from lowest frequency to highest frequency. The explanation on how these angles are generated from the beamforming feedback matrix *V* is given in 19.3.12.3.6. In Table 9-67, *Nc* is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field, *Nr* is the number of rows in a compressed beamforming feedback matrix determined by the Nr Index field of the VHT MIMO Control field.” Pages 764-765 of 802.11-2016
wherein the filtered transmission signal is a filtered first transmission signal that is transmitted using a first frequency and an 802.11-based orthogonal frequency-division	The Accused Instrumentalities and Services perform the prior steps listed above, wherein the filtered transmission signal is a filtered first transmission signal (e.g. a first one of multiple disjoint subsets of space-time streams, or any other signal, intended for reception at a first one of different STAs, etc.) that is transmitted using a first frequency (e.g. a frequency or band such as a 2.4 GHz band, etc.) and an 802.11-based orthogonal frequency-division multiplexing (OFDM) protocol via

multiplexing (OFDM) protocol via at least one antenna of a plurality of antennas, using a first power that is based on at least one of the one or more data structures; and	at least one antenna of a plurality of antennas, using a first power that is based on at least one of the one or more data structures. For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method, wherein the filtered transmission signal is a filtered first transmission signal (e.g. a first one of multiple disjoint subsets of space-time streams, or any other signal, intended for reception at a first one of different STAs, etc.) 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 at least one of the one or more data structures. **Note**: See evidence cited earlier in this independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "**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

	"**primary 20 MHz channel**: In a 40 MHz, 80 MHz, 160 MHz, or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 20 MHz channel that is used to transmit 20 MHz physical layer (PHY) protocol data units (PPDUs). In a VHT BSS, the primary 20 MHz channel is also the primary channel. **primary 40 MHz channel**: In an 80 MHz, 160 MHz, or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 40 MHz channel that is used to transmit 40 MHz physical layer (PHY) protocol data units (PPDUs). **primary 80 MHz channel**: In a 160 MHz or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 80 MHz channel that is used to transmit 80 MHz physical layer (PHY) protocol data units (PPDUs). **primary access category (AC)**: The access category (AC) associated with the enhanced distributed channel access function (EDCAF) that gains channel access. . . . **secondary 20 MHz channel**: In a 40 MHz very high throughput (VHT) basic service set (BSS), the 20 MHz channel adjacent to the primary 20 MHz channel that together form the 40 MHz channel of the 40 MHz VHT BSS. In an 80 MHz VHT BSS, the 20 MHz channel adjacent to the primary 20 MHz channel that together form the primary 40 MHz channel of the 80 MHz VHT BSS. In a 160 MHz or 80+80 MHz VHT BSS, the 20 MHz channel adjacent to the primary 20 MHz channel that together form the primary 40 MHz channel of the 160 MHz or 80+80 MHz VHT BSS. In a VHT BSS, the secondary 20 MHz channel is also the secondary channel. **secondary 40 MHz channel**: In an 80 MHz very high throughput (VHT) basic service set (BSS), the 40 MHz channel adjacent to the primary 40 MHz channel that together form the 80 MHz channel of the 80 MHz VHT BSS. In a 160 or 80+80 MHz VHT BSS, the 40 MHz channel adjacent to the primary 40 MHz channel that together form the primary 80 MHz channel.

	secondary 80 MHz channel: In a 160 MHz or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 80 MHz channel not including the primary 20 MHz channel, that together with the primary 80 MHz channel forms the 160 MHz or 80+80 MHz channel of the 160 MHz or 80+80 MHz VHT BSS. **secondary access category (AC)**: An access category (AC) that is not associated with the enhanced distributed channel access function (EDCAF) that gains channel access. NOTE—Traffic associated with a secondary AC can be included in a multi-user (MU) physical layer (PHY) protocol data unit (MU PPDU) that includes traffic associated with the primary AC. There could be multiple secondary ACs at a given time.” Pages 161-163 of 802.11-2016 • IEEE 802.11-2016: **21.3.11 SU-MIMO and DL-MU-MIMO Beamforming** and **21.3.11.1 General** specifies the steering matrix Q_k for DL-MU-MIMO, where k is one of the subcarriers, and Q_k is consisted of sub-matrices $Q_{k,u}$, each corresponding to one receiving STA u. • IEEE 802.11-2016: **21.3.11.2 Beamforming Feedback Matrix $\boldsymbol{V}$** 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.

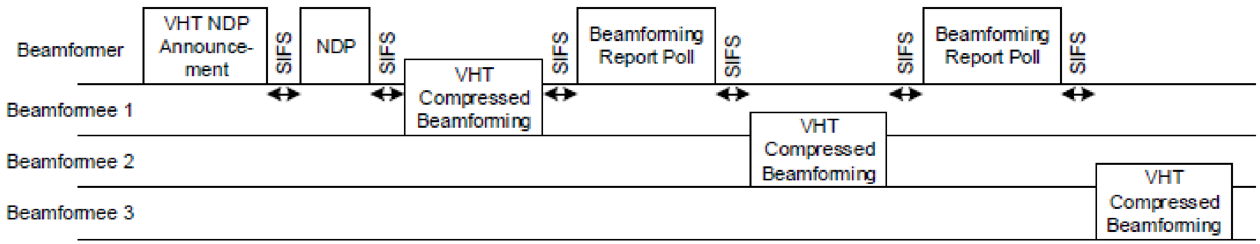

Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

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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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$Y_{k,u} = H_{k,u}$ x $[Q_{k,0}, Q_{k,1} \ldots, Q_{k,Nuser}-1]$ x $x_k + n$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions
N_{RXu} x 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 $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,Nuser}-1]$ 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 $u = 0, 1, \ldots, N_{user} -1$. 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)."

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"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
further comprising transmitting, using a second frequency and 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 at least one of the one or more data structures.	The Accused Instrumentalities and Services perform steps of a method as articulated above, further comprising transmitting, using a second frequency (e.g. another frequency or band such as a 5 GHz band, etc.) and the 802.11-based OFDM protocol, a filtered second transmission signal (e.g. a second one of multiple disjoint subsets of space-time streams, or any other signal, intended for reception at a second one of different STAs, etc.), simultaneously with the filtered first transmission signal, to the third node, using a second power that is based on at least one of the one or more data structures. For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method that includes transmitting, using the 802.11-based OFDM protocol, a filtered second transmission signal, simultaneously with the filtered first transmission signal [e.g. via multiple-user-multiple-input-multiple-output (MU-MIMO) technology], to the third node, using a second power (e.g. per one or more respective steering matrices) that is based on at least one of the one or more data structures. **Note**: See evidence cited earlier in this independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):

	“**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 “**primary 20 MHz channel**: In a 40 MHz, 80 MHz, 160 MHz, or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 20 MHz channel that is used to transmit 20 MHz physical layer (PHY) protocol data units (PPDUs). In a VHT BSS, the primary 20 MHz channel is also the primary channel. **primary 40 MHz channel**: In an 80 MHz, 160 MHz, or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 40 MHz channel that is used to transmit 40 MHz physical layer (PHY) protocol data units (PPDUs). **primary 80 MHz channel**: In a 160 MHz or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 80 MHz channel that is used to transmit 80 MHz physical layer (PHY) protocol data units (PPDUs). **primary access category (AC)**: The access category (AC) associated with the enhanced distributed channel access function (EDCAF) that gains channel access. . . .

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

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

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

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

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

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- IEEE 802.11-2016: **21.3.11 SU-MIMO and DL-MU-MIMO Beamforming** and **21.3.11.1 General** specifies the steering matrix Q_k for DL-MU-MIMO, where k is one of the subcarriers, and Q_k is consisted of sub-matrices $Q_{k,u}$, each corresponding to one receiving STA u.

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

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

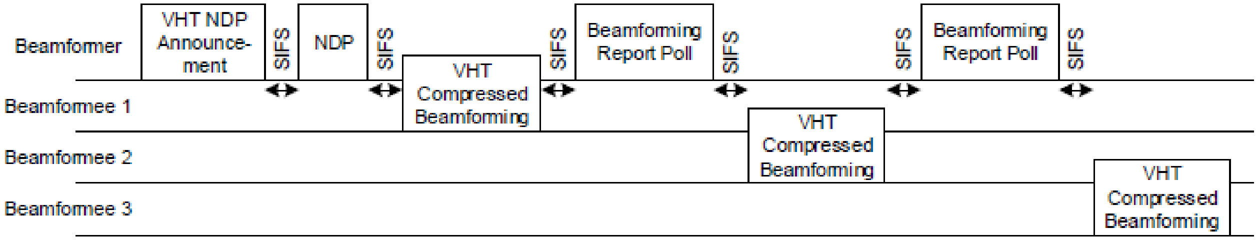

Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

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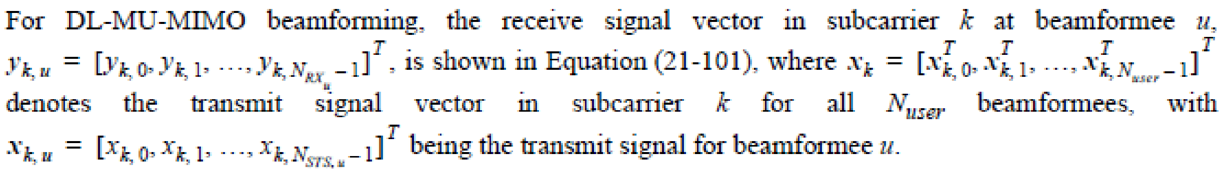
"21.3.11 SU-MIMO and DL-MU-MIMO Beamforming

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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1] \text{ x } x_k + n$$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions N_{RXu} x 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 $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1]$ 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 $u = 0, 1, \ldots, N_{user}$ -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, $Q_{steer,k} = Q_kV_k$, with V_k found from H_kQ_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, $H_{eff,k} = H_kQ_k$, 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
22. The method of claim 19, wherein the instruction includes a first instruction, and further comprising: receiving at the first node in the radio communications network a second instruction transmitted from the third node to avoid using a different plurality of frequencies to transmit to the third node; and	The Accused Instrumentalities and Services perform steps of a method as articulated above, wherein the instruction includes a first instruction, and further comprising receiving at the first node in the radio communications network a second instruction transmitted from the third node to avoid using a different plurality of frequencies to transmit to the third node. For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T’s provisioning of Wi-Fi and/or Hotspots, AT&T’s provisioning of business and residential Internet, etc.) and/or AT&T’s agents or customers, require performance of a method as articulated above, wherein the instruction includes a first instruction, and further comprising receiving at the first node in the radio communications network a second instruction transmitted from the third node to avoid using a different plurality of frequencies to transmit to the third node.

Note: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):

“**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.

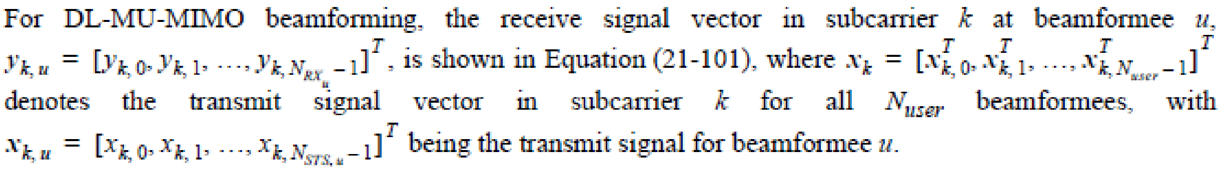
The RA field of the CTS frame shall be set to the nonbandwidth signaling TA obtained from the TA field of the RTS frame to which this CTS frame is a response. The Duration field in the CTS frame shall be the duration field from the received RTS frame, adjusted by subtraction of aSIFSTime and the number 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."

	Pages 1313-1314 of 802.11-2016
filtering a second transmission signal to remove power from the second transmission signal at each frequency in the different plurality of frequencies to be avoided, resulting in the filtered second transmission signal.	The Accused Instrumentalities and Services perform steps of a method as articulated above, further comprising filtering a second transmission signal to remove power from the second transmission signal at each frequency in the different plurality of frequencies to be avoided, resulting in the filtered second transmission signal. For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method as articulated above, further comprising filtering a second transmission signal to remove power from the second transmission signal at each frequency in the different plurality of frequencies to be avoided, resulting in the filtered second transmission signal. **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "**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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1] \text{ x } x_k + n$$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions
$N_{RXu} \text{ x } N_{TX}$

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 $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1]$ 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 $u = 0, 1, \ldots, N_{user} - 1$. The steering matrix that is computed (fleor 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, $Q_{steer,k} = Q_kV_k$, with V_k found from H_kQ_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, $H_{eff,k} = H_kQ_k$, 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
23. The method of claim 19, wherein the first power and the second power are the same.	The Accused Instrumentalities and Services perform steps of a method as articulated above, wherein the first power and the second power are the same. For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T’s provisioning of Wi-Fi and/or Hotspots, AT&T’s provisioning of business and residential Internet, etc.) and/or AT&T’s agents or customers, require performance of a method as articulated above, wherein the first power and the second power are the same. When used by AT&T, and/or AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below:

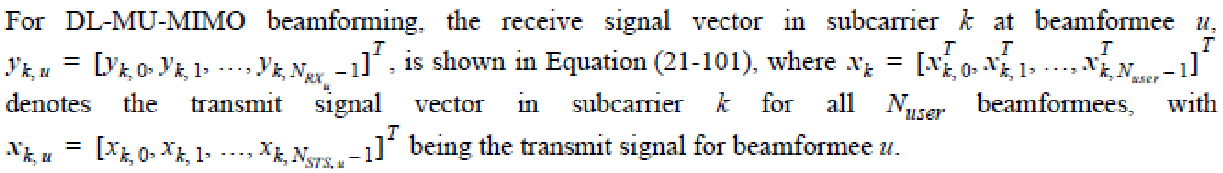
<u>Note</u>: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):

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

21.3.11.1 General

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

For SU-MIMO beamforming, <u>the steering matrix Q_k can be determined from the beamforming feedback matrix V_k that is sent back to the beamformer by the beamformee using the compressed beamforming feedback matrix format as defined in 19.3.12.3.6.</u> 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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0},\ Q_{k,l} \ldots,\ Q_{k,Nuser}\text{-}1] \text{ x } x_k + n$$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions
N_{RXu} x 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 $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,N_{user}}$-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 $u = 0, 1, \ldots, N_{user}$ -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

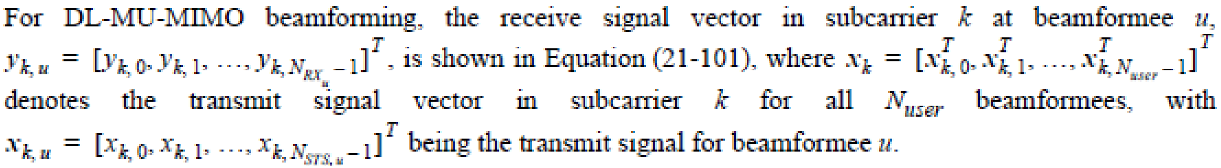
"**19.3.12.3 Explicit feedback beamforming**

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

24. The method of claim 19, wherein the first power and the second power are different.	The Accused Instrumentalities and Services perform steps of a method as articulated above, wherein the first power and the second power are different. For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method as articulated above, wherein the first power and the second power are different. **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "**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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$Y_{k,u} = H_{k,u} \mathrm{\ x\ } [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1] \mathrm{\ x\ } x_k + n$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions
$N_{RXu} \mathrm{\ x\ } N_{TX}$

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 $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1]$ 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 $u = 0, 1, \ldots, N_{user} -1$. 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
25. The method of claim 19, wherein an update of the compressed first feedback is repeatedly received at time periods of less than one second, and the first power is repeatedly updated based on an updated decompressed first feedback at time periods of less than one second; and an update of the compressed second feedback is repeatedly received at time periods of less than one second, and the second power is repeatedly updated based on an updated decompressed second feedback at time periods of less than one second.	When used by AT&T, and/or AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in 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 The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,Nuser}\text{-}1]$ 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 $u = 0, 1, \ldots, N_{user}$ -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 “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.” https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html
26. The method of claim 19, wherein the filtered first transmission signal and the filtered second transmission signal are transmitted via the same transceiver.	When used by AT&T, and/or AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):

AT&T Fiber® with AT&T All-Fi™

Powerful Wi-Fi you can rely on

Our next-generation Wi-Fi® delivers more coverage to more corners of your home than ever before.

Compatible gateway with Wi-Fi 6 subject to availability. Optimal performance requires Wi-Fi 6 enabled devices. Whole-home Wi-Fi connectivity may require AT&T Smart Wi-Fi® Extenders for an additional monthly charge.

AT&T All-Fi

A top-of-the-line Wi-Fi experience

Complete Wi-Fi coverage without dead zones

Up to 5,000 sq. ft. with mesh extender technology.

$10/mo. for up to five extenders. Number of extenders determined at the sole discretion of AT&T.

Speeds up to 5 GIG

Enjoy our fastest speeds, so you can enjoy more of what you love—on more devices.

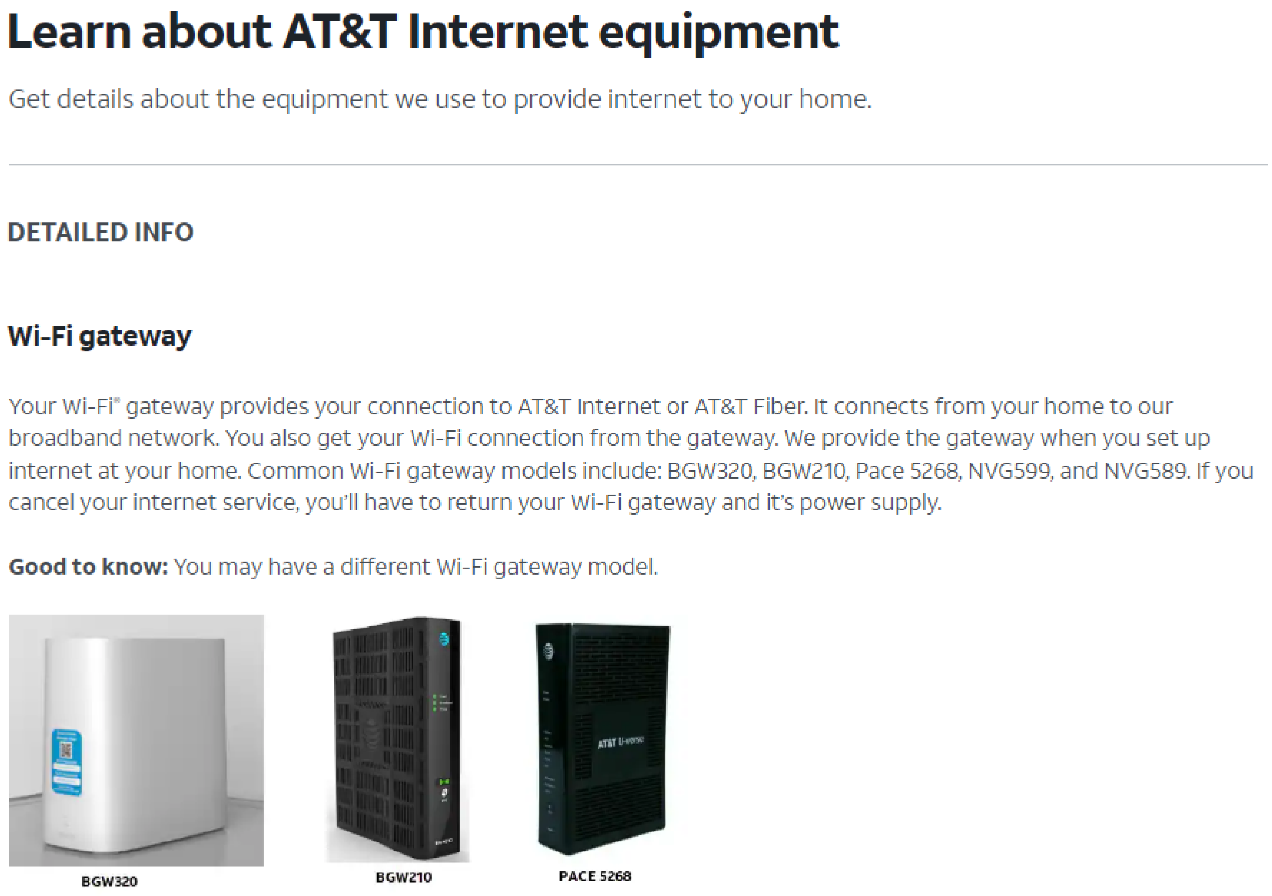
Ltd. avail/areas. Speeds based on wired connection Actual speeds may vary. Single device wired speed maximum 4.7Gbps. For more info, go to www.att.com/speed101.

AT&T ActiveArmor℠

24/7 security that helps block threats before they reach your devices.

Guards against known threats only. AT&T Smart Home Manager app required. Security features must be enabled.

	 **Easy 1-2-3 self-installation** If you qualify for an easy self-install kit, no technician is needed. ① **Unpack the AT&T Wi-Fi gateway** Plug the AT&T Wi-Fi gateway into an outlet. ② **Make the connection** Connect your AT&T Wi-Fi gateway to your computer using the provided cables. ③ **Sign in, register & get online** Follow the easy on-screen steps—and you're good to go. If you are unable to install the AT&T Wi-Fi Gateway, call 800.288.2020 to schedule a technician for a professional installation. https://www.att.com/wi-fi/



Learn about AT&T Internet equipment

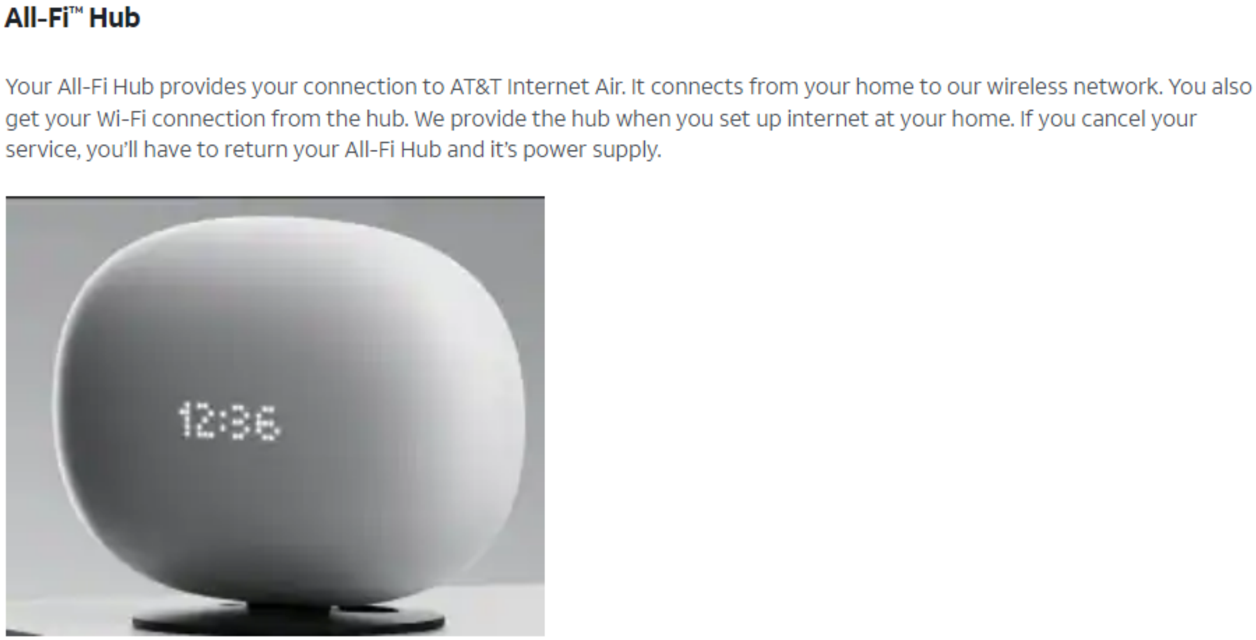
Get details about the equipment we use to provide internet to your home.

DETAILED INFO

Wi-Fi gateway

Your Wi-Fi® gateway provides your connection to AT&T Internet or AT&T Fiber. It connects from your home to our broadband network. You also get your Wi-Fi connection from the gateway. We provide the gateway when you set up internet at your home. Common Wi-Fi gateway models include: BGW320, BGW210, Pace 5268, NVG599, and NVG589. If you cancel your internet service, you'll have to return your Wi-Fi gateway and it's power supply.

Good to know: You may have a different Wi-Fi gateway model.



All-Fi™ Hub

Your All-Fi Hub provides your connection to AT&T Internet Air. It connects from your home to our wireless network. You also get your Wi-Fi connection from the hub. We provide the hub when you set up internet at your home. If you cancel your service, you'll have to return your All-Fi Hub and it's power supply.

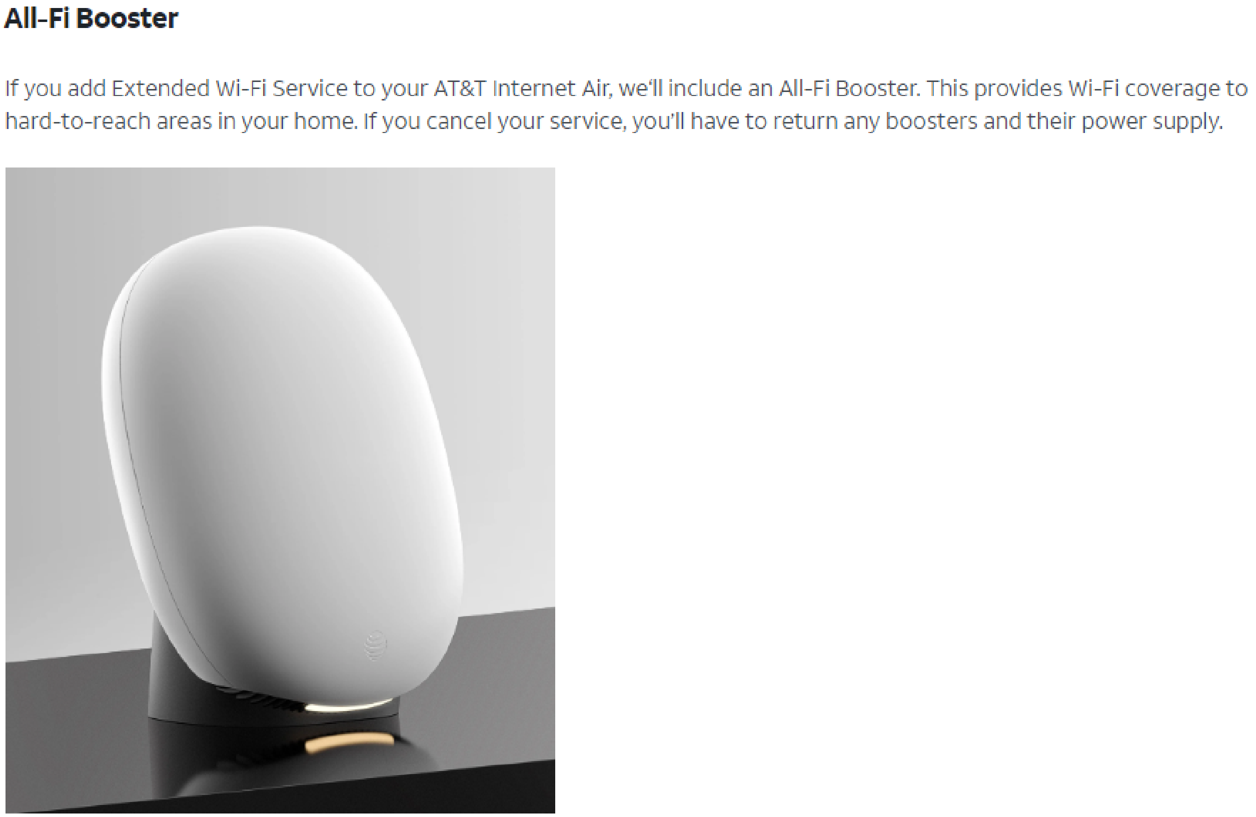
Wi-Fi extender

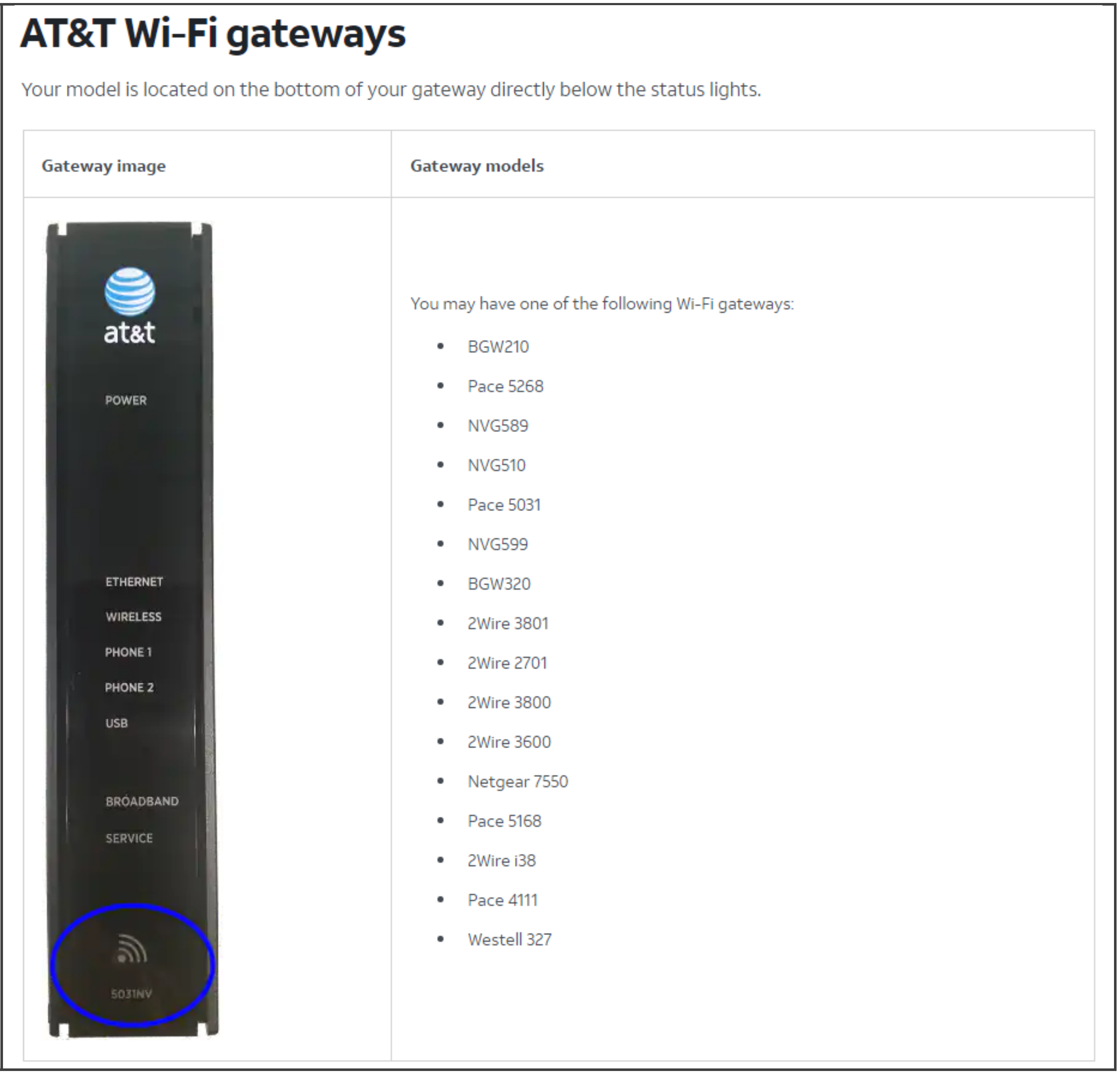
If you add Extended Wi-Fi Service to your internet plan, we'll include an AirTies 4971 Wi-Fi extender. This provides Wi-Fi coverage to hard-to-reach areas in your home. If you cancel your internet, you'll have to return any AirTies 4971 extenders and their power supply.

You may also have older models, including the AirTies 4920 or 4921. These were available for purchase and won't have to be returned.

AirTies 4971

AirTies 4921

	 **All-Fi Booster** If you add Extended Wi-Fi Service to your AT&T Internet Air, we'll include an All-Fi Booster. This provides Wi-Fi coverage to hard-to-reach areas in your home. If you cancel your service, you'll have to return any boosters and their power supply. https://www.att.com/support/article/u-verse-high-speed-internet/KM1011652/



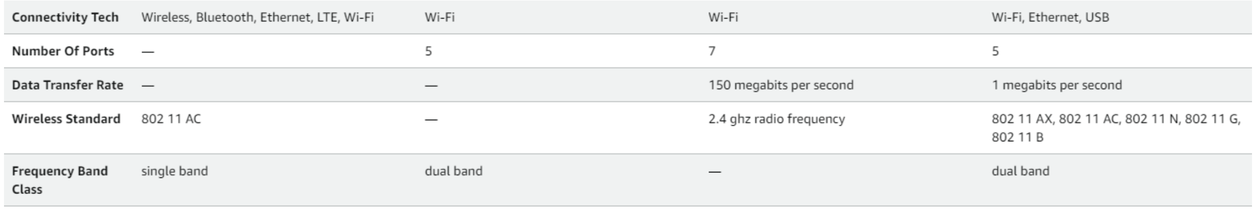
AT&T Wi-Fi gateways

Your model is located on the bottom of your gateway directly below the status lights.

Gateway image	Gateway models
	You may have one of the following Wi-Fi gateways: • BGW210 • Pace 5268 • NVG589 • NVG510 • Pace 5031 • NVG599 • BGW320 • 2Wire 3801 • 2Wire 2701 • 2Wire 3800 • 2Wire 3600 • Netgear 7550 • Pace 5168 • 2Wire i38 • Pace 4111 • Westell 327

https://www.att.com/support/article/dsl-high-speed/KM1047050/

This item: AT&T Wireless Internet WiFi Modem 4G LTE Home Base Router



Connectivity Tech	Wireless, Bluetooth, Ethernet, LTE, Wi-Fi	Wi-Fi	Wi-Fi	Wi-Fi, Ethernet, USB
Number Of Ports	—	5	7	5
Data Transfer Rate	—	—	150 megabits per second	1 megabits per second
Wireless Standard	802 11 AC	—	2.4 ghz radio frequency	802 11 AX, 802 11 AC, 802 11 N, 802 11 G, 802 11 B
Frequency Band Class	single band	dual band	—	dual band

https://www.amazon.com/Wireless-Internet-Hotspot-Antenna-AT/dp/B075JB968D?source=ps-sl-shoppingads-lpcontext&ref_=fplfs&psc=1&smid=A24OVZW9214RO6

27. The method of claim 19, wherein the filtered first transmission signal and the filtered second transmission signal are transmitted via different transceivers.	The Accused Instrumentalities and Services perform steps of a method as articulated above, wherein the first power and the second power are different. For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or

Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method as articulated above, wherein the first power and the second power are different.

Note: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):

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Powerful Wi-Fi you can rely on

Our next-generation Wi-Fi® delivers more coverage to more corners of your home than ever before.

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$10/mo. for up to five extenders. Number of extenders determined at the sole discretion of AT&T.

Speeds up to 5 GIG

Enjoy our fastest speeds, so you can enjoy more of what you love—on more devices.

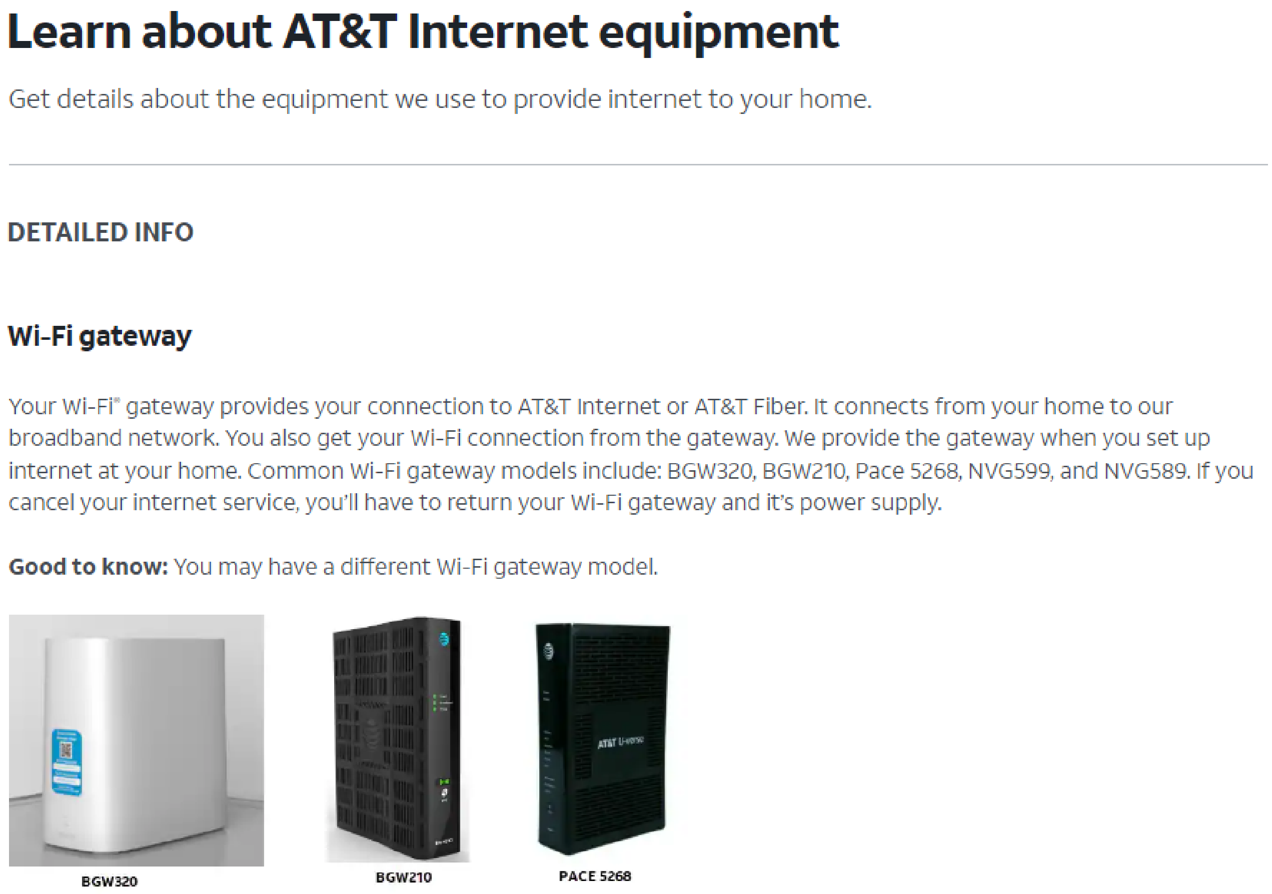
Ltd. avail/areas. Speeds based on wired connection Actual speeds may vary. Single device wired speed maximum 4.7Gbps. For more info, go to www.att.com/speed101.

AT&T ActiveArmor℠

24/7 security that helps block threats before they reach your devices.

Guards against known threats only. AT&T Smart Home Manager app required. Security features must be enabled.

	 **Easy 1-2-3 self-installation** If you qualify for an easy self-install kit, no technician is needed. 1 **Unpack the AT&T Wi-Fi gateway** Plug the AT&T Wi-Fi gateway into an outlet. 2 **Make the connection** Connect your AT&T Wi-Fi gateway to your computer using the provided cables. 3 **Sign in, register & get online** Follow the easy on-screen steps—and you're good to go. If you are unable to install the AT&T Wi-Fi Gateway, call 800.288.2020 to schedule a technician for a professional installation. https://www.att.com/wi-fi/



Learn about AT&T Internet equipment

Get details about the equipment we use to provide internet to your home.

DETAILED INFO

Wi-Fi gateway

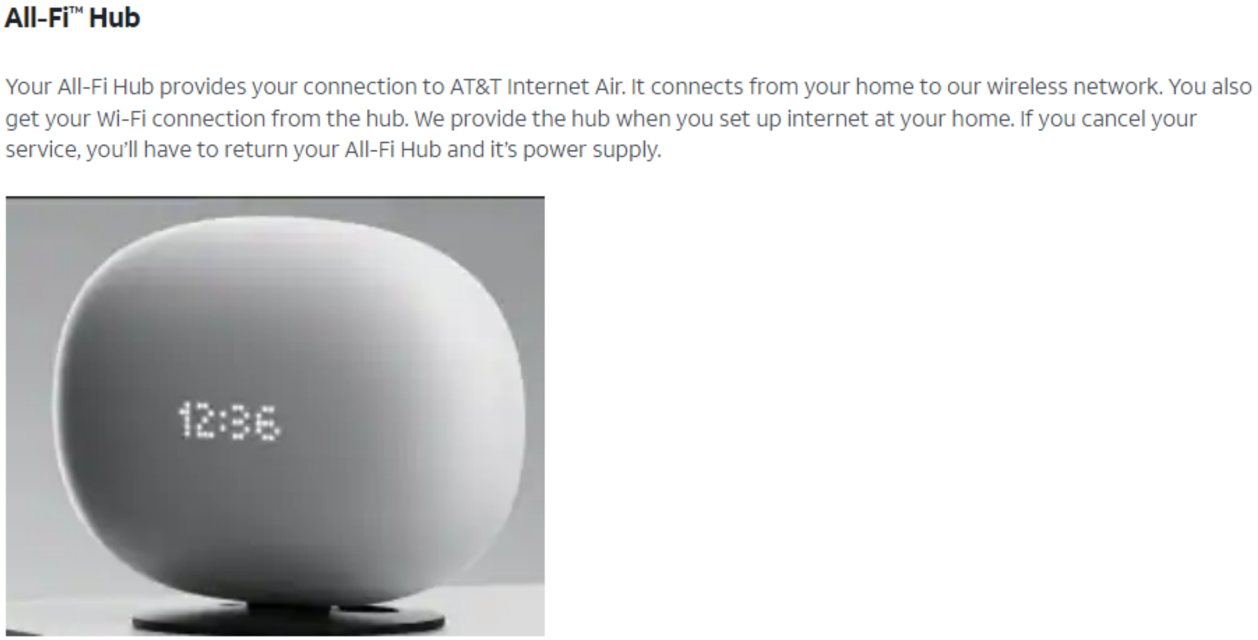
Your Wi-Fi® gateway provides your connection to AT&T Internet or AT&T Fiber. It connects from your home to our broadband network. You also get your Wi-Fi connection from the gateway. We provide the gateway when you set up internet at your home. Common Wi-Fi gateway models include: BGW320, BGW210, Pace 5268, NVG599, and NVG589. If you cancel your internet service, you'll have to return your Wi-Fi gateway and it's power supply.

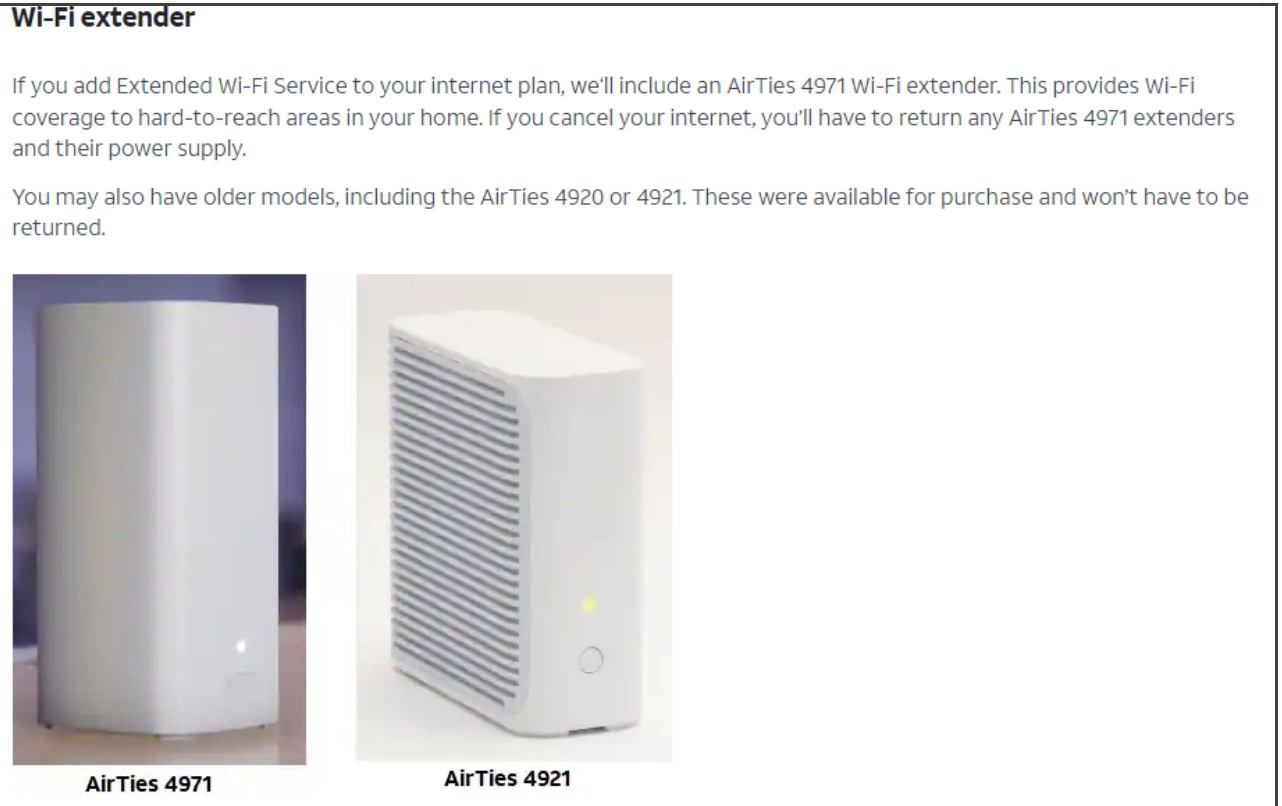
Good to know: You may have a different Wi-Fi gateway model.

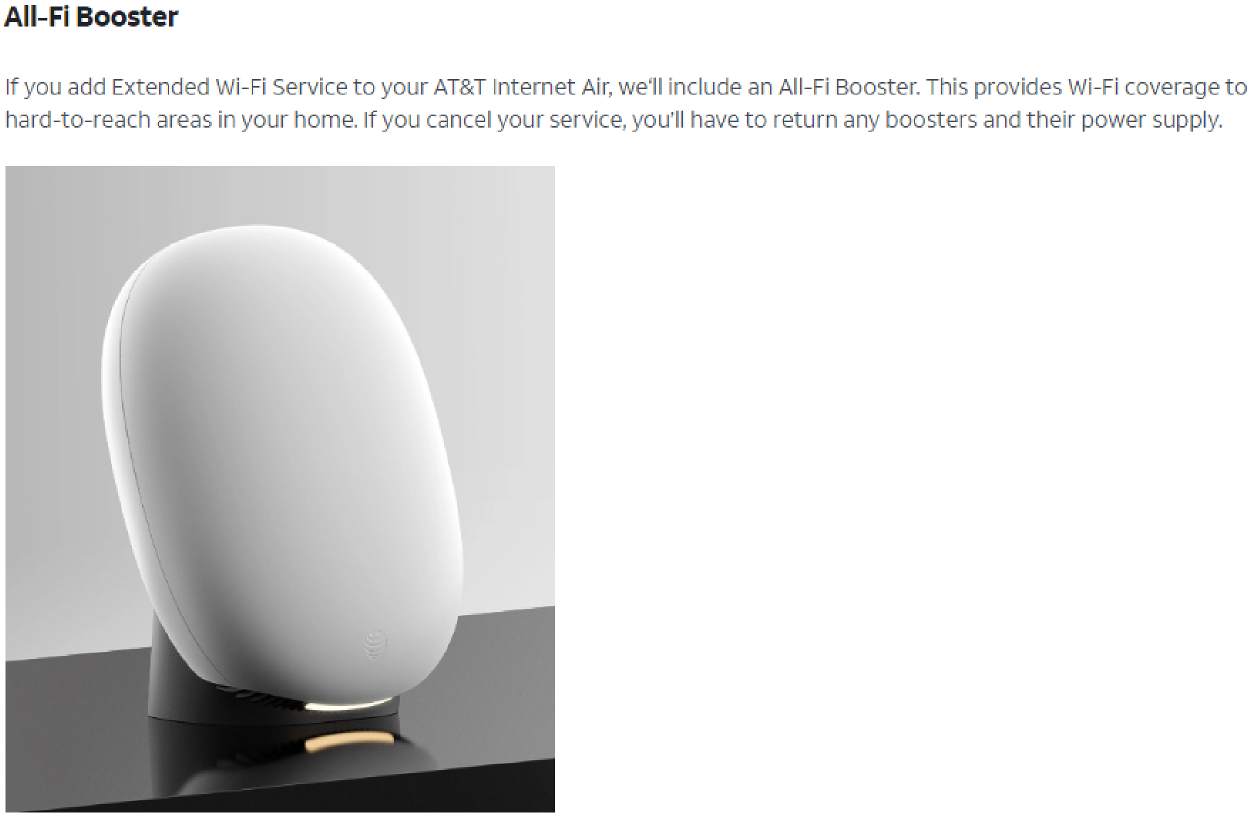
BGW320

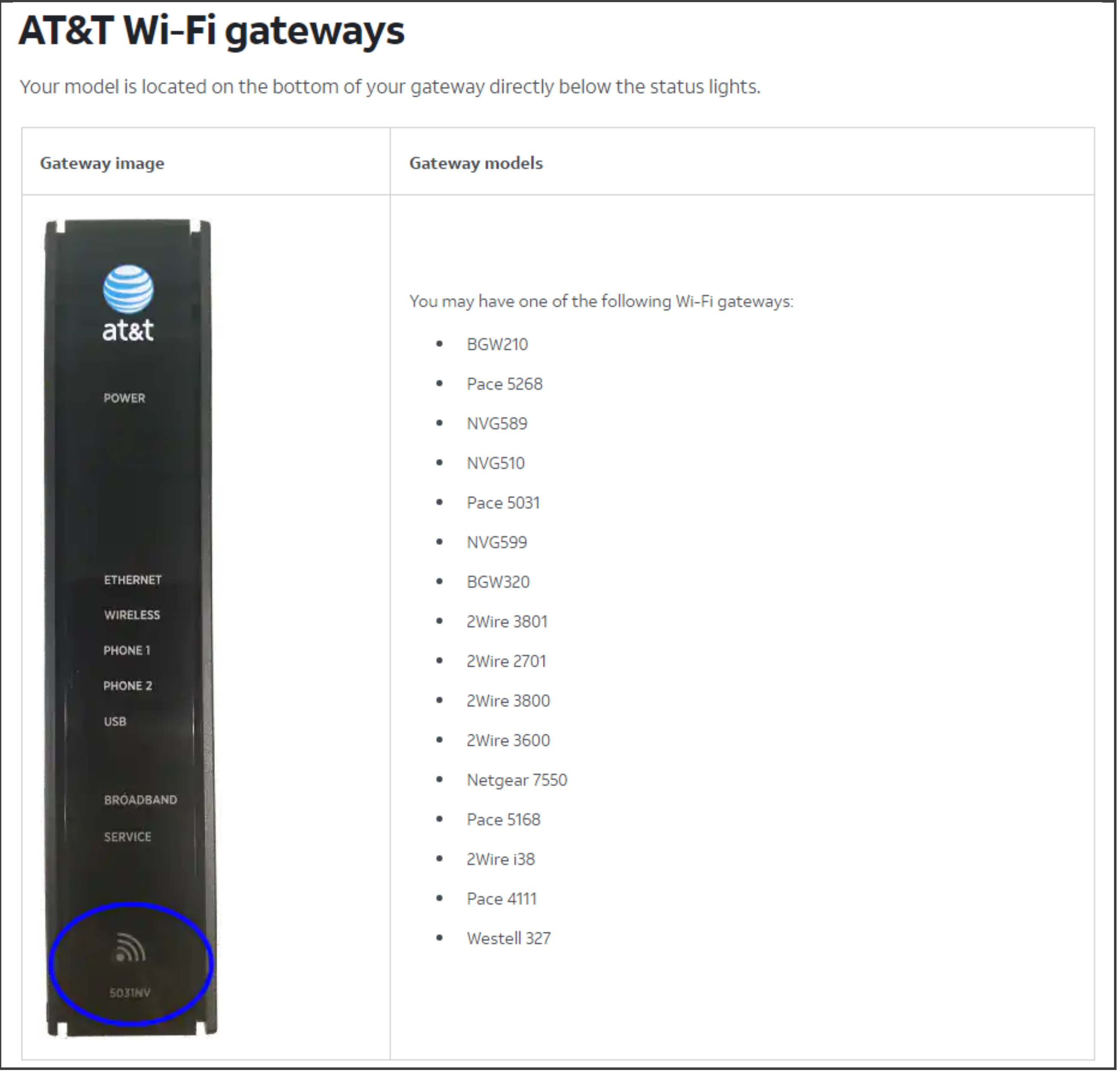
BGW210

PACE 5268

	 **All-Fi™ Hub** Your All-Fi Hub provides your connection to AT&T Internet Air. It connects from your home to our wireless network. You also get your Wi-Fi connection from the hub. We provide the hub when you set up internet at your home. If you cancel your service, you'll have to return your All-Fi Hub and it's power supply.

	 **Wi-Fi extender** If you add Extended Wi-Fi Service to your internet plan, we'll include an AirTies 4971 Wi-Fi extender. This provides Wi-Fi coverage to hard-to-reach areas in your home. If you cancel your internet, you'll have to return any AirTies 4971 extenders and their power supply. You may also have older models, including the AirTies 4920 or 4921. These were available for purchase and won't have to be returned. **AirTies 4971** **AirTies 4921**

	 **All-Fi Booster** If you add Extended Wi-Fi Service to your AT&T Internet Air, we'll include an All-Fi Booster. This provides Wi-Fi coverage to hard-to-reach areas in your home. If you cancel your service, you'll have to return any boosters and their power supply. https://www.att.com/support/article/u-verse-high-speed-internet/KM1011652/



AT&T Wi-Fi gateways

Your model is located on the bottom of your gateway directly below the status lights.

Gateway image	Gateway models
	You may have one of the following Wi-Fi gateways: • BGW210 • Pace 5268 • NVG589 • NVG510 • Pace 5031 • NVG599 • BGW320 • 2Wire 3801 • 2Wire 2701 • 2Wire 3800 • 2Wire 3600 • Netgear 7550 • Pace 5168 • 2Wire i38 • Pace 4111 • Westell 327

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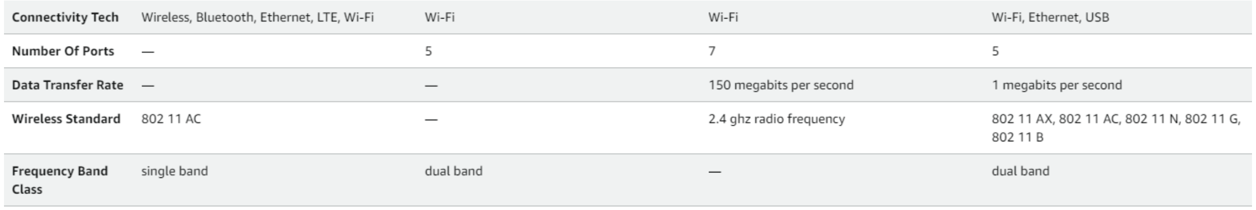
https://www.att.com/support/article/dsl-high-speed/KM1047050/

This item: AT&T Wireless Internet WiFi Modem 4G LTE Home Base Router



<table>
<tr><th></th><th></th><th></th><th></th><th></th></tr>
<tr><td>Connectivity Tech</td><td>Wireless, Bluetooth, Ethernet, LTE, Wi-Fi</td><td>Wi-Fi</td><td>Wi-Fi</td><td>Wi-Fi, Ethernet, USB</td></tr>
<tr><td>Number Of Ports</td><td>—</td><td>5</td><td>7</td><td>5</td></tr>
<tr><td>Data Transfer Rate</td><td>—</td><td>—</td><td>150 megabits per second</td><td>1 megabits per second</td></tr>
<tr><td>Wireless Standard</td><td>802 11 AC</td><td>—</td><td>2.4 ghz radio frequency</td><td>802 11 AX, 802 11 AC, 802 11 N, 802 11 G, 802 11 B</td></tr>
<tr><td>Frequency Band Class</td><td>single band</td><td>dual band</td><td>—</td><td>dual band</td></tr>
</table>

https://www.amazon.com/Wireless-Internet-Hotspot-Antenna-AT/dp/B075JB968D?source=ps-sl-shoppingads-lpcontext&ref_=fplfs&psc=1&smid=A24OVZW9214RO6

</td>
</tr>
<tr>
<td>28. The method of claim 19, wherein the instruction is received utilizing a dedicated channel.</td>
<td>

The Accused Instrumentalities and Services perform steps of a method as articulated above, wherein the instruction is received utilizing a dedicated channel.

For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents

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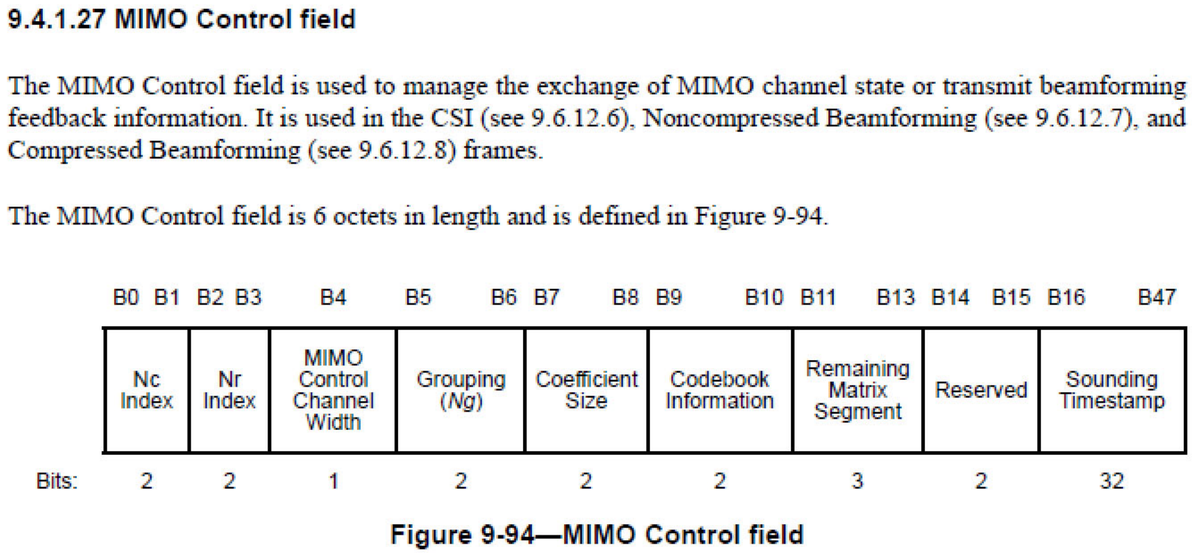
<td>
or customers, require performance of a method as articulated above, wherein the instruction is received utilizing a dedicated channel.

Note: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):


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.

<table>
<tr><td></td><td>B0 B1</td><td>B2 B3</td><td>B4</td><td>B5 B6</td><td>B7 B8</td><td>B9 B10</td><td>B11 B13</td><td>B14 B15</td><td>B16 B47</td></tr>
<tr><td></td><td>Nc Index</td><td>Nr Index</td><td>MIMO Control Channel Width</td><td>Grouping (<i>Ng</i>)</td><td>Coefficient Size</td><td>Codebook Information</td><td>Remaining Matrix Segment</td><td>Reserved</td><td>Sounding Timestamp</td></tr>
<tr><td>Bits:</td><td>2</td><td>2</td><td>1</td><td>2</td><td>2</td><td>2</td><td>3</td><td>2</td><td>32</td></tr>
</table>
Figure 9-94—MIMO Control field
Page 745 of 802.11-2016
</td>
</tr>
<tr>
<td>29. The method of claim 19, wherein the instruction is received via an antenna configured for omnidirectional communication.</td>
<td>
The Accused Instrumentalities and Services perform steps of a method as articulated above, wherein the instruction is received via an antenna configured for omnidirectional communication.

For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method as articulated above, wherein the instruction is received via an antenna configured for omnidirectional communication.
</td>
</tr>
</table>

	Note: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): “If the STA has multiple antennas, it shall transmit using an approximation to an omnidirectional pattern.” Page 1787 of 802.11-2016
30. The method of claim 19, wherein the compressed first feedback and the compressed second feedback are received utilizing a dedicated channel.	The Accused Instrumentalities and Services perform steps of a method as articulated above, wherein the compressed first feedback and the compressed second feedback are received utilizing a dedicated channel. For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T’s provisioning of Wi-Fi and/or Hotspots, AT&T’s provisioning of business and residential Internet, etc.) and/or AT&T’s agents or customers, require performance of a method as articulated above, wherein the compressed first feedback and the compressed second feedback are received utilizing a dedicated channel. **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):

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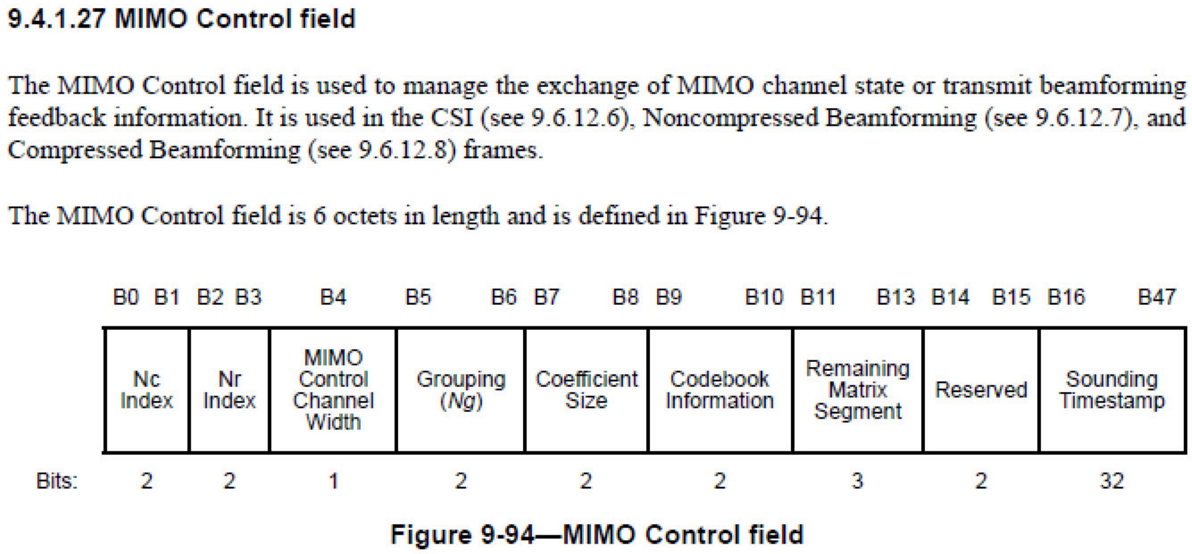


9.4.1.27 MIMO Control field

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.

<table>
<tr><td></td><td>B0 B1</td><td>B2 B3</td><td>B4</td><td>B5 B6</td><td>B7 B8</td><td>B9 B10</td><td>B11 B13</td><td>B14 B15</td><td>B16 B47</td></tr>
<tr><td></td><td>Nc Index</td><td>Nr Index</td><td>MIMO Control Channel Width</td><td>Grouping (<i>Ng</i>)</td><td>Coefficient Size</td><td>Codebook Information</td><td>Remaining Matrix Segment</td><td>Reserved</td><td>Sounding Timestamp</td></tr>
<tr><td>Bits:</td><td>2</td><td>2</td><td>1</td><td>2</td><td>2</td><td>2</td><td>3</td><td>2</td><td>32</td></tr>
</table>

Figure 9-94—MIMO Control field

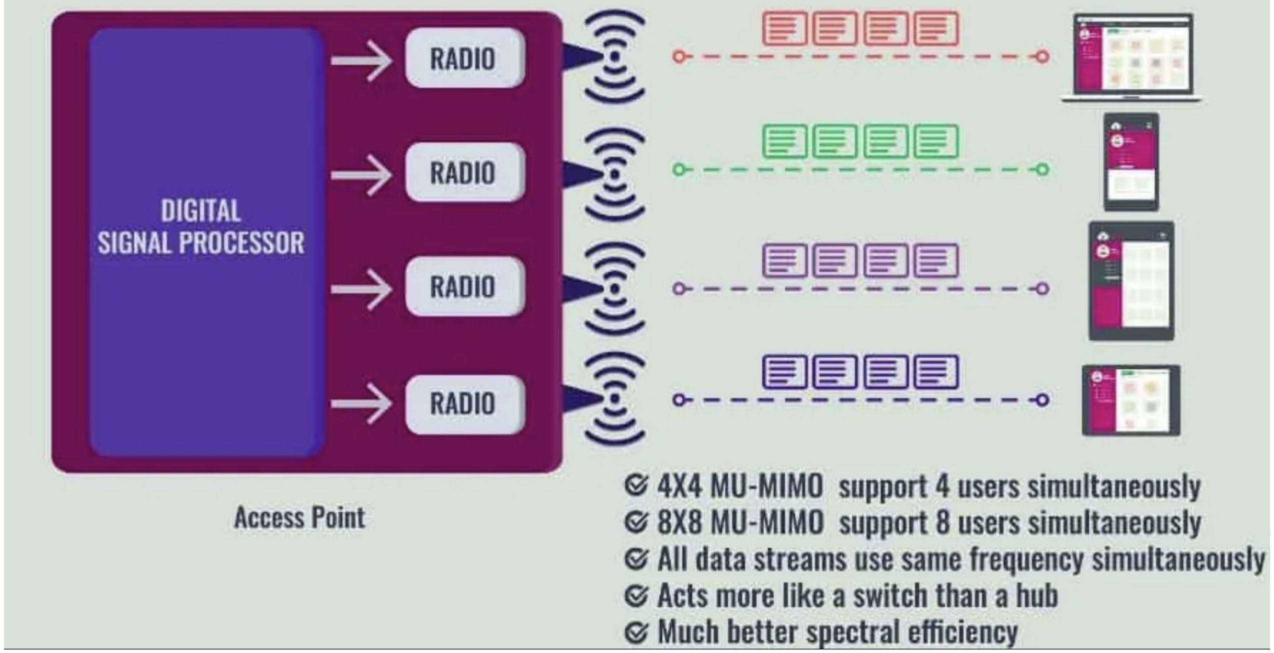
Page 745 of 802.11-2016
</td>
</tr>
<tr>
<td>31. The method of claim 19, wherein the compressed first feedback and the compressed second feedback are received via an antenna configured for omnidirectional communication.</td>
<td>

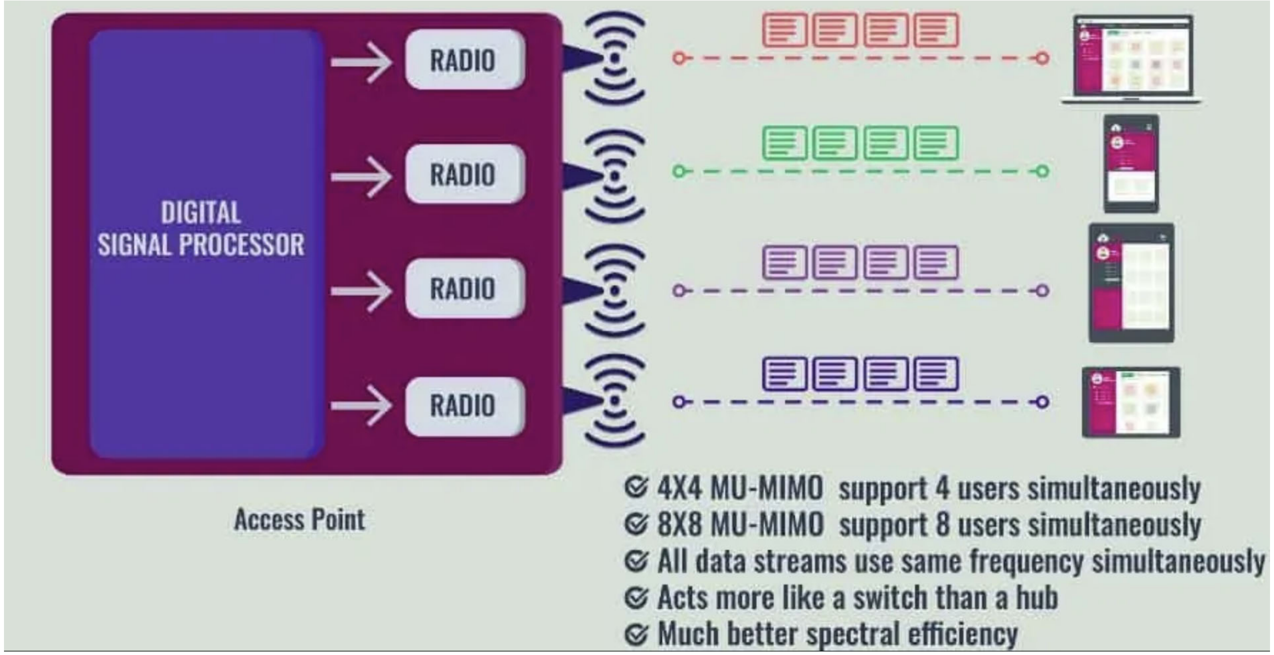
The Accused Instrumentalities and Services perform steps of a method as articulated above, wherein the compressed first feedback and the compressed second feedback are received via an antenna configured for omnidirectional communication.

For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method as articulated above, wherein the compressed first feedback and the compressed second feedback are received via an antenna configured for omnidirectional communication.

<u>**Note**</u>: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
</td>
</tr>
</table>

	"If the STA has multiple antennas, it shall transmit using an approximation to an omnidirectional pattern." Page 1787 of 802.11-2016
32. The method of claim 19, wherein the decompressed first feedback and the decompressed second feedback are used to increase spatial separation among transmissions.	The Accused Instrumentalities and Services perform steps of a method as articulated above, wherein the decompressed first feedback and the decompressed second feedback are used to increase spatial separation among transmissions. For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method as articulated above, wherein the decompressed first feedback and the decompressed second feedback are used to increase spatial separation among transmissions. **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "In very high density environments, such as sports arenas and stadiums, high density coverage is typically achieved by using highly directional antennas to divide up the area into very small sectors, which may not provide the spatial separation that MU-MIMO requires." http://www.emperorwifi.com/2015/04/a-simplified-explanation-of-80211nac.html

	 https://www.comparitech.com/net-admin/what-is-mu-mimo/
33. The method of claim 19, wherein the decompressed first feedback and the decompressed second feedback are used to increase spatial separation among transmissions at the same frequency.	The Accused Instrumentalities and Services perform steps of a method as articulated above, wherein the decompressed first feedback and the decompressed second feedback are used to increase spatial separation among transmissions at the same frequency. For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method as articulated above, wherein the decompressed first feedback and the decompressed second feedback are used to increase spatial separation among transmissions at the same frequency.

	Note: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "In very high density environments, such as sports arenas and stadiums, high density coverage is typically achieved by using highly directional antennas to divide up the area into very small sectors, which may not provide the spatial separation that MU-MIMO requires." http://www.emperorwifi.com/2015/04/a-simplified-explanation-of-80211nac.html  https://www.comparitech.com/net-admin/what-is-mu-mimo/
34. The method of claim 19, and further comprising: receiving a compressed third feedback from a fourth node that characterizes receipt of a third	The Accused Instrumentalities and Services perform steps of a method as articulated above, further comprising receiving a compressed third feedback from a fourth node that characterizes receipt of a third signal sent from the first node to the fourth node, the fourth node being a legacy node; decompressing the compressed third feedback resulting in a decompressed third feedback; transmitting, using a third frequency and another 802.11-based OFDM protocol, the third transmission signal to the fourth node using a transceiver separate from one or more other

signal sent from the first node to the fourth node, the fourth node being a legacy node; decompressing the compressed third feedback resulting in a decompressed third feedback; transmitting, using a third frequency and another 802.11-based OFDM protocol, the third transmission signal to the fourth node using a transceiver separate from one or more other transceivers used to transmit the filtered first transmission signal and the filtered second transmission signal, and further using a third power that is based on the decompressed third feedback.	transceivers used to transmit the filtered first transmission signal and the filtered second transmission signal, and further using a third power that is based on the decompressed third feedback. For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method as articulated above, further comprising receiving a compressed third feedback from a fourth node that characterizes receipt of a third signal sent from the first node to the fourth node, the fourth node being a legacy node; decompressing the compressed third feedback resulting in a decompressed third feedback; transmitting, using a third frequency and another 802.11-based OFDM protocol, the third transmission signal to the fourth node using a transceiver separate from one or more other transceivers used to transmit the filtered first transmission signal and the filtered second transmission signal, and further using a third power that is based on the decompressed third feedback. **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):

AT&T Fiber® with AT&T All-Fi™

Powerful Wi-Fi you can rely on

Our next-generation Wi-Fi® delivers more coverage to more corners of your home than ever before.

Compatible gateway with Wi-Fi 6 subject to availability. Optimal performance requires Wi-Fi 6 enabled devices. Whole-home Wi-Fi connectivity may require AT&T Smart Wi-Fi® Extenders for an additional monthly charge.

AT&T All-Fi

A top-of-the-line Wi-Fi experience

Complete Wi-Fi coverage without dead zones

Up to 5,000 sq. ft. with mesh extender technology.

$10/mo. for up to five extenders. Number of extenders determined at the sole discretion of AT&T.

Speeds up to 5 GIG

Enjoy our fastest speeds, so you can enjoy more of what you love—on more devices.

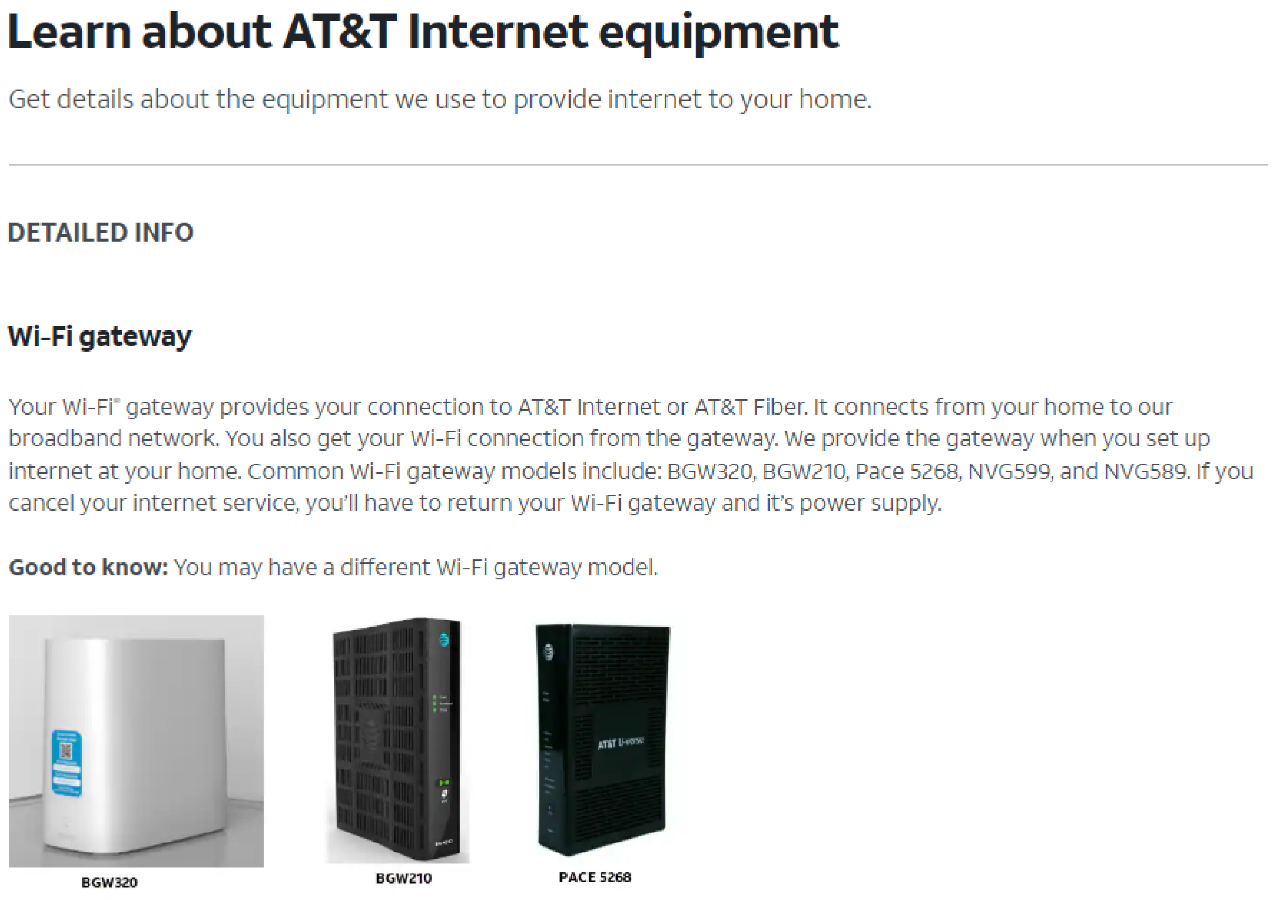
Ltd. avail/areas. Speeds based on wired connection Actual speeds may vary. Single device wired speed maximum 4.7Gbps. For more info, go to www.att.com/speed101.

AT&T ActiveArmor℠

24/7 security that helps block threats before they reach your devices.

Guards against known threats only. AT&T Smart Home Manager app required. Security features must be enabled.

	 Easy 1-2-3 self-installation If you qualify for an easy self-install kit, no technician is needed. 1 Unpack the AT&T Wi-Fi gateway Plug the AT&T Wi-Fi gateway into an outlet. 2 Make the connection Connect your AT&T Wi-Fi gateway to your computer using the provided cables. 3 Sign in, register & get online Follow the easy on-screen steps—and you're good to go. If you are unable to install the AT&T Wi-Fi Gateway, call 800.288.2020 to schedule a technician for a professional installation. https://www.att.com/wi-fi/



Learn about AT&T Internet equipment

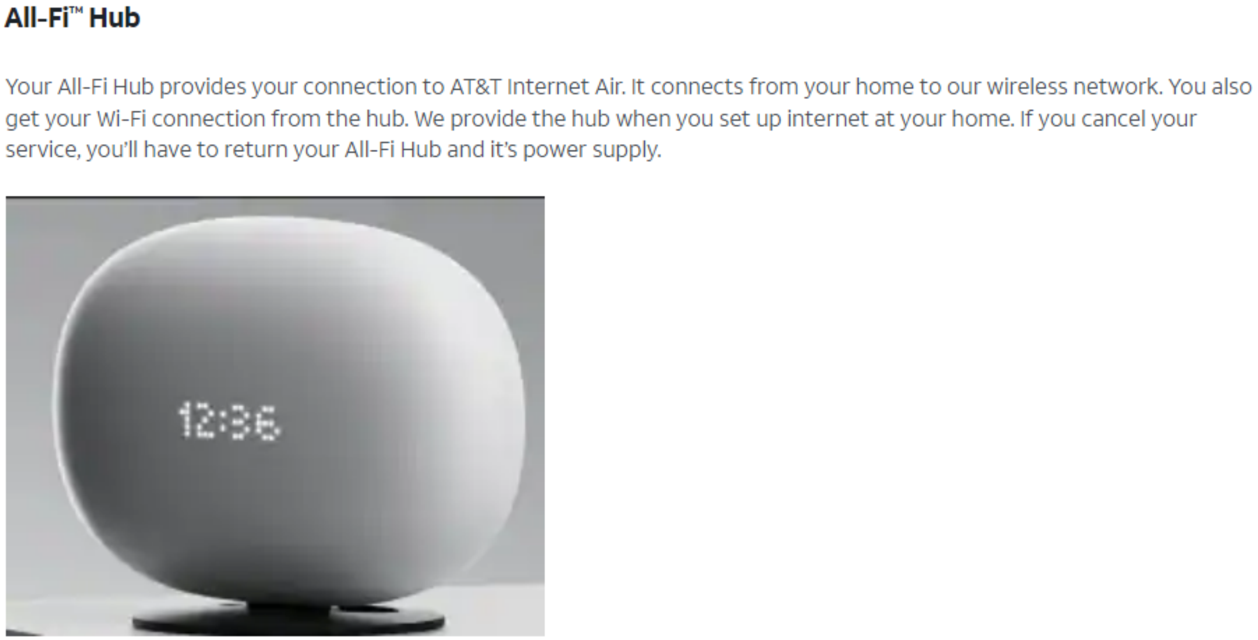
Get details about the equipment we use to provide internet to your home.

DETAILED INFO

Wi-Fi gateway

Your Wi-Fi® gateway provides your connection to AT&T Internet or AT&T Fiber. It connects from your home to our broadband network. You also get your Wi-Fi connection from the gateway. We provide the gateway when you set up internet at your home. Common Wi-Fi gateway models include: BGW320, BGW210, Pace 5268, NVG599, and NVG589. If you cancel your internet service, you'll have to return your Wi-Fi gateway and it's power supply.

Good to know: You may have a different Wi-Fi gateway model.

	 **All-Fi™ Hub** Your All-Fi Hub provides your connection to AT&T Internet Air. It connects from your home to our wireless network. You also get your Wi-Fi connection from the hub. We provide the hub when you set up internet at your home. If you cancel your service, you'll have to return your All-Fi Hub and it's power supply.

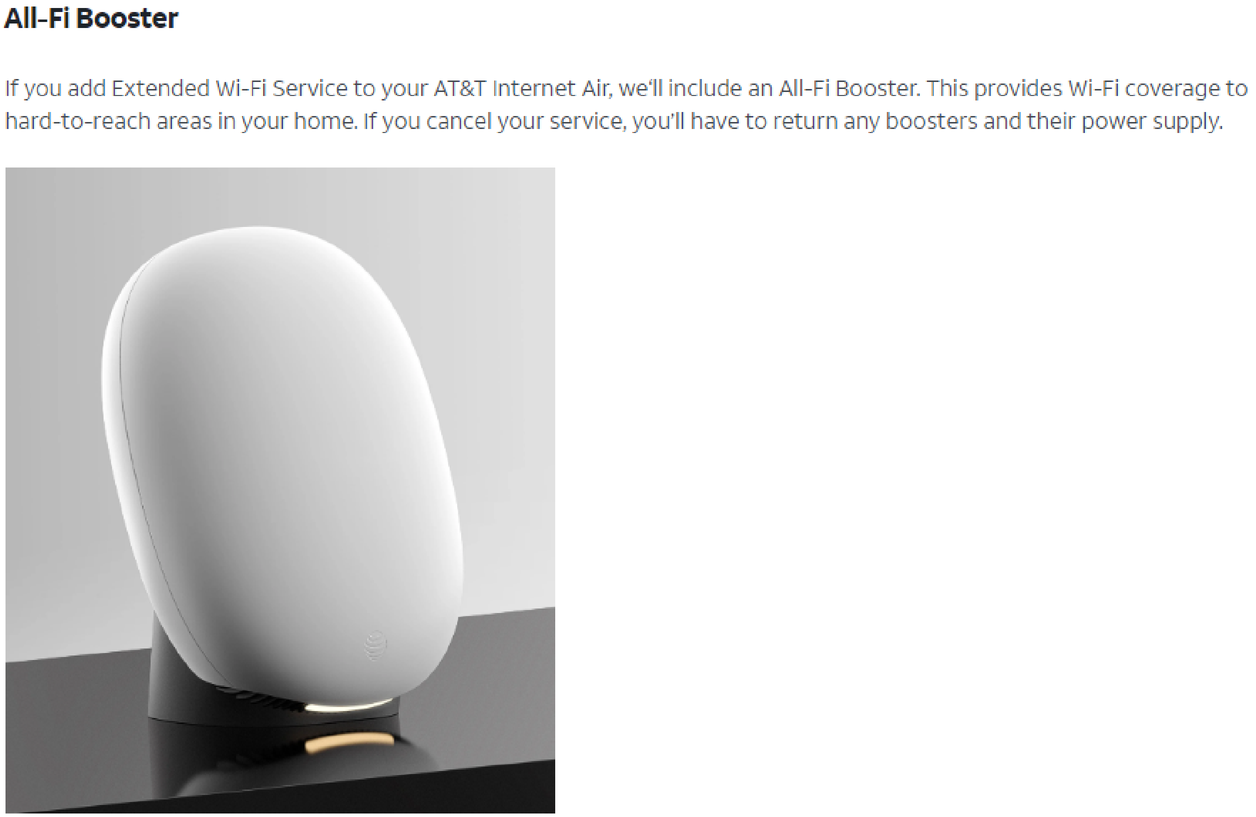
Wi-Fi extender

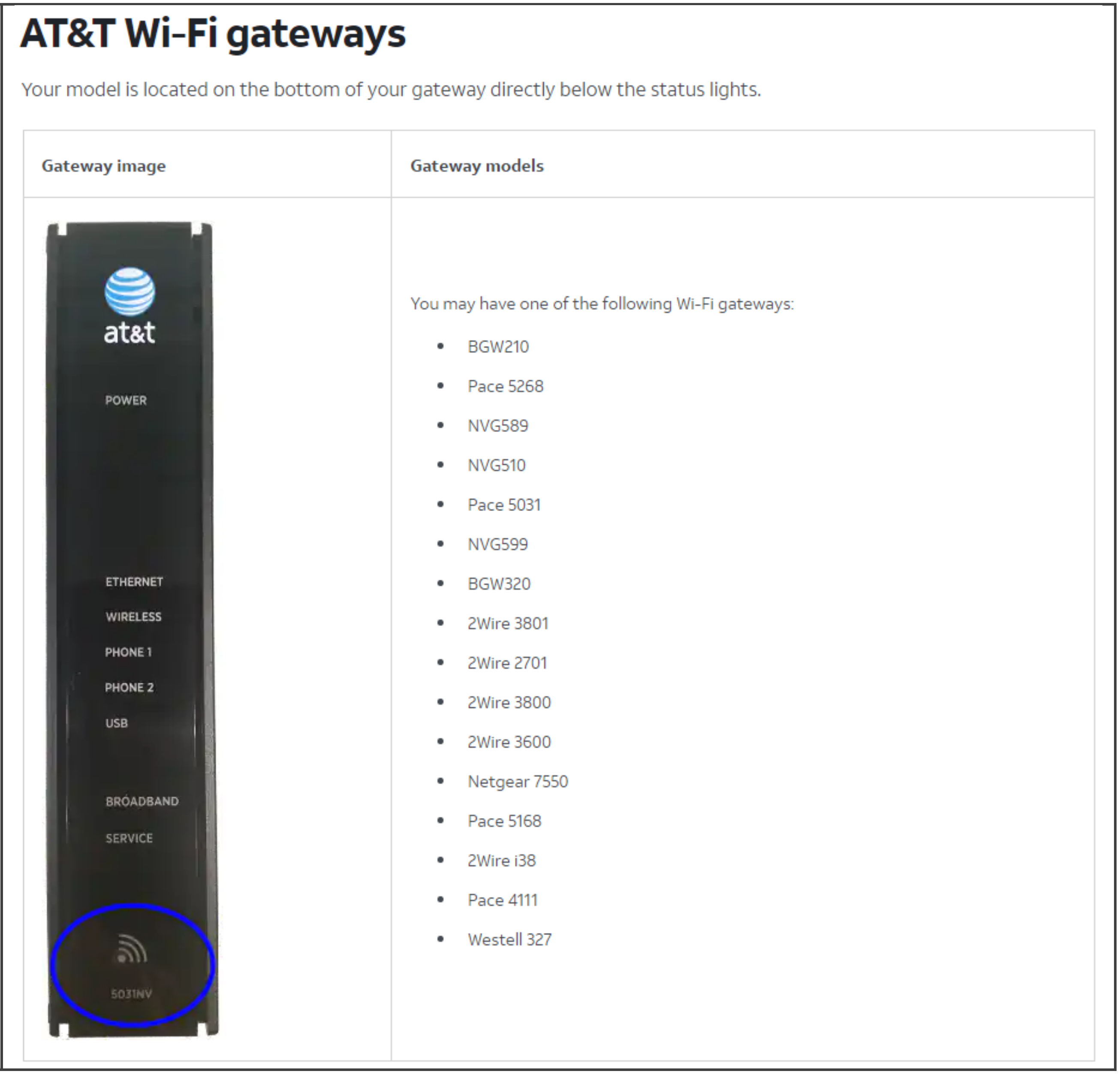
If you add Extended Wi-Fi Service to your internet plan, we'll include an AirTies 4971 Wi-Fi extender. This provides Wi-Fi coverage to hard-to-reach areas in your home. If you cancel your internet, you'll have to return any AirTies 4971 extenders and their power supply.

You may also have older models, including the AirTies 4920 or 4921. These were available for purchase and won't have to be returned.

AirTies 4971

AirTies 4921

	 **All-Fi Booster** If you add Extended Wi-Fi Service to your AT&T Internet Air, we'll include an All-Fi Booster. This provides Wi-Fi coverage to hard-to-reach areas in your home. If you cancel your service, you'll have to return any boosters and their power supply. https://www.att.com/support/article/u-verse-high-speed-internet/KM1011652/

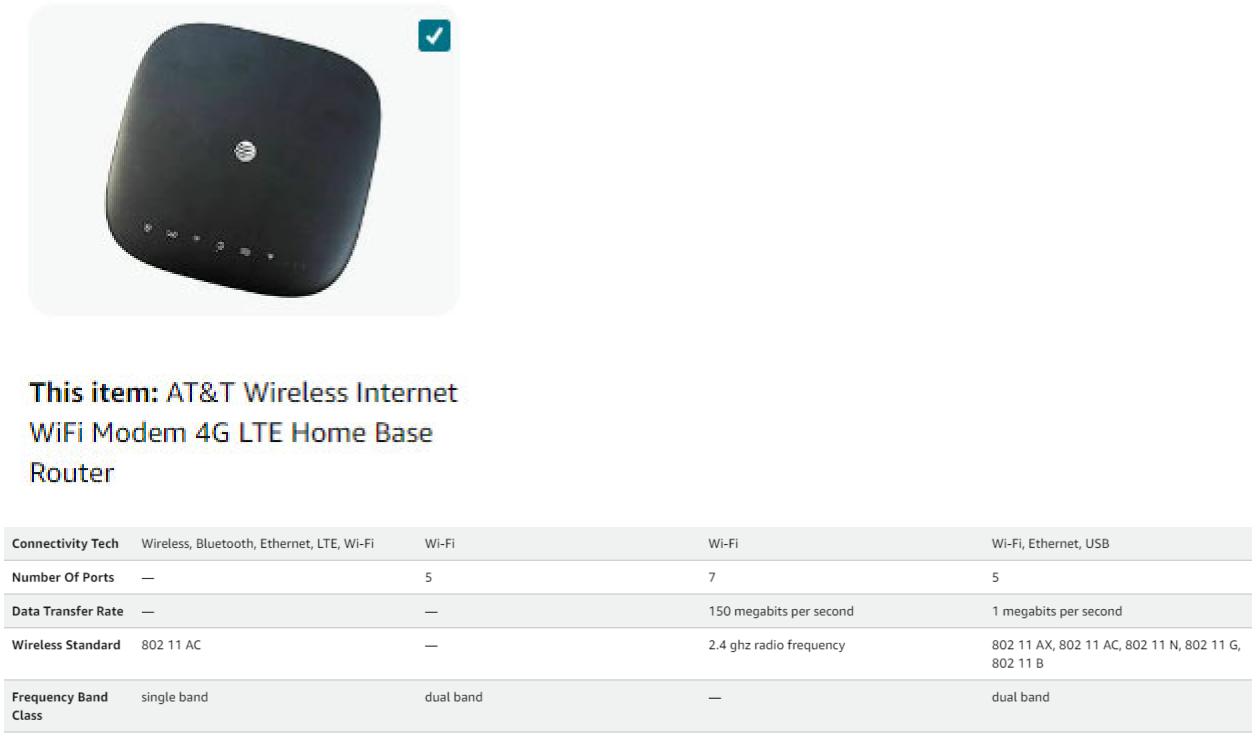


AT&T Wi-Fi gateways

Your model is located on the bottom of your gateway directly below the status lights.

Gateway image	Gateway models
	You may have one of the following Wi-Fi gateways: • BGW210 • Pace 5268 • NVG589 • NVG510 • Pace 5031 • NVG599 • BGW320 • 2Wire 3801 • 2Wire 2701 • 2Wire 3800 • 2Wire 3600 • Netgear 7550 • Pace 5168 • 2Wire i38 • Pace 4111 • Westell 327

https://www.att.com/support/article/dsl-high-speed/KM1047050/



This item: AT&T Wireless Internet WiFi Modem 4G LTE Home Base Router

Connectivity Tech	Wireless, Bluetooth, Ethernet, LTE, Wi-Fi	Wi-Fi	Wi-Fi	Wi-Fi, Ethernet, USB
Number Of Ports	—	5	7	5
Data Transfer Rate	—	—	150 megabits per second	1 megabits per second
Wireless Standard	802 11 AC	—	2.4 ghz radio frequency	802 11 AX, 802 11 AC, 802 11 N, 802 11 G, 802 11 B
Frequency Band Class	single band	dual band	—	dual band

https://www.amazon.com/Wireless-Internet-Hotspot-Antenna-AT/dp/B075JB968D?source=ps-sl-shoppingads-lpcontext&ref_=fplfs&psc=1&smid=A24OVZW9214RO6

"AT&T All-Fi is complimentary to all AT&T Fiber customers, regardless of their fiber internet speed plan . . . Everyone with All-Fi gets the AT&T Wi-Fi Gateway" https://www.att.com/internet/what-is-all-fi/#storyoffer7; *see also* https://www.att.com/legal/terms.wiFiServices.html

"AT&T All-Fi Hub and All-Fi Booster are devices that . . . are actually related to AT&T's wireless internet service—AT&T Internet Air—which allows Wi-Fi service through AT&T's cellular network." https://www.att.com/internet/what-is-all-fi/#storyoffer7

AT&T charges significant sum and invests significant resources to test and confirm 802.11 protocol compatibility within its networks, including up to or more than $50,000 per device. https://iotdevices.att.com/certified-devices.aspx; https://iotdevices.att.com/networkready.aspx; https://iotdevices.att.com/devices.aspx#:~:text=For%20chipset%2Dbased%20device%20designs,while%20ensuring%20ongoing%20network%20compatibility.

"AT&T's most recent generation of Wi-Fi equipment generally supports Wi-Fi 6 (IEEE 802.11ax) standard and is compatible with older Wi-Fi (IEEE 802.11 a/b/g/n/ac) standards . . . AT&T reserves the right to manage remotely any equiprement used to access any Internet Servic e, whether that equipment is connected via a wired or wireless connection . . . Access to AT&T's nationwide network of Wi-Fi Hot Spots may be available to use as part of the Service . . . ." https://www.att.com/legal/terms.consumerserviceagreement.html

"Nationwide Wi-Fi Hotspot Service. AT&T's mass market Wi-Fi broadband internet access service is designed to provide customers with the highest speed available from the network at any given point in time, subject to the many different factors discussed above that can affect network performance. AT&T's Wi-Fi services generally support the IEEE 802.11n/ac standard . . . ." https://about.att.com/sites/broadband/performance#:~:text=Nationwide%20Wi%2DFi%20Hotspot%20Service,access%20services%2C%20please%20click%20here.

"These Terms of Service & Acceptable Use Policy (the "Terms") govern your use of the AT&T Wi-Fi Services ("Service") provided to you through premises operators pursuant to contracts with AT&T or delivered to you directly by AT&T. . . The Service is provided by AT&T Wi-Fi Services, an affiliate of AT&T Corp. ("AT&T"). In order to provide the Service to Customers, AT&T contracts with owners and operators of popular establishments and businesses who purchase the Service to provide it to their employees, patrons, and invited guests at specific sites or locations (Locations). AT&T also offers the Service for the benefit of AT&T Mobility, AT&T DSL and U-verse subscribers for use in select public venues and for certain events, for example, in a city park or performance concert ("AT&T Hot Zones") . . . The Service is designed to provide you with the highest speed available from the network at any given point in time, subject to the many different factors discussed above that can affect network performance. The Service generally supports the IEEE 802.11n/ac standard . . . ."

	https://www.att.com/legal/terms.wiFiServices.html "Enjoy a fully managed Wi-Fi service with a robust Day 0, 1, and 2 support model. From site design to professional installation to ongoing care, we have you covered . . . Choose which equipment option will best suit your needs (Cisco Meraki, Aruba, or Mist). Then decide whether you would like AT&T to professionally install the equipment or you would like to self-install . . .No matter which equipment option you choose, all come with Wi-Fi 6 compatible devices. . . . AT&T offers a robust support model with Day 0, 1, and 2 support available. AT&T offers professional services to conduct site surveys, design networks, install equipment, and provide ongoing care and maintenance." https://www.business.att.com/products/business-wifi.html "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 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." 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.
35. The method of claim 34, wherein the third transmission signal is transmitted simultaneously with the filtered first transmission signal and the filtered second transmission signal via at least one different antenna of the plurality of antennas.	The Accused Instrumentalities and Services perform steps of a method as articulated above, wherein the third transmission signal is transmitted simultaneously with the filtered first transmission signal and the filtered second transmission signal via at least one different antenna of the plurality of antennas. For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method as articulated above, wherein the third transmission

	signal is transmitted simultaneously with the filtered first transmission signal and the filtered second transmission signal via at least one different antenna of the plurality of antennas. **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "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 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." https://www.extremenetworks.com/wifi6/what-is-80211ax/#:~:text=Is%20802.11ax%20backward%20compatible,g%2Fn%2Fac%20radios.
36. The method of claim 19, wherein the compressed first feedback is based on a received power at a plurality of frequencies via which the first signal is received.	The Accused Instrumentalities and Services perform steps of a method as articulated above, wherein the compressed first feedback is based on a received power at a plurality of frequencies via which the first signal is received. For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method as articulated above, wherein the compressed first feedback is based on a received power at a plurality of frequencies via which the first signal is received. **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): **21.3.11.2 Beamforming Feedback Matrix *V*** "Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in Table 21-11 from the measured channel before computing a set of matrices for feedback to the beamformer. The beamforming feedback matrix, $V_{k,u}$, found by the beamformee *u*

for subcarrier *k* shall be compressed in the form of angles using the method described in 19.3.12.3.6. The angles, $\varphi(k,v)$ and $\psi(k,u)$, are quantized according to Table 9-68. The number of bits for quantization is chosen by the beamformee, based on the indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DLMU- MIMO beamforming. The compressed beamforming feedback using 19.3.12.3.6 is the only Clause 21 beamforming feedback format defined.

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

After receiving the angle information, $\varphi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,N_{user}}-1]$ using $V_{k,u}$ and $SNR_{k,u}$ ($0 \le u \le N_{user}-1$) 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."

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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,

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

Nr is the number of rows in a compressed beamforming feedback matrix determined by the Nr Index field of the VHT MIMO Control field.”

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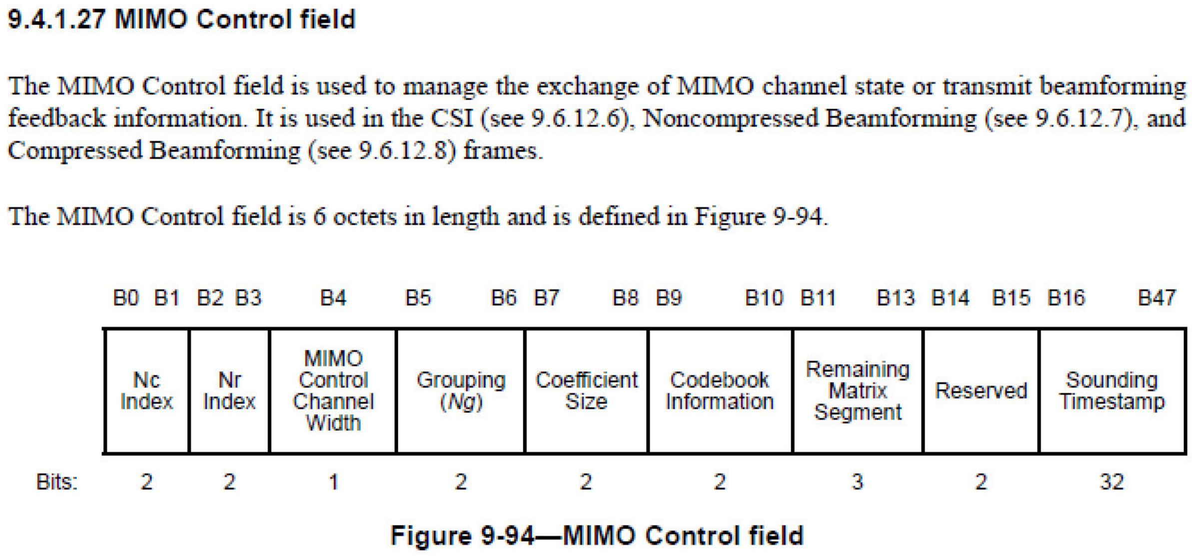

9.4.1.27 MIMO Control field

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.

	B0 B1	B2 B3	B4	B5 B6	B7 B8	B9 B10	B11 B13	B14 B15	B16 B47
	Nc Index	Nr Index	MIMO Control Channel Width	Grouping (*Ng*)	Coefficient Size	Codebook Information	Remaining Matrix Segment	Reserved	Sounding Timestamp
Bits:	2	2	1	2	2	2	3	2	32

Figure 9-94—MIMO Control field

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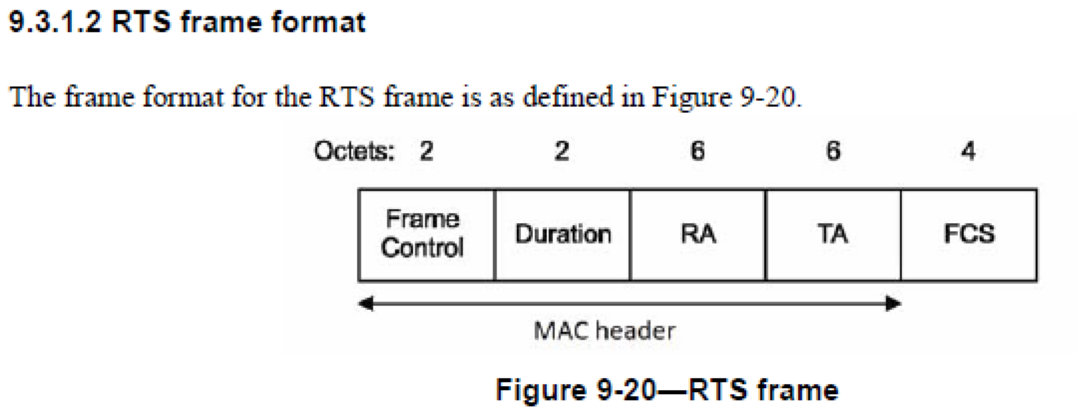
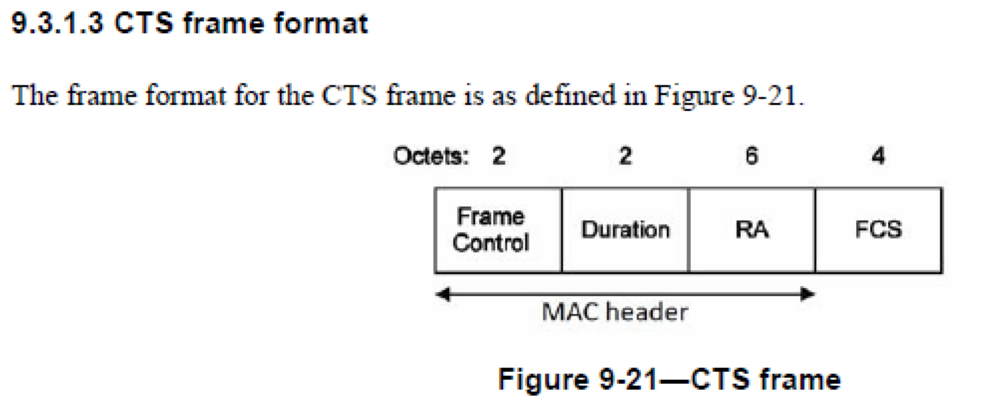
	"Calculating the feedback matrix can only begin after receiving the NDP from the beamformer. Once the NDP is received, each OFDM subcarrier is processed independently in its own matrix that describes the performance of the subcarrier between each transmitter antenna element and each receiver antenna element. The contents of the matrix are based on the received power and phase shifts between each pair of antennas." https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html
37. The method of claim 19, wherein the instruction is received prior to the receipt of the compressed first feedback.	The Accused Instrumentalities and Services perform steps of a method as articulated above, wherein the instruction is received prior to the receipt of the compressed first feedback. For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method as articulated above, wherein the instruction is received prior to the receipt of the compressed first feedback. **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):  **9.3.1.2 RTS frame format** The frame format for the RTS frame is as defined in Figure 9-20. **Figure 9-20—RTS frame**



9.3.1.3 CTS frame format

The frame format for the CTS frame is as defined in Figure 9-21.

Figure 9-21—CTS frame

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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,

	Nc is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field, *Nr* is the number of rows in a compressed beamforming feedback matrix determined by the Nr Index field of the VHT MIMO Control field.” Pages 764-765 of 802.11-2016
38. The method of claim 19, wherein the filtered second transmission signal is transmitted simultaneously with the filtered first transmission signal via the same plurality of antennas.	The Accused Instrumentalities and Services perform steps of a method as articulated above, wherein the filtered second transmission signal is transmitted simultaneously with the filtered first transmission signal via the same plurality of antennas. For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T’s provisioning of Wi-Fi and/or Hotspots, AT&T’s provisioning of business and residential Internet, etc.) and/or AT&T’s agents or customers, require performance of a method as articulated above, wherein the filtered second transmission signal is transmitted simultaneously with the filtered first transmission signal via the same plurality of antennas. **Note**: See evidence cited earlier in 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, where k is one of the subcarriers, and Q_k is consisted of sub-matrices $Q_{k,u}$, each corresponding to one receiving STA u. • IEEE 802.11-2016: **21.3.11.2 Beamforming Feedback Matrix *V*** further specifies that $Q_{k,u}$ is dependent on the feedback matrix $V_{k,u}$ provided by each STA u, which is based on the actual channel measurement by each STA u. • IEEE 802.11-2016: Figure 10-53 (below) illustrates that each STA (beamformee) is getting a different polling packet, based on which the feedback matrix $V_{k,u}$ is measured and should be different from STA to STA.

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

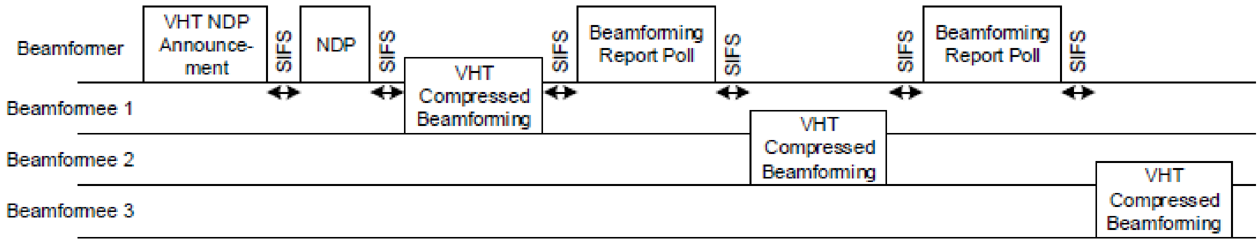

Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

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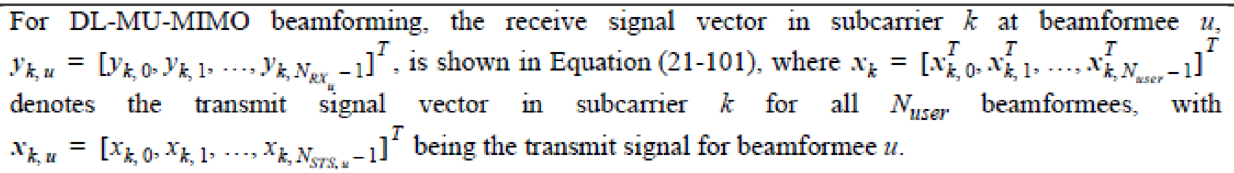
“21.3.11 SU-MIMO and DL-MU-MIMO Beamforming

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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0}, Q_{k,1} \ldots, Q_{k,Nuser}\text{-}1] \text{ x } x_k + n$$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions N_{RXu} x 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 $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,Nuser}\text{-}1]$ 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 $u = 0, 1, \ldots, N_{user} -1$. 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)."

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"**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."

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MU-MIMO technology further changed the rules of wireless engagement, enabling an AP or router to use its separate spatial streams to talk to multiple endpoints or users concurrently.

MIMO. Both the transmitting device and the receiving client(s) can send and receive multiple streams using multiple antennas. Alternatively, the transmitting device has multiple antennas that it uses to simultaneously transmit to multiple clients, some or all of which have only one receiving antenna each.
https://www.techtarget.com/searchnetworking/feature/5-things-to-know-about-MU-MIMO-technology-in-Wi-Fi-networks

"Wi-Fi 6 has five key technologies . . . Multi-user multiple-input, multiple-output (MU-MIMO) allows more data to be transferred at once, enabling an access point to handle a larger number of concurrent users. This contributes to the efficiency of the spectrum and massive device connectivity." https://www.business.att.com/content/dam/attbusiness/briefs/att-will-5g-replace-wifi-general-business-brief.pdf

39. The method of claim 19, wherein the first frequency is selected as a function of the compressed first feedback, and the second frequency is selected as a function of the compressed second feedback.	The Accused Instrumentalities and Services perform steps of a method as articulated above, wherein the first frequency is selected as a function of the compressed first feedback, and the second frequency is selected as a function of the compressed second feedback. For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method as articulated above, wherein the first frequency is selected as a function of the compressed first feedback, and the second frequency is selected as a function of the compressed second feedback. **<u>Note</u>**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "**21.3.11 SU-MIMO and DL-MU-MIMO Beamforming** **21.3.11.1 General** SU-MIMO and DL-MU-MIMO beamforming are techniques used by a STA with multiple antennas (the beamformer) to steer signals using knowledge of the channel to improve throughput. With SU-MIMO beamforming all space-time streams in the transmitted signal are intended for reception at a single STA. With DL-MU-MIMO beamforming, disjoint subsets of the space-time streams are intended for reception at different STAs. For SU-MIMO beamforming, <u>the steering matrix Q_k can be determined from the beamforming feedback matrix V_k that is sent back to the beamformer by the beamformee using the compressed beamforming feedback matrix format as defined in 19.3.12.3.6.</u> 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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}-1] \text{ x } x_k + n$$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions
N_{RXu} x 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 $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}-1]$ 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 $u = 0, 1, \ldots, N_{user} -1$. 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)."

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"**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
40. The method of claim 19, wherein the instruction includes a 802.11 clear to send (CTS) instruction.	When used by AT&T, and/or AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "**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
41. The method of claim 19, wherein the instruction includes a 802.11 request to send (RTS) instruction.	When used by AT&T, and/or AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **<u>Note</u>**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "**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. <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>" Page 1304 of 802.11-2016
42. The method of claim 19, wherein the filtered second transmission signal is transmitted simultaneously with the filtered first transmission signal via at least one different antenna of the plurality of antennas.	When used by AT&T, and/or AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **<u>Note</u>**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): • IEEE 802.11-2016: **<u>21.3.11 SU-MIMO and DL-MU-MIMO Beamforming</u>** 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.

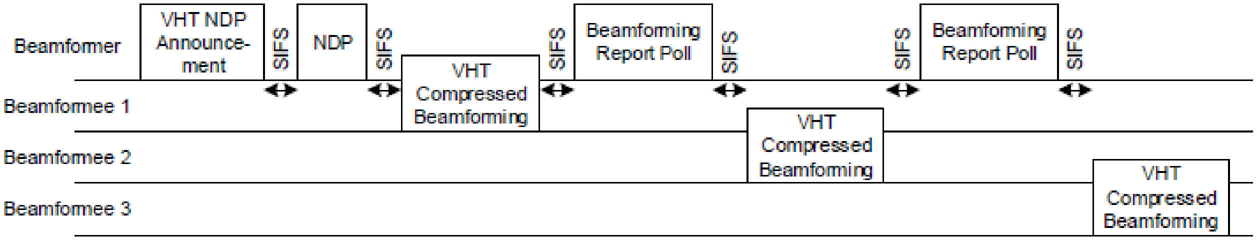

Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

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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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0},\ Q_{k,l} \ldots,\ Q_{k,Nuser}\text{-}1] \text{ x } x_k + n$$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \text{ x } N_{TX}$

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 $Q_k = [Q_{k,0},\ Q_{k,l} \ldots,\ Q_{k,Nuser}\text{-}1]$ 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 $u = 0, 1, \ldots, N_{user}$ -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).”

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“**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.”

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MU-MIMO technology further changed the rules of wireless engagement, enabling an AP or router to use its separate spatial streams to talk to multiple endpoints or users concurrently.

MIMO. Both the transmitting device and the receiving client(s) can send and receive multiple streams using multiple antennas. Alternatively, the transmitting device has multiple antennas that it uses to simultaneously transmit to multiple clients, some or all of which have only one receiving antenna each.

https://www.techtarget.com/searchnetworking/feature/5-things-to-know-about-MU-MIMO-technology-in-Wi-Fi-networks

“Wi-Fi 6 has five key technologies . . . Multi-user multiple-input, multiple-output (MU-MIMO) allows more data to be transferred at once, enabling an access point to handle a larger number of concurrent users. This contributes to the efficiency of the spectrum and massive device

	connectivity.” https://www.business.att.com/content/dam/attbusiness/briefs/att-will-5g-replace-wifi-general-business-brief.pdf “Enjoy a fully managed Wi-Fi service with a robust Day 0, 1, and 2 support model. From site design to professional installation to ongoing care, we have you covered . . . Choose which equipment option will best suit your needs (Cisco Meraki, Aruba, or Mist). Then decide whether you would like AT&T to professionally install the equipment or you would like to self-install . . .No matter which equipment option you choose, all come with Wi-Fi 6 compatible devices. . . . AT&T offers a robust support model with Day 0, 1, and 2 support available. AT&T offers professional services to conduct site surveys, design networks, install equipment, and provide ongoing care and maintenance.” https://www.business.att.com/products/business-wifi.html
43. The method of claim 19, wherein the filtered second transmission signal is transmitted simultaneously with the filtered first transmission signal using the at least one antenna of the plurality of antennas.	When used by AT&T, and/or AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in 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, where k is one of the subcarriers, and Q_k is consisted of sub-matrices $Q_{k,u}$, each corresponding to one receiving STA u. • IEEE 802.11-2016: **21.3.11.2 Beamforming Feedback Matrix *V*** further specifies that $Q_{k,u}$ is dependent on the feedback matrix $V_{k,u}$ provided by each STA u, which is based on the actual channel measurement by each STA u. • IEEE 802.11-2016: Figure 10-53 (below) illustrates that each STA (beamformee) is getting a different polling packet, based on which the feedback matrix $V_{k,u}$ is measured and should be different from STA to STA.

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

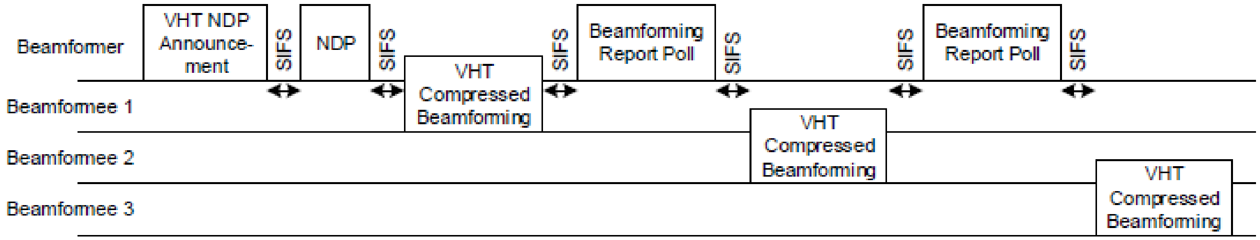

Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

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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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$Y_{k,u} = H_{k,u}$ x $[Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1]$ x $x_k + n$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions N_{RXu} x 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 $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1]$ 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 $u = 0, 1, \ldots, N_{user}$ -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

MU-MIMO technology further changed the rules of wireless engagement, enabling an AP or router to use its separate spatial streams to talk to multiple endpoints or users concurrently.

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https://www.techtarget.com/searchnetworking/feature/5-things-to-know-about-MU-MIMO-technology-in-Wi-Fi-networks

"Wi-Fi 6 has five key technologies . . . Multi-user multiple-input, multiple-output (MU-MIMO) allows more data to be transferred at once, enabling an access point to handle a larger number of concurrent users. This contributes to the efficiency of the spectrum and massive device connectivity." https://www.business.att.com/content/dam/attbusiness/briefs/att-will-5g-replace-wifi-general-business-brief.pdf

"Enjoy a fully managed Wi-Fi service with a robust Day 0, 1, and 2 support model. From site design to professional installation to ongoing care, we have you covered . . . Choose which equipment option will best suit your needs (Cisco Meraki, Aruba, or Mist). Then decide whether

	you would like AT&T to professionally install the equipment or you would like to self-install . . .No matter which equipment option you choose, all come with Wi-Fi 6 compatible devices. . . . AT&T offers a robust support model with Day 0, 1, and 2 support available. AT&T offers professional services to conduct site surveys, design networks, install equipment, and provide ongoing care and maintenance." https://www.business.att.com/products/business-wifi.html
45. The method of claim 19, wherein the removal of power from the transmission signal at each frequency in the plurality of frequencies to be avoided is accomplished by adjusting a processing of the transmission signal so that certain power that was previously used in connection with the transmission signal at each frequency in the plurality of frequencies to be avoided before the instruction is received, is no longer used in connection with the transmission signal at each frequency in the plurality of frequencies to be avoided in accordance with the instruction.	When used by AT&T, and/or AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): 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. Pages 1313-1314 of 802.11-2016
46. The method of claim 19, wherein the removal of power from the transmission signal at each frequency in the plurality of frequencies to be avoided is accomplished by adjusting a processing of the transmission signal so that certain power that	When used by AT&T, and/or AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):

was previously used in connection with the transmission signal at each frequency in the plurality of frequencies to be avoided before the instruction is received, is no longer used in connection with the transmission signal at each frequency in the plurality of frequencies to be avoided in accordance with the instruction, which specifies at least one frequency to use so as to avoid using the plurality of frequencies to be avoided in order to transmit to the second node.	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. Pages 1313-1314 of 802.11-2016
47. The method of claim 19, wherein network forwarding decisions are guided using instantaneous information from a media access control (MAC) layer.	When used by AT&T, and/or AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "R.3 QoS mapping guidelines for interworking with external networks R.3.1 General The EDCA and HCCA mechanism defined in 10.22 provide QoS control at the MAC layer. However, the QoS control parameters used by the EDCA and HCCA cannot match directly with other QoS control parameters of the interworked external networks, e.g., SSPN. For example, the SSPN could have different metrics for defining the QoS levels. Destination Network 1 (DN1) and DN2 can use DSCP values differently, in which case, STA1 and STA2 would require different QoS mapping information. Therefore, mapping from these external QoS control parameters to the QoS parameters of this standard is necessary."

	Page 3495 of 802.11-2016
48. The method of claim 47, wherein the network forwarding decisions are guided to eliminate a dominant end-to-end latency effect of channel access delay at at least one hop.	When used by AT&T, and/or AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "R.3 QoS mapping guidelines for interworking with external networks R.3.1 General The EDCA and HCCA mechanism defined in 10.22 provide QoS control at the MAC layer. However, the QoS control parameters used by the EDCA and HCCA cannot match directly with other QoS control parameters of the interworked external networks, e.g., SSPN. For example, the SSPN could have different metrics for defining the QoS levels. Destination Network 1 (DN1) and DN2 can use DSCP values differently, in which case, STA1 and STA2 would require different QoS mapping information. Therefore, mapping from these external QoS control parameters to the QoS parameters of this standard is necessary." Page 3495 of 802.11-2016
49. The method of claim 19, wherein frequency channels are reused in order to increase spatial reuse across multiple basic service sets.	When used by AT&T, and/or AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "In order to advertise the availability of truncatable SP time for reuse through AP or PCP dynamic allocation, a non-AP and non-PCP STA shall transmit an CF-End frame to the AP or PCP. A STA is not required to truncate an SP if a portion of the SP is unused."

	Page 1517 of 802.11-2016
50. The method of claim 19, wherein RTS/CTS signaling is extended such that frequency channels are reused in order to increase spatial reuse across multiple basic service sets.	When used by AT&T, and/or AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "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
51. The method of claim 19, wherein RTS/CTS signaling is extended such that frequency channels are reused in order to increase spatial reuse across multiple basic service sets, to accommodate legacy access points.	When used by AT&T, and/or AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "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

52. A method for managing interference in a radio communications network, comprising the steps of:	When used by AT&T, and/or AT&T's agents or customers, the Accused Instrumentalities and Services perform a method for managing interference in a radio communications network. For example, as evidenced below, AT&T makes, uses, or sells 802.11ac-compliant access points (AP) (including, but not limited to Networking, Gateway, and Hotspot Devices, etc.) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method for managing interference in a radio communications network (e.g., a 802.11ac-compliant network).

AT&T Fiber® with AT&T All-Fi™

Powerful Wi-Fi you can rely on

Our next-generation Wi-Fi® delivers more coverage to more corners of your home than ever before.

Compatible gateway with Wi-Fi 6 subject to availability. Optimal performance requires Wi-Fi 6 enabled devices. Whole-home Wi-Fi connectivity may require AT&T Smart Wi-Fi® Extenders for an additional monthly charge.

AT&T All-Fi

A top-of-the-line Wi-Fi experience

Complete Wi-Fi coverage without dead zones

Up to 5,000 sq. ft. with mesh extender technology.

$10/mo. for up to five extenders. Number of extenders determined at the sole discretion of AT&T.

Speeds up to 5 GIG

Enjoy our fastest speeds, so you can enjoy more of what you love—on more devices.

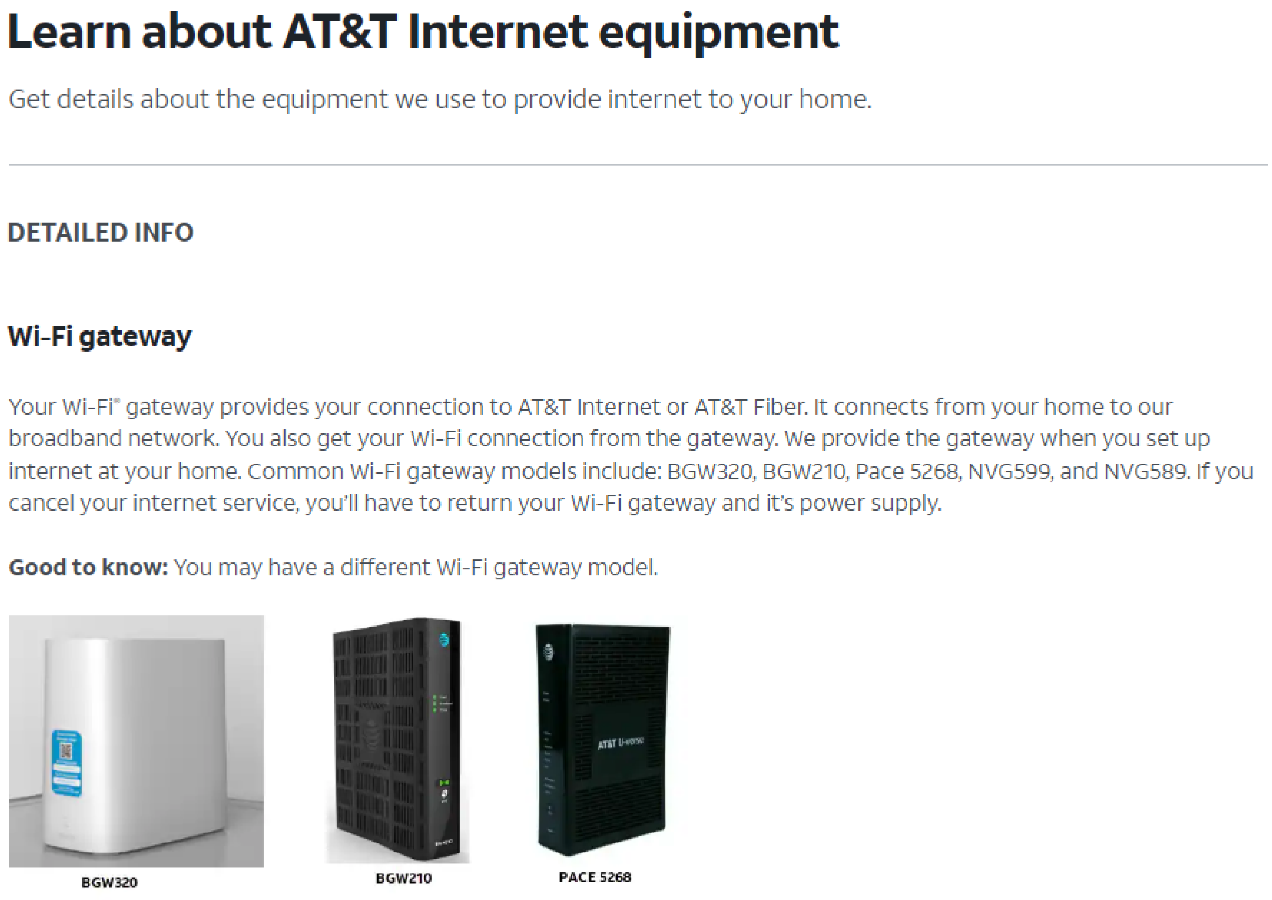
Ltd. avail/areas. Speeds based on wired connection Actual speeds may vary. Single device wired speed maximum 4.7Gbps. For more info, go to www.att.com/speed101.

AT&T ActiveArmor℠

24/7 security that helps block threats before they reach your devices.

Guards against known threats only. AT&T Smart Home Manager app required. Security features must be enabled.

	 **Easy 1-2-3 self-installation** If you qualify for an easy self-install kit, no technician is needed. ① **Unpack the AT&T Wi-Fi gateway** Plug the AT&T Wi-Fi gateway into an outlet. ② **Make the connection** Connect your AT&T Wi-Fi gateway to your computer using the provided cables. ③ **Sign in, register & get online** Follow the easy on-screen steps—and you're good to go. If you are unable to install the AT&T Wi-Fi Gateway, call 800.288.2020 to schedule a technician for a professional installation. https://www.att.com/wi-fi/



Learn about AT&T Internet equipment

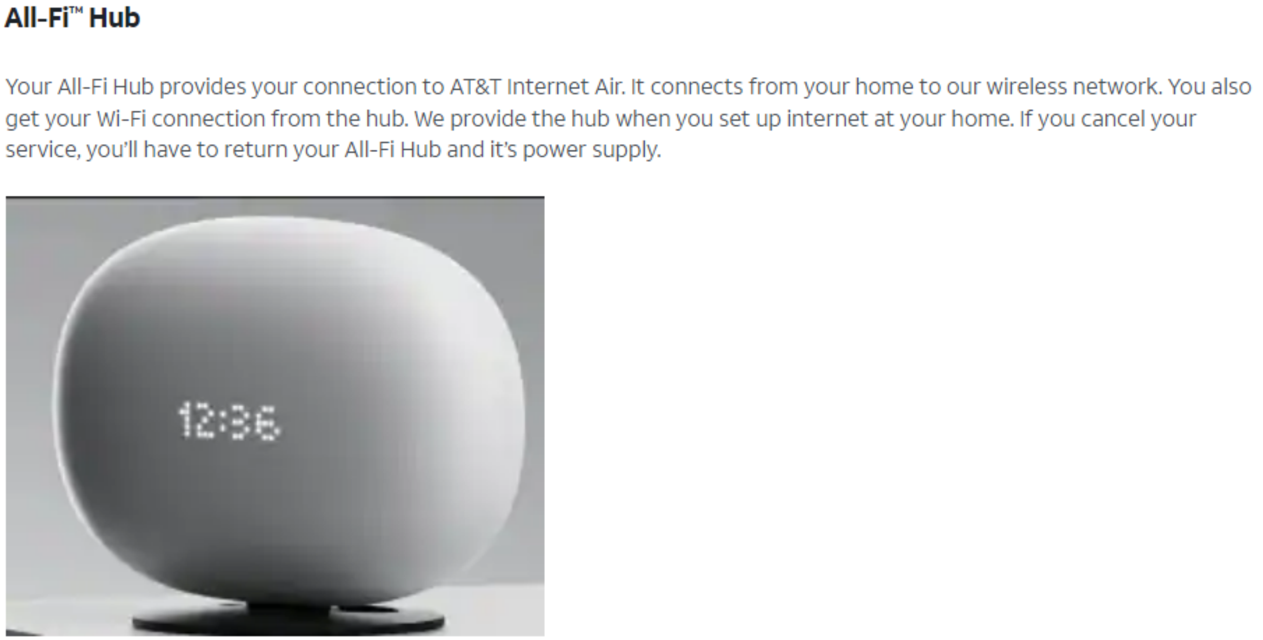
Get details about the equipment we use to provide internet to your home.

DETAILED INFO

Wi-Fi gateway

Your Wi-Fi® gateway provides your connection to AT&T Internet or AT&T Fiber. It connects from your home to our broadband network. You also get your Wi-Fi connection from the gateway. We provide the gateway when you set up internet at your home. Common Wi-Fi gateway models include: BGW320, BGW210, Pace 5268, NVG599, and NVG589. If you cancel your internet service, you'll have to return your Wi-Fi gateway and it's power supply.

Good to know: You may have a different Wi-Fi gateway model.

	 **All-Fi™ Hub** Your All-Fi Hub provides your connection to AT&T Internet Air. It connects from your home to our wireless network. You also get your Wi-Fi connection from the hub. We provide the hub when you set up internet at your home. If you cancel your service, you'll have to return your All-Fi Hub and it's power supply.

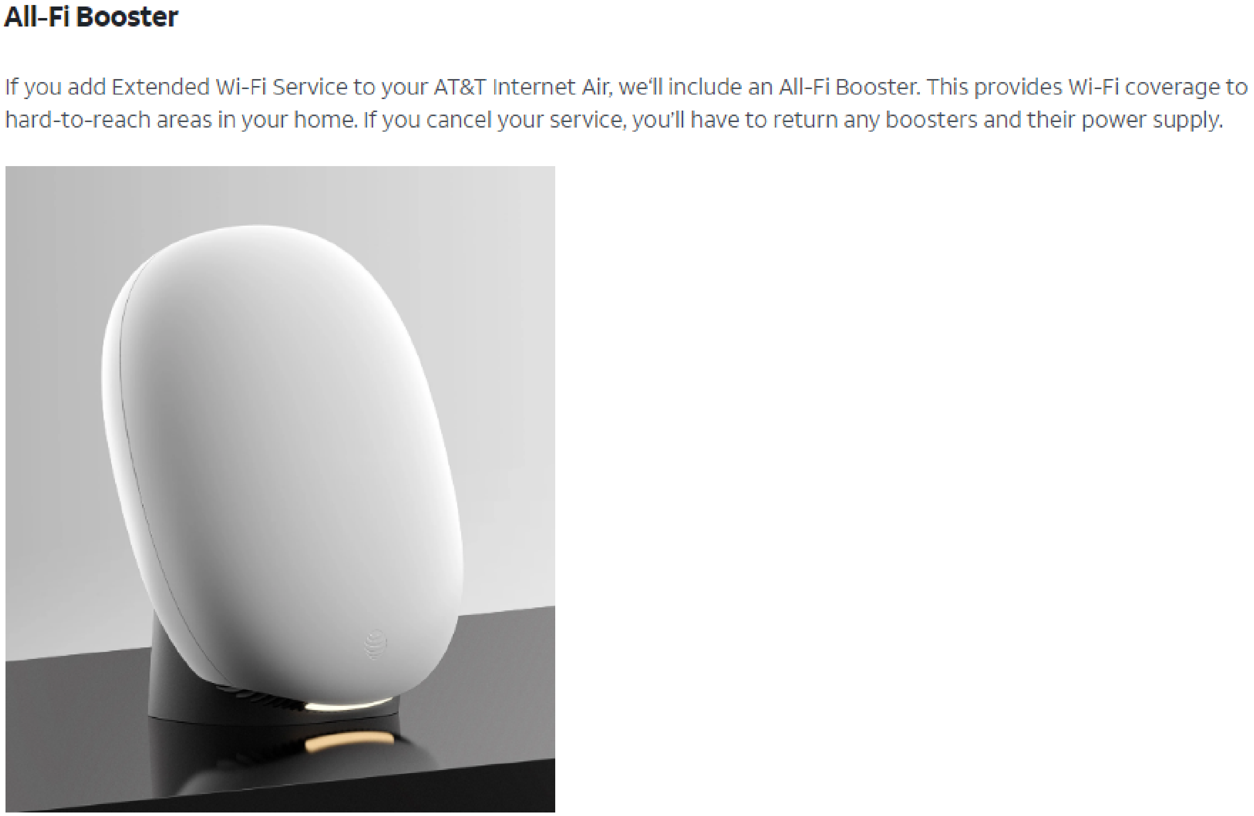
Wi-Fi extender

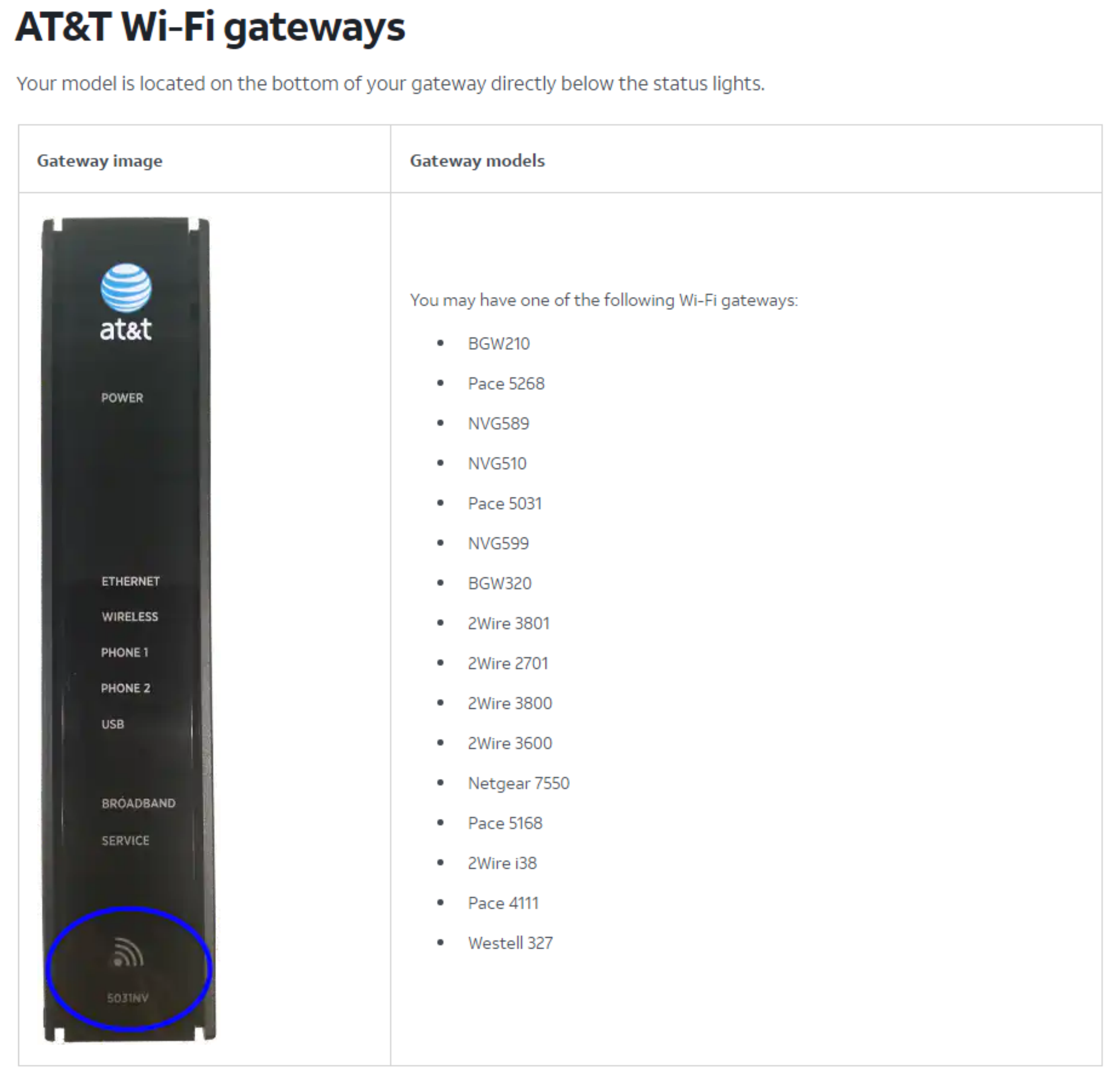
If you add Extended Wi-Fi Service to your internet plan, we'll include an AirTies 4971 Wi-Fi extender. This provides Wi-Fi coverage to hard-to-reach areas in your home. If you cancel your internet, you'll have to return any AirTies 4971 extenders and their power supply.

You may also have older models, including the AirTies 4920 or 4921. These were available for purchase and won't have to be returned.

AirTies 4971

AirTies 4921

	 **All-Fi Booster** If you add Extended Wi-Fi Service to your AT&T Internet Air, we'll include an All-Fi Booster. This provides Wi-Fi coverage to hard-to-reach areas in your home. If you cancel your service, you'll have to return any boosters and their power supply. https://www.att.com/support/article/u-verse-high-speed-internet/KM1011652/

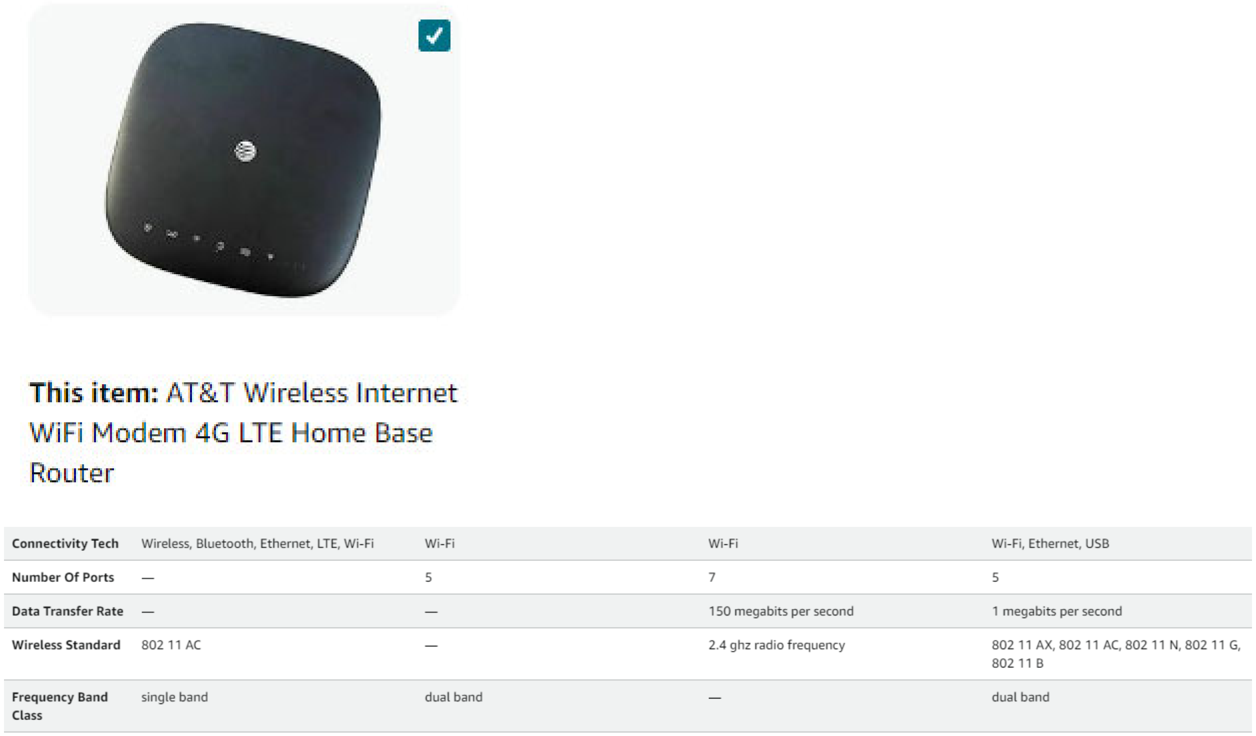


AT&T Wi-Fi gateways

Your model is located on the bottom of your gateway directly below the status lights.

Gateway image	Gateway models
	You may have one of the following Wi-Fi gateways: • BGW210 • Pace 5268 • NVG589 • NVG510 • Pace 5031 • NVG599 • BGW320 • 2Wire 3801 • 2Wire 2701 • 2Wire 3800 • 2Wire 3600 • Netgear 7550 • Pace 5168 • 2Wire i38 • Pace 4111 • Westell 327

https://www.att.com/support/article/dsl-high-speed/KM1047050/



This item: AT&T Wireless Internet WiFi Modem 4G LTE Home Base Router

Connectivity Tech	Wireless, Bluetooth, Ethernet, LTE, Wi-Fi	Wi-Fi	Wi-Fi	Wi-Fi, Ethernet, USB
Number Of Ports	—	5	7	5
Data Transfer Rate	—	—	150 megabits per second	1 megabits per second
Wireless Standard	802 11 AC	—	2.4 ghz radio frequency	802 11 AX, 802 11 AC, 802 11 N, 802 11 G, 802 11 B
Frequency Band Class	single band	dual band	—	dual band

https://www.amazon.com/Wireless-Internet-Hotspot-Antenna-AT/dp/B075JB968D?source=ps-sl-shoppingads-lpcontext&ref_=fplfs&psc=1&smid=A24OVZW9214RO6

“AT&T All-Fi is complimentary to all AT&T Fiber customers, regardless of their fiber internet speed plan . . . Everyone with All-Fi gets the AT&T Wi-Fi Gateway” https://www.att.com/internet/what-is-all-fi/#storyoffer7; *see also* https://www.att.com/legal/terms.wiFiServices.html

“AT&T All-Fi Hub and All-Fi Booster are devices that . . . are actually related to AT&T’s wireless internet service—AT&T Internet Air—which allows Wi-Fi service through AT&T’s cellular network.” https://www.att.com/internet/what-is-all-fi/#storyoffer7

AT&T charges significant sum and invests significant resources to test and confirm 802.11 protocol compatibility within its networks, including up to or more than $50,000 per device. https://iotdevices.att.com/certified-devices.aspx; https://iotdevices.att.com/networkready.aspx; https://iotdevices.att.com/devices.aspx#:~:text=For%20chipset%2Dbased%20device%20designs,while%20ensuring%20ongoing%20network%20compatibility.

"AT&T's most recent generation of Wi-Fi equipment generally supports Wi-Fi 6 (IEEE 802.11ax) standard and is compatible with older Wi-Fi (IEEE 802.11 a/b/g/n/ac) standards . . . AT&T reserves the right to manage remotely any equiprement used to access any Internet Servic e, whether that equipment is connected via a wired or wireless connection . . . Access to AT&T's nationwide network of Wi-Fi Hot Spots may be available to use as part of the Service . . . ." https://www.att.com/legal/terms.consumerserviceagreement.html

"AT&T provides a router and management for as little as $1 a day." https://www.business.att.com/products/att-dedicated-internet.html

"AT&T provides Wi-Fi access at more than 18,000 hot spots in 42 countries globally (including company-owned and roaming locations)." https://www.att.com/gen/general?pid=7462

"Get unlimited access at more than 30,000 AT&T Wi-Fi Hot Spots nationwide." https://www.att.com/plans/tethering/

"Nationwide Wi-Fi Hotspot Service. AT&T's mass market Wi-Fi broadband internet access service is designed to provide customers with the highest speed available from the network at any given point in time, subject to the many different factors discussed above that can affect network performance. AT&T's Wi-Fi services generally support the IEEE 802.11n/ac standard . . . ." https://about.att.com/sites/broadband/performance#:~:text=Nationwide%20Wi%2DFi%20Hotspot%20Service,access%20services%2C%20please%20click%20here.

"These Terms of Service & Acceptable Use Policy (the "Terms") govern your use of the AT&T Wi-Fi Services ("Service") provided to you through premises operators pursuant to contracts with

	AT&T or delivered to you directly by AT&T. . . The Service is provided by AT&T Wi-Fi Services, an affiliate of AT&T Corp. (“AT&T”). In order to provide the Service to Customers, AT&T contracts with owners and operators of popular establishments and businesses who purchase the Service to provide it to their employees, patrons, and invited guests at specific sites or locations (Locations). AT&T also offers the Service for the benefit of AT&T Mobility, AT&T DSL and U-verse subscribers for use in select public venues and for certain events, for example, in a city park or performance concert (“AT&T Hot Zones”) . . . The Service is designed to provide you with the highest speed available from the network at any given point in time, subject to the many different factors discussed above that can affect network performance. The Service generally supports the IEEE 802.11n/ac standard . . . .” https://www.att.com/legal/terms.wiFiServices.html “AT&T Business Wi-Fi helps you deliver a connected full-service experience. Our highly secure solution delivers a fully-integrated, managed Wi-Fi service that connects and protects your business and consumers . . . Professional and self-installation options are available, based on your needs. Select from three flexible management options for equipment and services. If you prefer a capex model, you can purchase the equipment, and AT&T will manage it at a reduced monthly fee per access point . . . AT&T is a preeminent provider of Wi-Fi services, delivering highly reliable and scalable connectivity, **with 24/7 support for both your end users and your employees. We can handle a variety of deployment types and support a wide array of applications. We’ll take care of everything from network design to installation.** Get the high-quality service you want, from a company you trust. AT&T..” https://www.business.att.com/content/dam/attbusiness/briefs/att-business-wi-fi-product-brief.pdf “Use AT&T Wi-Fi Hot Spots to connect your mobile device or laptop to high-speed internet. You can find them in public places like coffee shops, airports, and restaurants. They’re available nationwide . . . Your device automatically connects to our Wi-Fi network when you’re at an AT&T Wi-Fi Hot Spot location.” https://www.att.com/support/article/wireless/KM1103818/ “Enjoy a fully managed Wi-Fi service with a robust Day 0, 1, and 2 support model. From site design to professional installation to ongoing care, we have you covered . . . Choose which equipment option will best suit your needs (Cisco Meraki, Aruba, or Mist). Then decide whether you would like AT&T to professionally install the equipment or you would like to self-install . .

.No matter which equipment option you choose, all come with Wi-Fi 6 compatible devices. . . . AT&T offers a robust support model with Day 0, 1, and 2 support available. AT&T offers professional services to conduct site surveys, design networks, install equipment, and provide ongoing care and maintenance.” https://www.business.att.com/products/business-wifi.html

“AT&T Wireless LAN Service - WLAN is an extension of MLAN that includes IEEE 802.11 compliant wireless LAN controllers, Wi-Fi access points and their communication with compatible edge devices. WLAN requires that the Customer’s wired LAN also be under AT&T management. AT&T provides design, implementation and remote in band monitoring and management of a Customer's Wi-Fi LAN infrastructure from one of AT&T's Management centers.”
https://serviceguidenew.att.com/sg_CustomPreviewer?attachmentId=00PPV00000Iw3842AB

“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 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.” 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. An RTS/CTS exchange by VHT STAs also performs fast collision inference on the secondary 20 MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel and helps the VHT STA transmitting the RTS to determine the available bandwidth at the responder.

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

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

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

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

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

BSSBasicRateSet parameter of the SelectedBSS parameter of the MLME-JOIN.request primitive; see 6.3.4.2.4 and 6.3.11.2.4.

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

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

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

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

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

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

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

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"**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." 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;	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services 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, AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method that includes receiving at a first node (e.g. first STA) in the radio communications network an instruction [e.g. "Clear to Send" (CTS) instruction 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. "**<u>primary 20 MHz channel</u>**: 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. **<u>primary 40 MHz channel</u>**: 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). **<u>primary 80 MHz channel</u>**: In a 160 MHz or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 80 MHz channel that is used to transmit 80 MHz physical layer (PHY) protocol data units (PPDUs).

	primary access category (AC): The access category (AC) associated with the enhanced distributed channel access function (EDCAF) that gains channel access. . . . **secondary 20 MHz channel**: In a 40 MHz very high throughput (VHT) basic service set (BSS), the 20 MHz channel adjacent to the primary 20 MHz channel that together form the 40 MHz channel of the 40 MHz VHT BSS. In an 80 MHz VHT BSS, the 20 MHz channel adjacent to the primary 20 MHz channel that together form the primary 40 MHz channel of the 80 MHz VHT BSS. In a 160 MHz or 80+80 MHz VHT BSS, the 20 MHz channel adjacent to the primary 20 MHz channel that together form the primary 40 MHz channel of the 160 MHz or 80+80 MHz VHT BSS. In a VHT BSS, the secondary 20 MHz channel is also the secondary channel. **secondary 40 MHz channel**: In an 80 MHz very high throughput (VHT) basic service set (BSS), the 40 MHz channel adjacent to the primary 40 MHz channel that together form the 80 MHz channel of the 80 MHz VHT BSS. In a 160 or 80+80 MHz VHT BSS, the 40 MHz channel adjacent to the primary 40 MHz channel that together form the primary 80 MHz channel. **secondary 80 MHz channel**: In a 160 MHz or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 80 MHz channel not including the primary 20 MHz channel, that together with the primary 80 MHz channel forms the 160 MHz or 80+80 MHz channel of the 160 MHz or 80+80 MHz VHT BSS. **secondary access category (AC)**: An access category (AC) that is not associated with the enhanced distributed channel access function (EDCAF) that gains channel access. NOTE—Traffic associated with a secondary AC can be included in a multi-user (MU) physical layer (PHY) protocol data unit (MU PPDU) that includes traffic associated with the primary AC. There could be multiple secondary ACs at a given time.” 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.
- 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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“**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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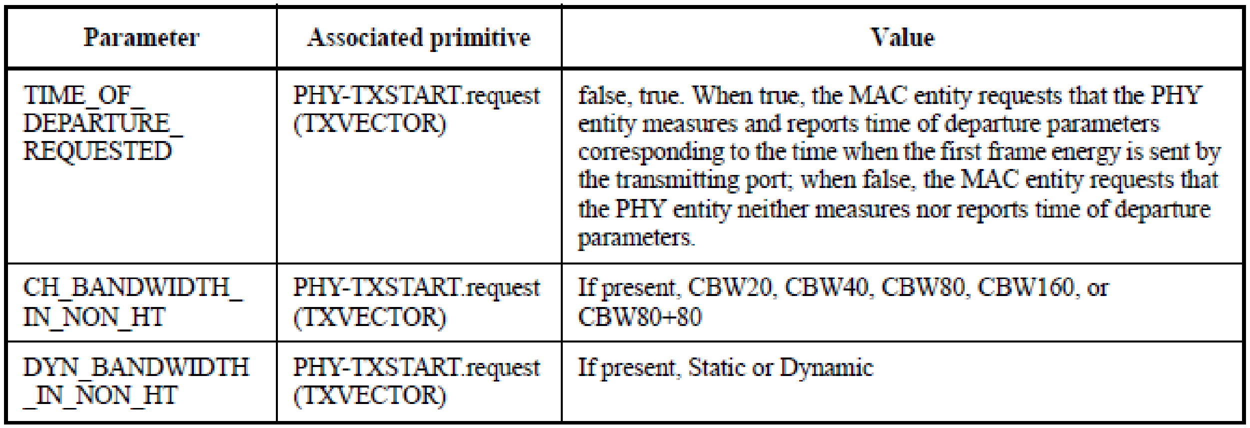
"17.2.2.1 General

. . .

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

. . .

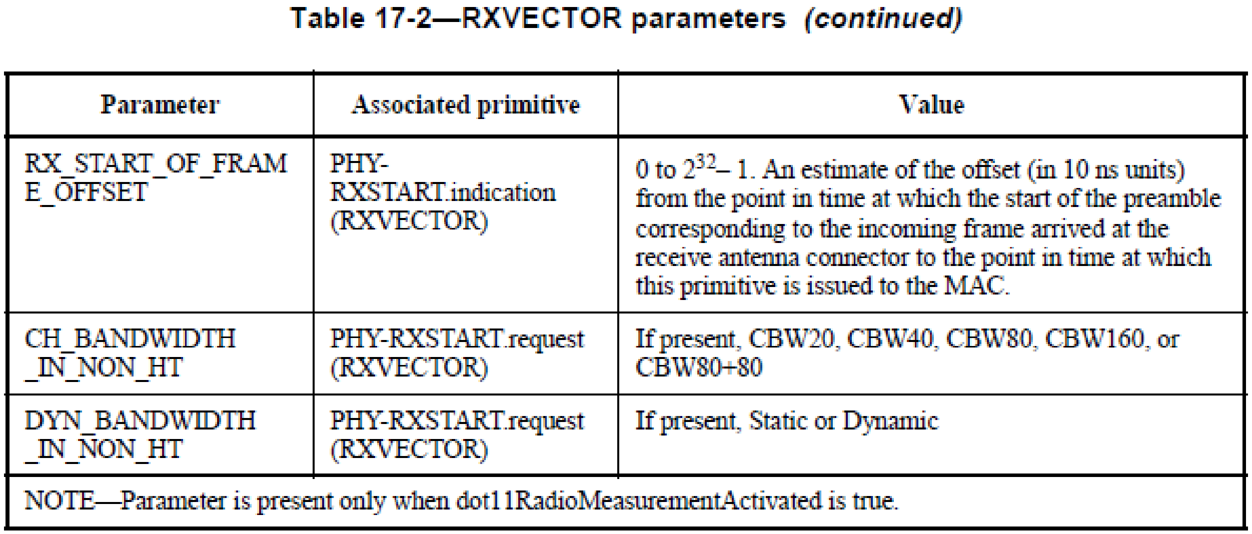

Table 17-2—RXVECTOR parameters *(continued)*

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).” Pages 2281-2282 of 802.11-2016

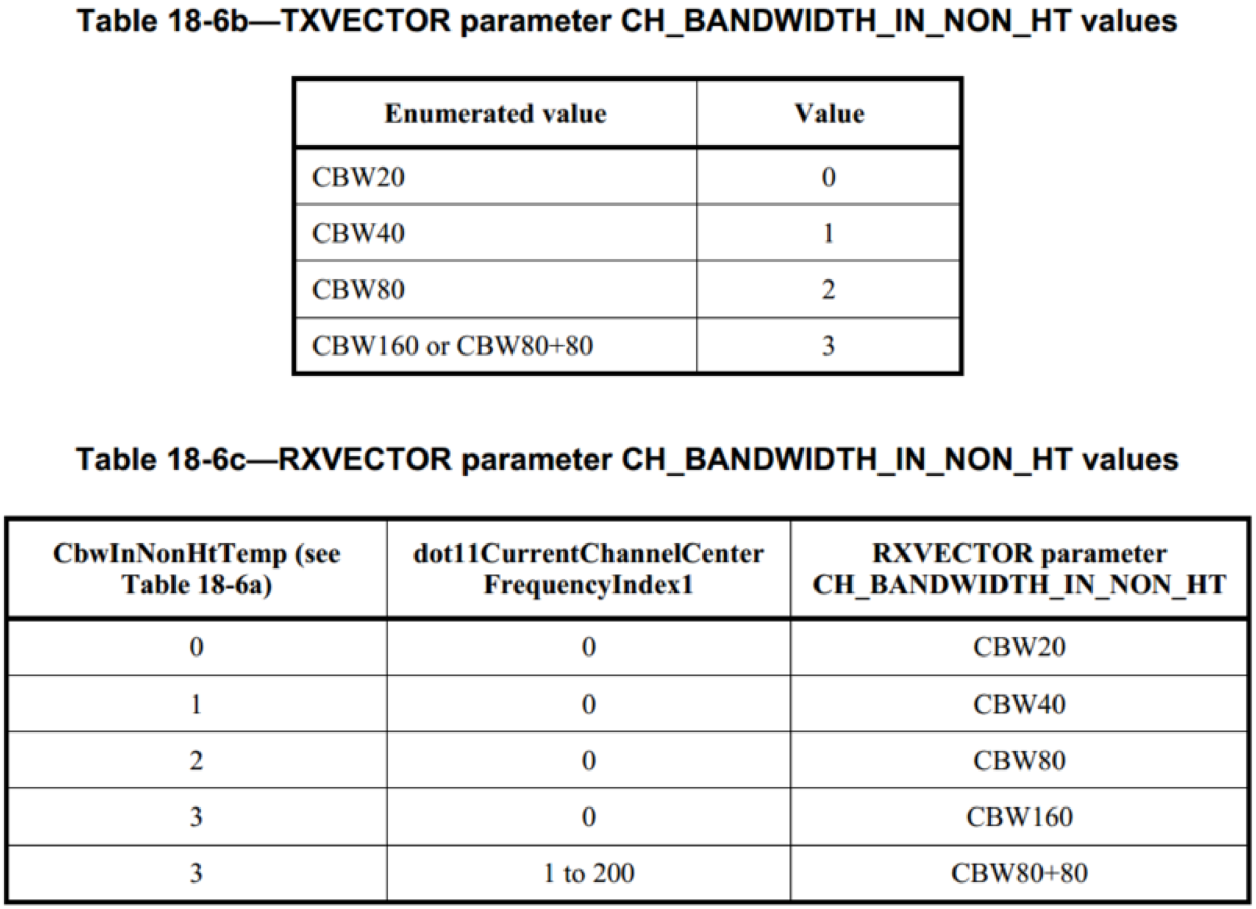

Table 18-6b—TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

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

Table 18-6c—RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

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

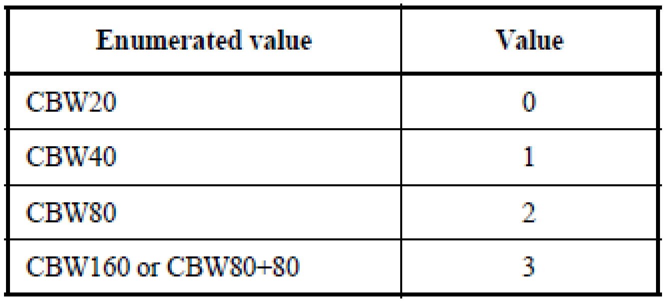

Table 17-8—TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

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

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

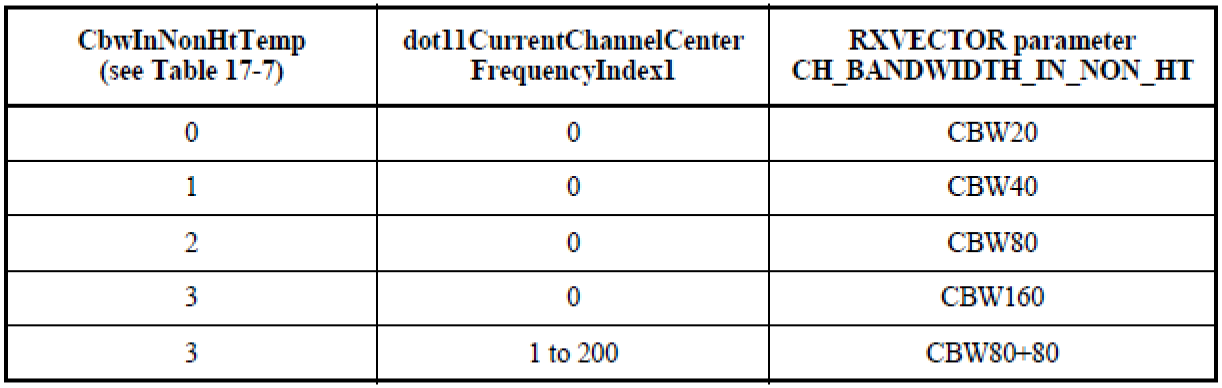

Table 17-9—RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

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

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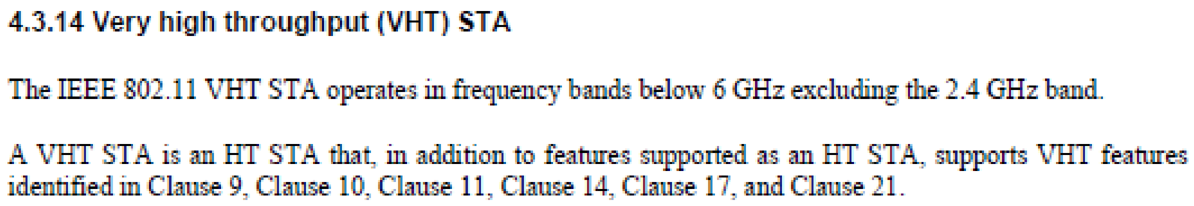
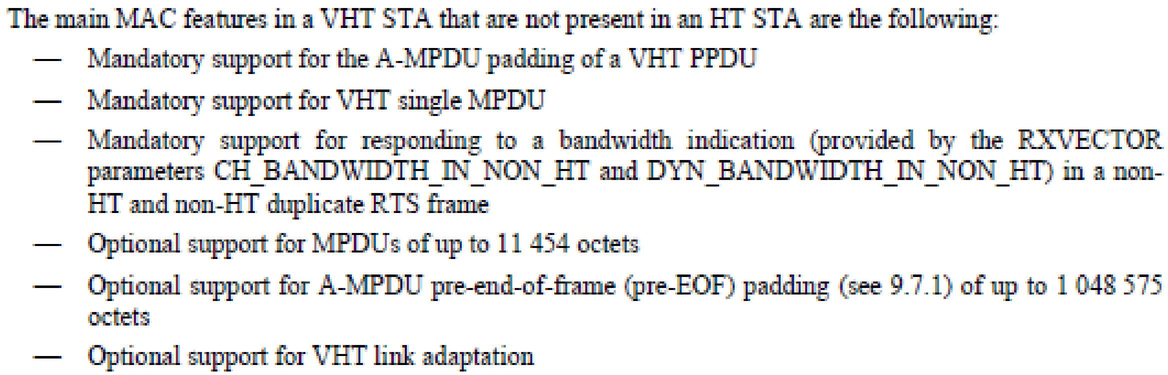


4.3.14 Very high throughput (VHT) STA

The IEEE 802.11 VHT STA operates in frequency bands below 6 GHz excluding the 2.4 GHz band.

A VHT STA is an HT STA that, in addition to features supported as an HT STA, supports VHT features identified in Clause 9, Clause 10, Clause 11, Clause 14, Clause 17, and Clause 21.

. . .



The main MAC features in a VHT STA that are not present in an HT STA are the following:

- Mandatory support for the A-MPDU padding of a VHT PPDU
- Mandatory support for VHT single MPDU
- Mandatory support for responding to a bandwidth indication (provided by the RXVECTOR parameters CH_BANDWIDTH_IN_NON_HT and DYN_BANDWIDTH_IN_NON_HT) in a non-HT and non-HT duplicate RTS frame
- Optional support for MPDUs of up to 11 454 octets
- Optional support for A-MPDU pre-end-of-frame (pre-EOF) padding (see 9.7.1) of up to 1 048 575 octets
- Optional support for VHT link adaptation

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9.3.1.2 RTS frame format

The frame format for the RTS frame is as defined in Figure 9-20.

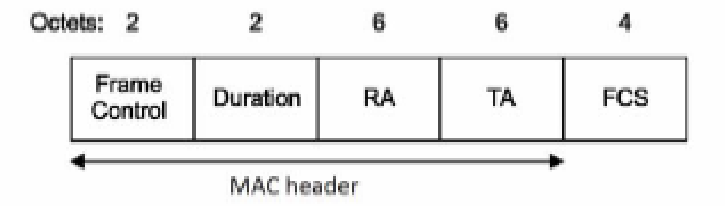
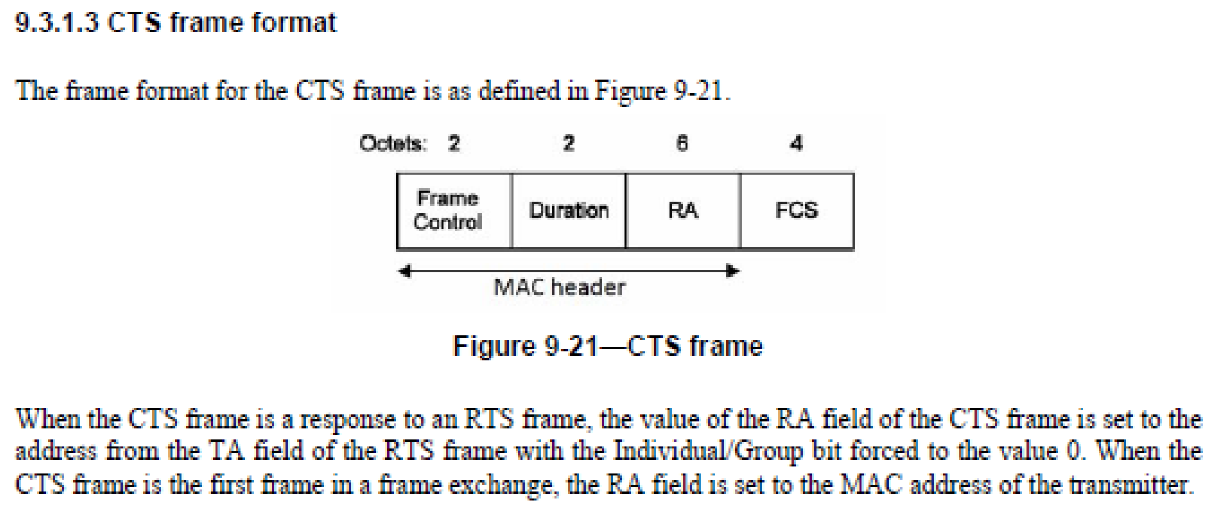


Figure 9-20—RTS frame

The RA field value of the RTS frame is the address of the STA, on the WM, that is the intended immediate recipient of the pending individually addressed Data, Management, or Control frame.

The TA field value is the address of the STA transmitting the RTS frame or the bandwidth signaling TA of the STA transmitting the RTS frame. In an RTS frame transmitted by a VHT STA in a non-HT or non-HT duplicate format and where the scrambling sequence carries the TXVECTOR parameters CH_BANDWIDTH_IN_NON_HT and DYN_BANDWIDTH_IN_NON_HT (see 10.3.2.6), the TA field is a bandwidth signaling TA.



9.3.1.3 CTS frame format

The frame format for the CTS frame is as defined in Figure 9-21.

Figure 9-21—CTS frame

When the CTS frame is a response to an RTS frame, the value of the RA field of the CTS frame is set to the address from the TA field of the RTS frame with the Individual/Group bit forced to the value 0. When the CTS frame is the first frame in a frame exchange, the RA field is set to the MAC address of the transmitter.

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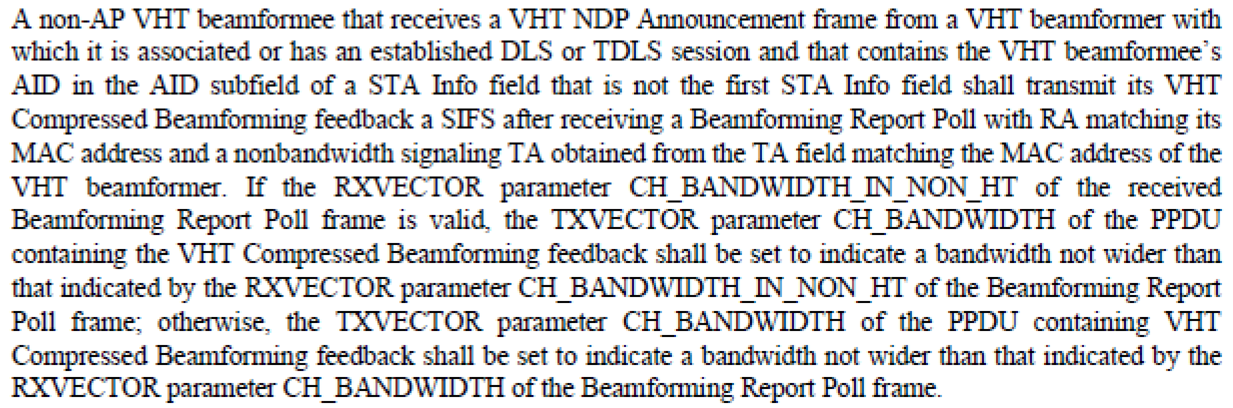
10.34.5.2 Rules for VHT sounding protocol sequences



A non-AP VHT beamformee that receives a VHT NDP Announcement frame from a VHT beamformer with which it is associated or has an established DLS or TDLS session and that contains the VHT beamformee's AID in the AID subfield of a STA Info field that is not the first STA Info field shall transmit its VHT Compressed Beamforming feedback a SIFS after receiving a Beamforming Report Poll with RA matching its MAC address and a nonbandwidth signaling TA obtained from the TA field matching the MAC address of the VHT beamformer. If the RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT of the received Beamforming Report Poll frame is valid, the TXVECTOR parameter CH_BANDWIDTH of the PPDU containing the VHT Compressed Beamforming feedback shall be set to indicate a bandwidth not wider than that indicated by the RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT of the Beamforming Report Poll frame; otherwise, the TXVECTOR parameter CH_BANDWIDTH of the PPDU containing VHT Compressed Beamforming feedback shall be set to indicate a bandwidth not wider than that indicated by the RXVECTOR parameter CH_BANDWIDTH of the Beamforming Report Poll frame.

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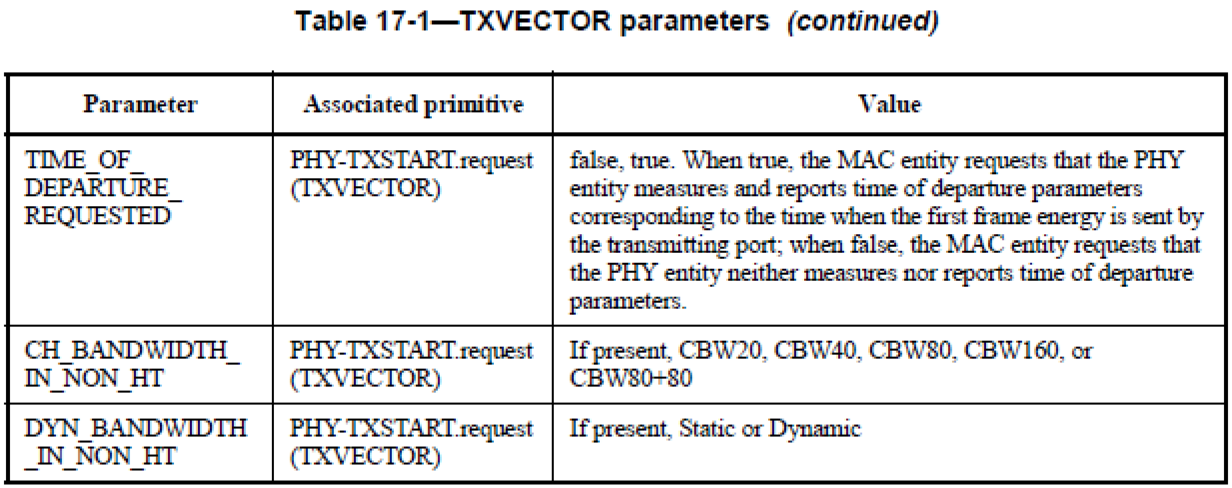
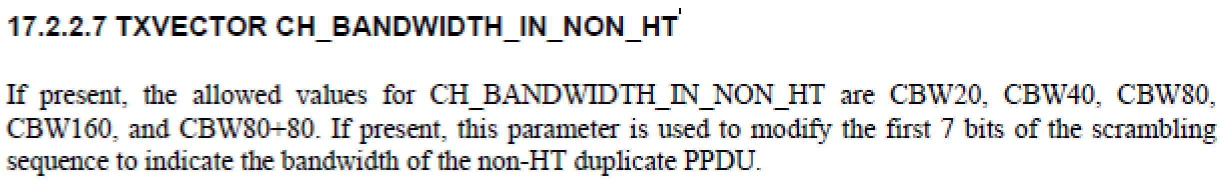


Table 17-1—TXVECTOR parameters *(continued)*

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



17.2.2.7 TXVECTOR 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, this parameter is used to modify the first 7 bits of the scrambling sequence to indicate the bandwidth of the non-HT duplicate PPDU.

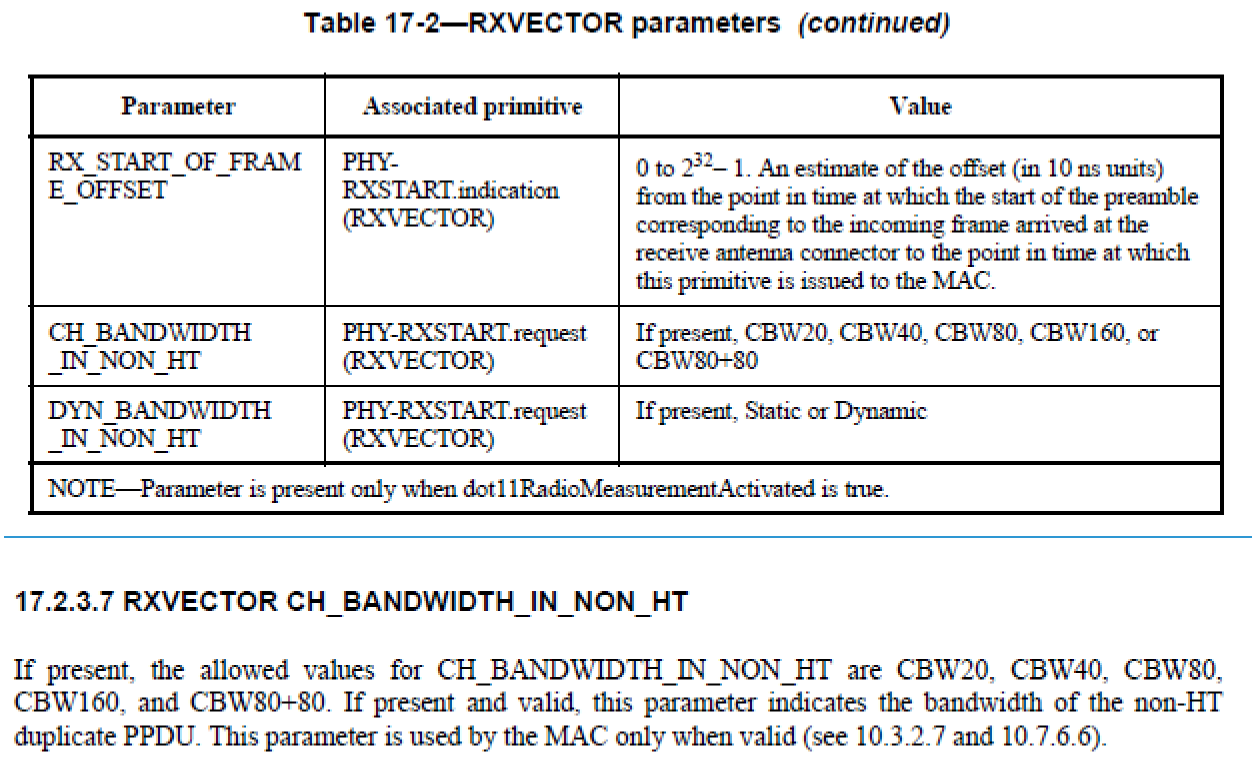


Table 17-2—RXVECTOR parameters *(continued)*

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).

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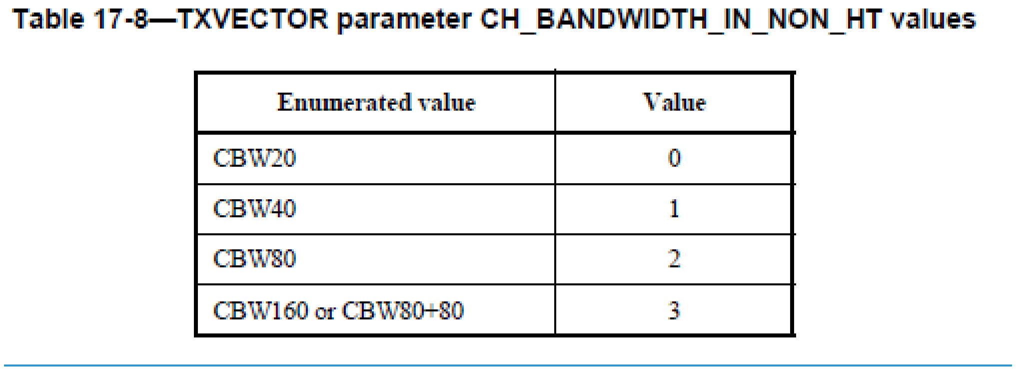

Table 17-8—TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

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

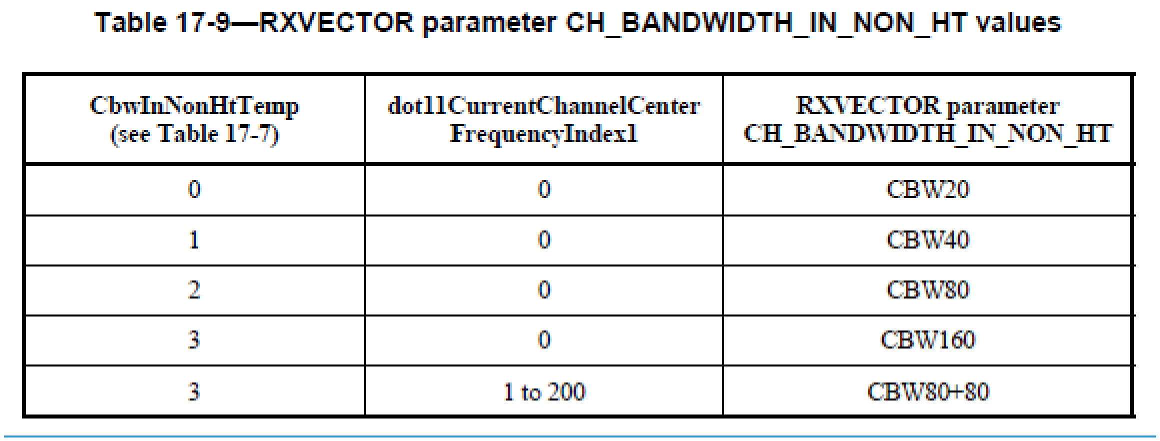

Table 17-9—RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

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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	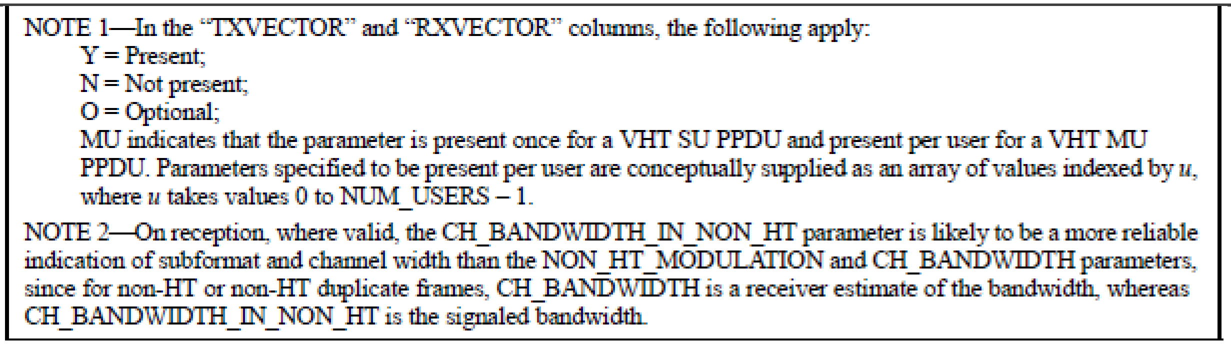 NOTE 1—In the "TXVECTOR" and "RXVECTOR" columns, the following apply: Y = Present; N = Not present; O = Optional; MU indicates that the parameter is present once for a VHT SU PPDU and present per user for a VHT MU PPDU. Parameters specified to be present per user are conceptually supplied as an array of values indexed by *u*, where *u* takes values 0 to NUM_USERS – 1. NOTE 2—On reception, where valid, the CH_BANDWIDTH_IN_NON_HT parameter is likely to be a more reliable indication of subformat and channel width than the NON_HT_MODULATION and CH_BANDWIDTH parameters, since for non-HT or non-HT duplicate frames, CH_BANDWIDTH is a receiver estimate of the bandwidth, whereas CH_BANDWIDTH_IN_NON_HT is the signaled bandwidth. Page 2633 of 802.11-2016
filtering a transmission signal to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided;	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services 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 AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents or customers, require performance of a method that includes filtering a transmission signal (e.g. via a mask PPDU and resulting scrambling, and/or another filtering that results in power (that was used or could be used) being removed, etc.) to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided (e.g. based on the CTS instruction 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.

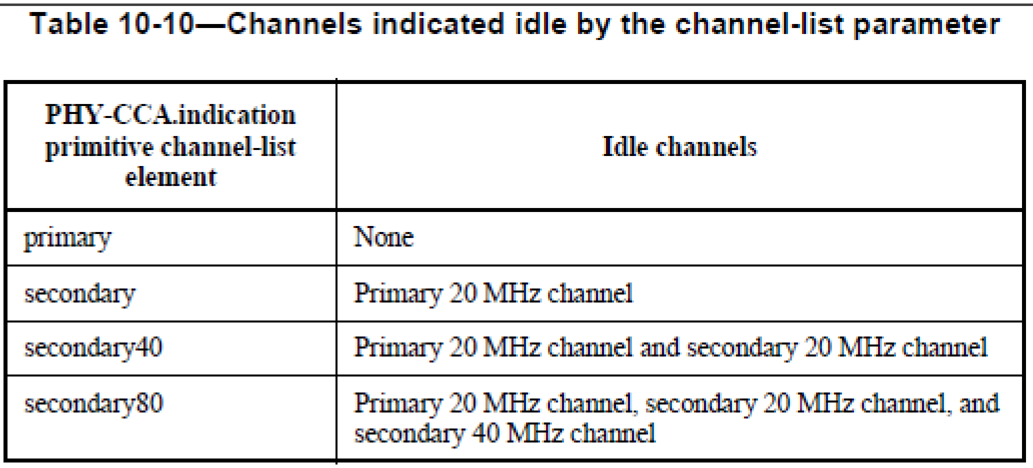

Table 10-10—Channels indicated idle by the channel-list parameter

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:

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

Replace Figure 18-7 with the following:

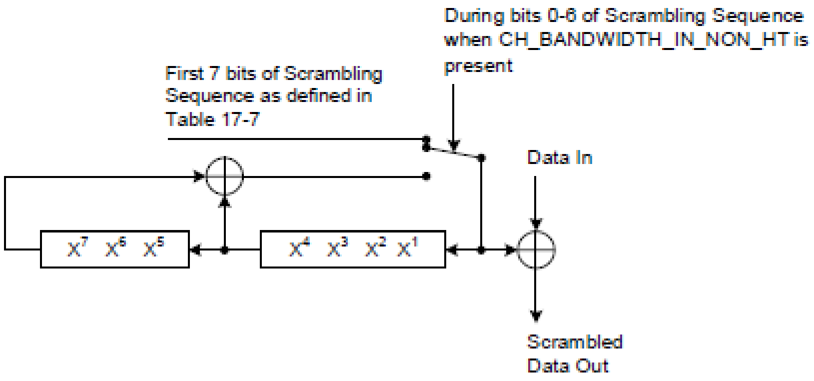

Figure 17-7—Data scrambler

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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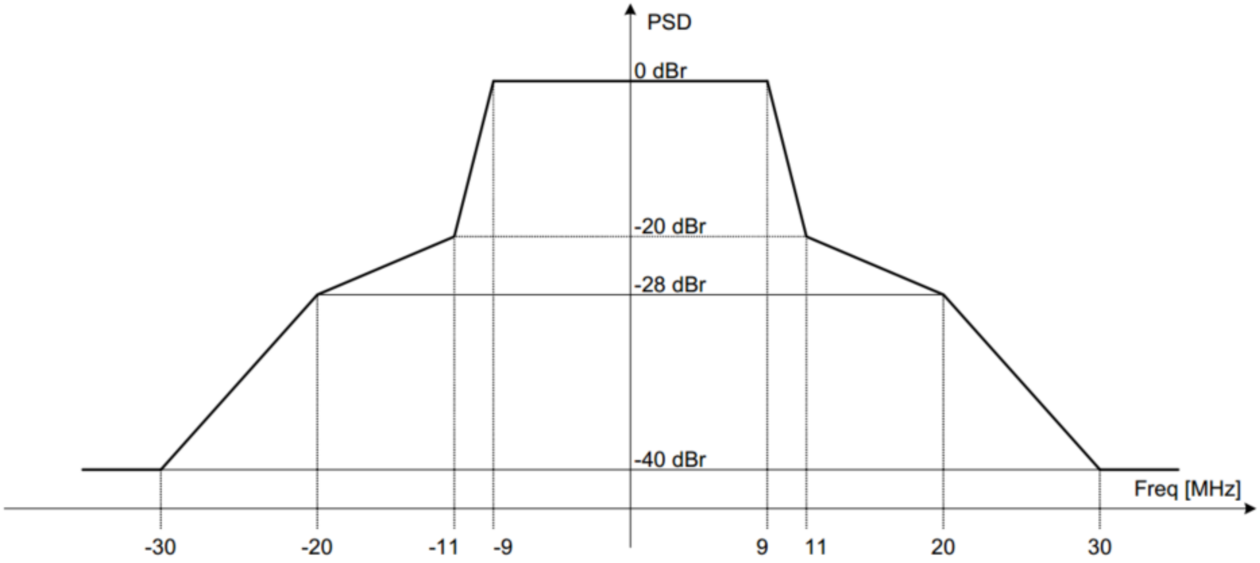
“**21.3.17 VHT transmit specification**

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 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
transmitting the filtered transmission signal to the second node;	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the step of transmitting the filtered transmission signal to the second node.

For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T (e.g., employees conducting regular business activities, installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's customers, 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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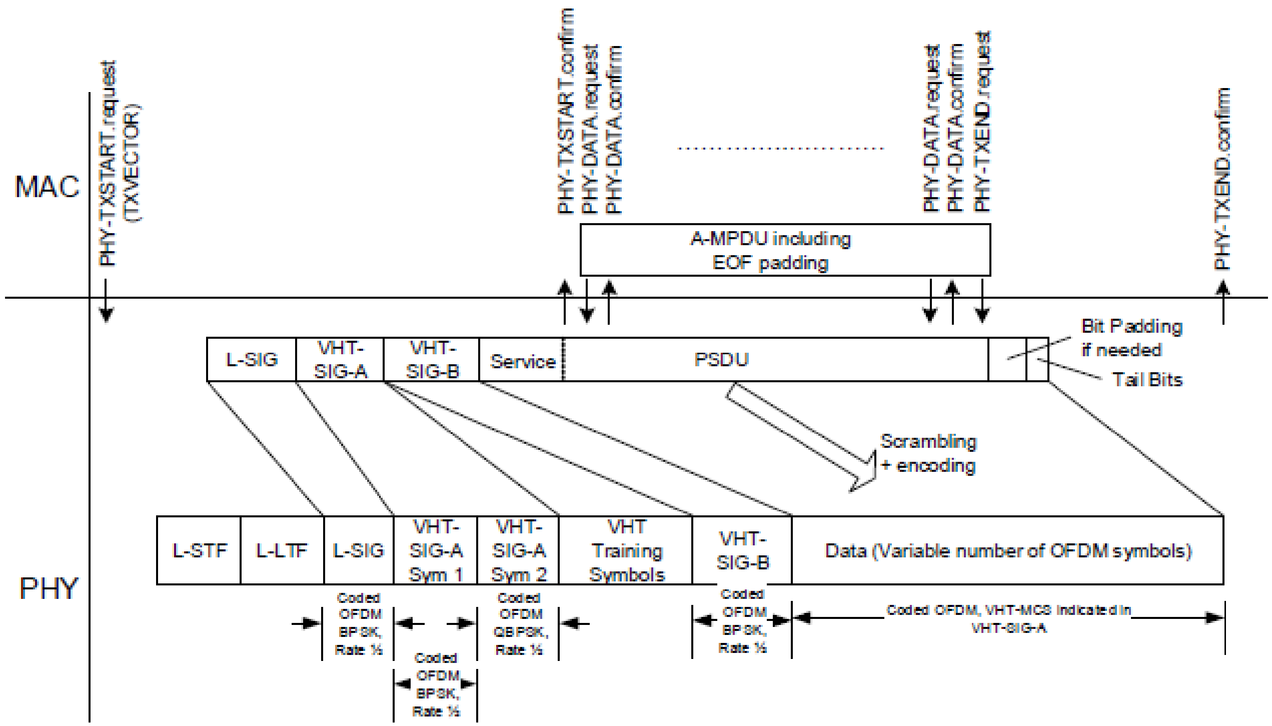

NOTE—This procedure does not describe the operation of optional features, such as MU-MIMO, LDPC or STBC.

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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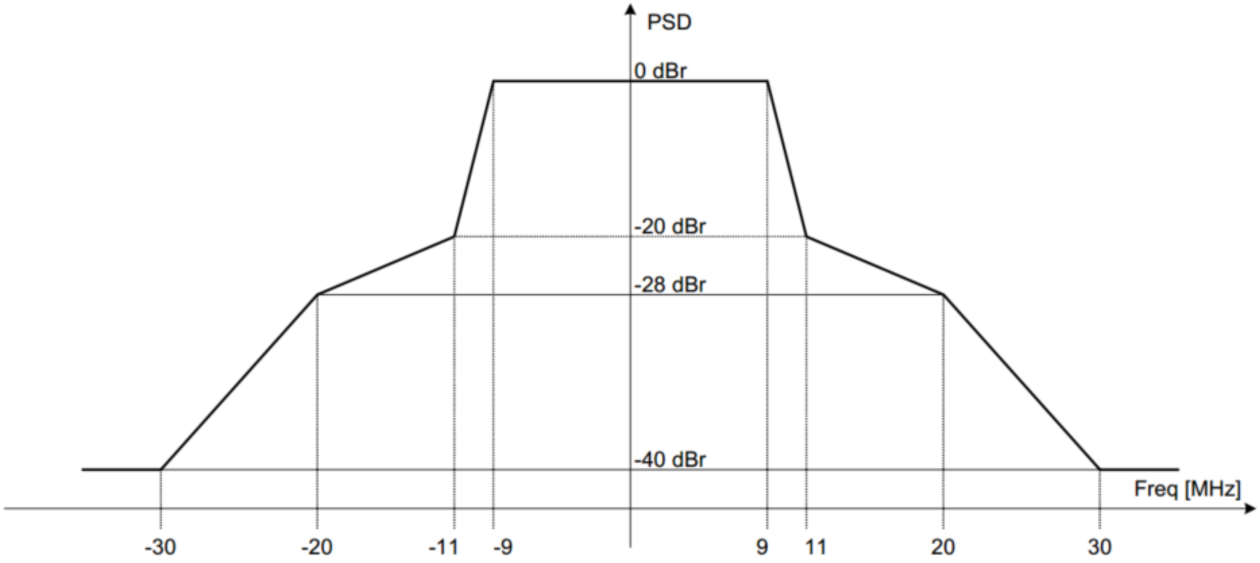
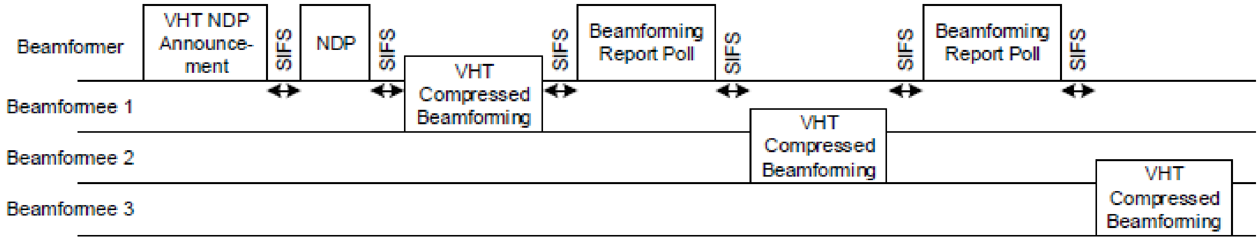
“21.3.17 VHT transmit specification

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.

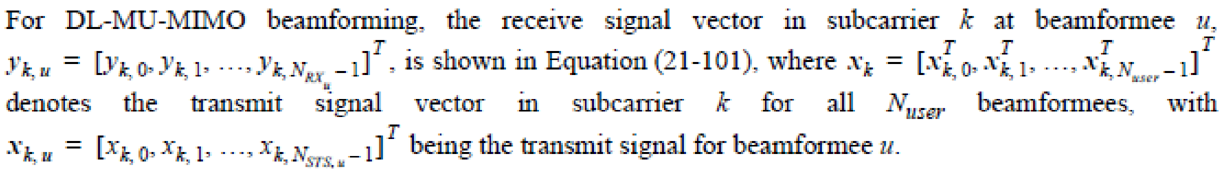
For a 20 MHz mask PPDU of non-HT, HT or VHT format, the interim transmit spectral mask shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth of 18 MHz, –20 dBr at 11 MHz frequency offset, –28 dBr at 20 MHz frequency offset, and –40 dBr at 30 MHz frequency offset and 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
wherein the instruction includes a first instruction and the filtered transmission signal includes a	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the prior steps listed above, wherein the instruction includes a first instruction and the filtered transmission signal includes a filtered first transmission signal (e.g. a first one of multiple

filtered first transmission signal that is transmitted to the second node using a first power via an 802.11-based orthogonal frequency-division multiplexing (OFDM) protocol, and further comprising	disjoint subsets of space-time streams, or any other signal, intended for reception at a first one of different STAs, etc.) that is transmitted to the second node using a first power via an 802.11-based orthogonal frequency-division multiplexing (OFDM) protocol. - IEEE 802.11-2016: **21.3.11 SU-MIMO and DL-MU-MIMO Beamforming** and **21.3.11.1 General** specifies the steering matrix Q_k for DL-MU-MIMO, where k is one of the subcarriers, and Q_k is consisted of sub-matrices $Q_{k,u}$, each corresponding to one receiving STA u. - IEEE 802.11-2016: **21.3.11.2 Beamforming Feedback Matrix *V*** further specifies that $Q_{k,u}$ is dependent on the feedback matrix $V_{k,u}$ provided by each STA u, which is based on the actual channel measurement by each STA u. - IEEE 802.11-2016: Figure 10-53 (below) illustrates that each STA (beamformee) is getting a different polling packet, based on which the feedback matrix $V_{k,u}$ is measured and should be different from STA to STA. An example of the VHT sounding protocol with more than one VHT beamformee is shown in Figure 10-8.  **Figure 10-53—Example of the sounding protocol with more than one VHT beamformee** 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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}-1] \text{ x } x_k + n$$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions
N_{RXu} x 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 $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,N_{user}}$-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 $u = 0, 1, \ldots, N_{user}$ -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
receiving at the first node in the radio communications network a second instruction transmitted from a third node in the radio communications network to	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the step of receiving at the first node in the radio communications network a second instruction transmitted from a third node in the radio communications network to avoid using a different plurality of frequencies to transmit to the third node.

avoid using a different plurality of frequencies to transmit to the third node;	**<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): “**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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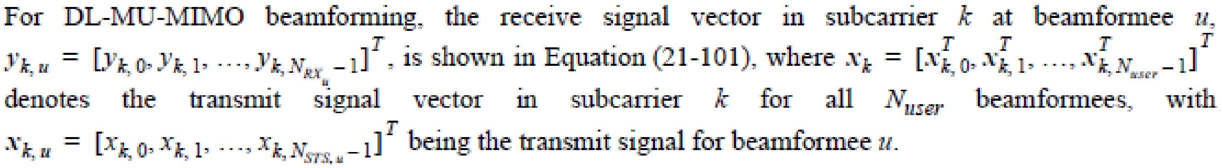
filtering a second transmission signal to remove power from the second transmission signal at each frequency in the different plurality of frequencies to be avoided; and	When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the step of filtering a second transmission signal to remove power from the second transmission signal at each frequency in the different plurality of frequencies to be avoided. **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 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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u. $Y_{k,u} = H_{k,u} \mathrm{x} [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1] \mathrm{x}\ x_k + n$ where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions
N_{RXu} x 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 $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}-1]$ 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 $u = 0, 1, \ldots, N_{user} -1$. 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)."

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"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 a second power via the 802.11-based OFDM protocol and simultaneously with the filtered first transmission signal, the filtered second transmission signal to the third node.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the step of transmitting, using a second power via the 802.11-based OFDM protocol and simultaneously with the filtered first transmission signal, the filtered second transmission signal to the third node. **<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): • IEEE 802.11-2016: **<u>21.3.11 SU-MIMO and DL-MU-MIMO Beamforming</u>** 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.

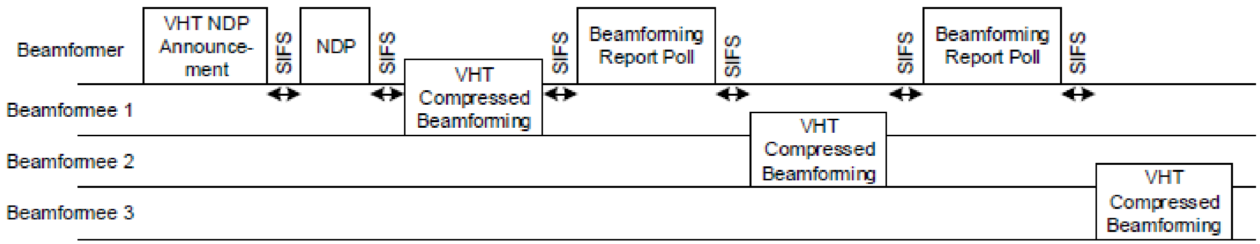

Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

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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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \times [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}-1] \times x_k + n$$

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 $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}-1]$ 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 $u = 0, 1, \ldots, N_{user} -1$. 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)."

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"**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."

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MU-MIMO technology further changed the rules of wireless engagement, enabling an AP or router to use its separate spatial streams to talk to multiple endpoints or users concurrently.

MIMO. Both the transmitting device and the receiving client(s) can send and receive multiple streams using multiple antennas. Alternatively, the transmitting device has multiple antennas that it uses to simultaneously transmit to multiple clients, some or all of which have only one receiving antenna each.
https://www.techtarget.com/searchnetworking/feature/5-things-to-know-about-MU-MIMO-technology-in-Wi-Fi-networks

"Wi-Fi 6 has five key technologies . . . Multi-user multiple-input, multiple-output (MU-MIMO) allows more data to be transferred at once, enabling an access point to handle a larger number of concurrent users. This contributes to the efficiency of the spectrum and massive device connectivity." https://www.business.att.com/content/dam/attbusiness/briefs/att-will-5g-replace-wifi-general-business-brief.pdf

"Enjoy a fully managed Wi-Fi service with a robust Day 0, 1, and 2 support model. From site design to professional installation to ongoing care, we have you covered . . . Choose which equipment option will best suit your needs (Cisco Meraki, Aruba, or Mist). Then decide whether you would like AT&T to professionally install the equipment or you would like to self-install . .

	.No matter which equipment option you choose, all come with Wi-Fi 6 compatible devices. . . . AT&T offers a robust support model with Day 0, 1, and 2 support available. AT&T offers professional services to conduct site surveys, design networks, install equipment, and provide ongoing care and maintenance." https://www.business.att.com/products/business-wifi.html
53. A method for managing interference in a radio communications network, comprising the steps of:	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform a method for managing interference in a radio communications network. For example, as evidenced below, AT&T makes, uses, or sells 802.11ac-compliant access points (AP) (including, but not limited to Networking, Gateway, and Hotspot Devices, etc.) which, when operated by AT&T and/or AT&T's agents or customers, require performance of a method for managing interference in a radio communications network (e.g., a 802.11ac-compliant network).

AT&T Fiber® with AT&T All-Fi™

Powerful Wi-Fi you can rely on

Our next-generation Wi-Fi® delivers more coverage to more corners of your home than ever before.

Compatible gateway with Wi-Fi 6 subject to availability. Optimal performance requires Wi-Fi 6 enabled devices. Whole-home Wi-Fi connectivity may require AT&T Smart Wi-Fi® Extenders for an additional monthly charge.

AT&T All-Fi

A top-of-the-line Wi-Fi experience

Complete Wi-Fi coverage without dead zones

Up to 5,000 sq. ft. with mesh extender technology.

$10/mo. for up to five extenders. Number of extenders determined at the sole discretion of AT&T.

Speeds up to 5 GIG

Enjoy our fastest speeds, so you can enjoy more of what you love—on more devices.

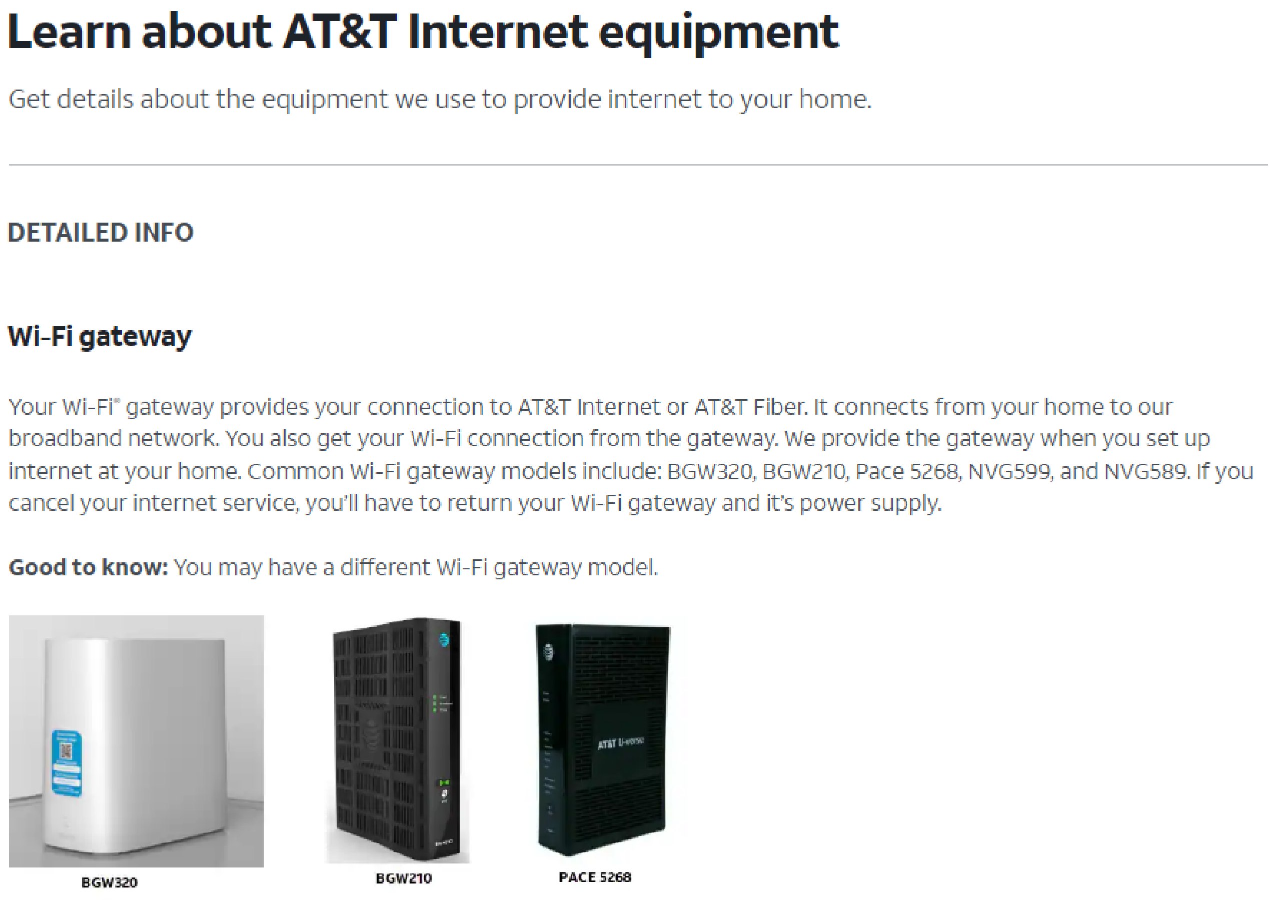
Ltd. avail/areas. Speeds based on wired connection Actual speeds may vary. Single device wired speed maximum 4.7Gbps. For more info, go to www.att.com/speed101.

AT&T ActiveArmor℠

24/7 security that helps block threats before they reach your devices.

Guards against known threats only. AT&T Smart Home Manager app required. Security features must be enabled.

	 **Easy 1-2-3 self-installation** If you qualify for an easy self-install kit, no technician is needed. ① **Unpack the AT&T Wi-Fi gateway** Plug the AT&T Wi-Fi gateway into an outlet. ② **Make the connection** Connect your AT&T Wi-Fi gateway to your computer using the provided cables. ③ **Sign in, register & get online** Follow the easy on-screen steps—and you're good to go. If you are unable to install the AT&T Wi-Fi Gateway, call 800.288.2020 to schedule a technician for a professional installation. https://www.att.com/wi-fi/



Learn about AT&T Internet equipment

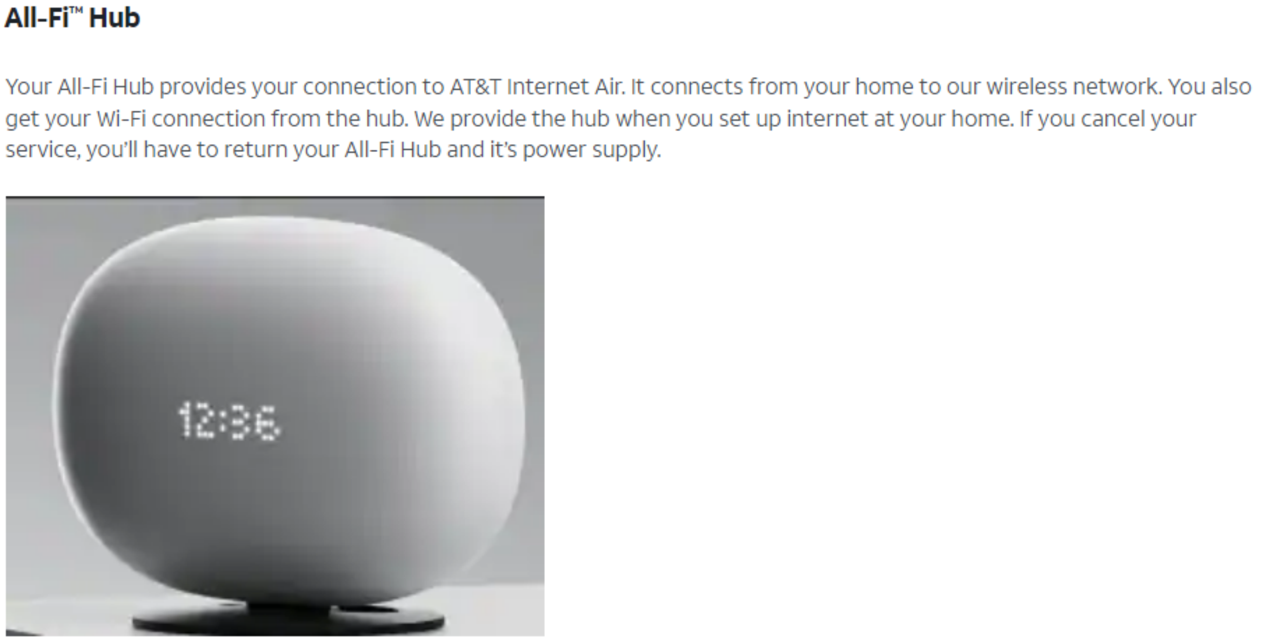
Get details about the equipment we use to provide internet to your home.

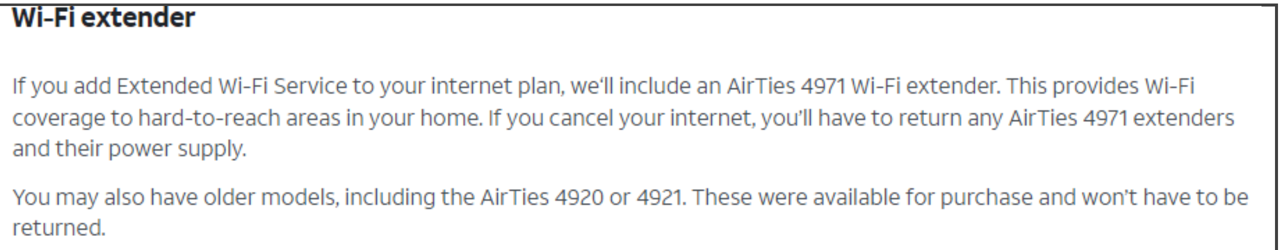
DETAILED INFO

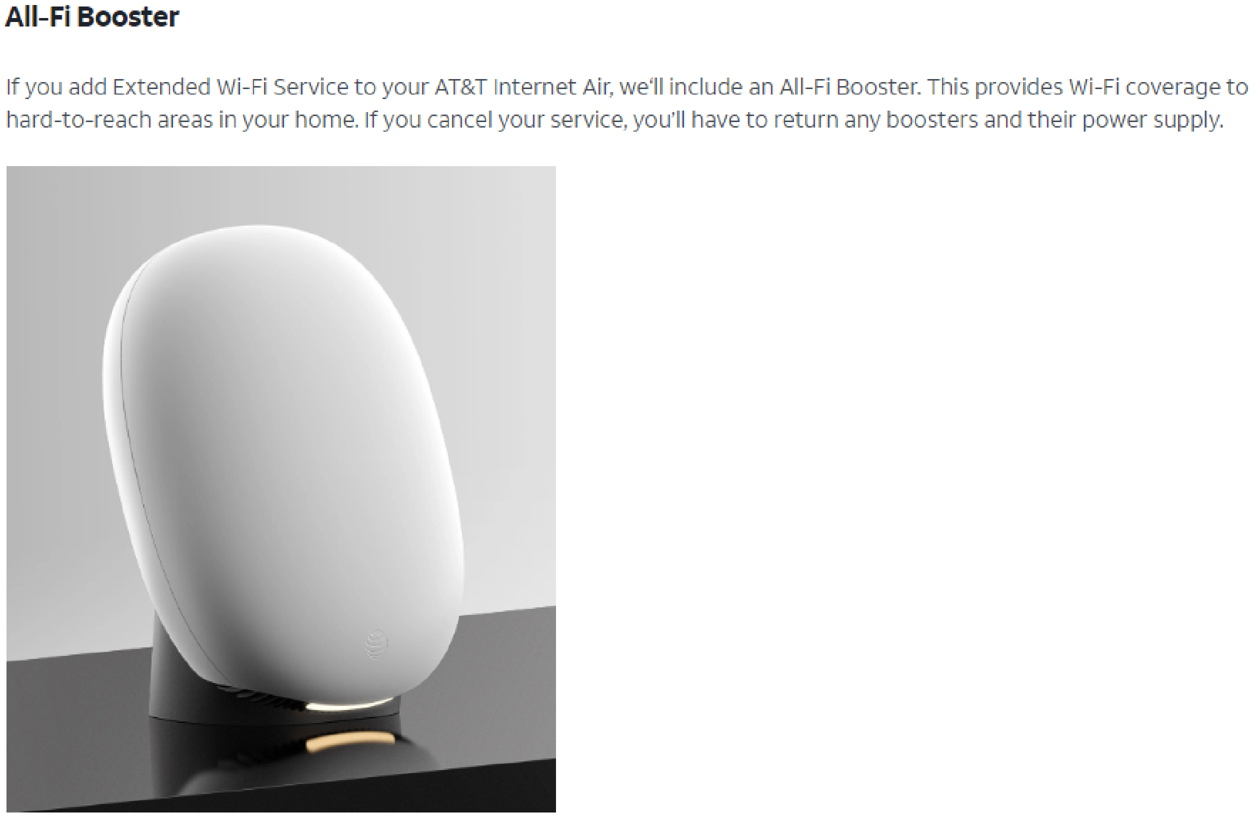
Wi-Fi gateway

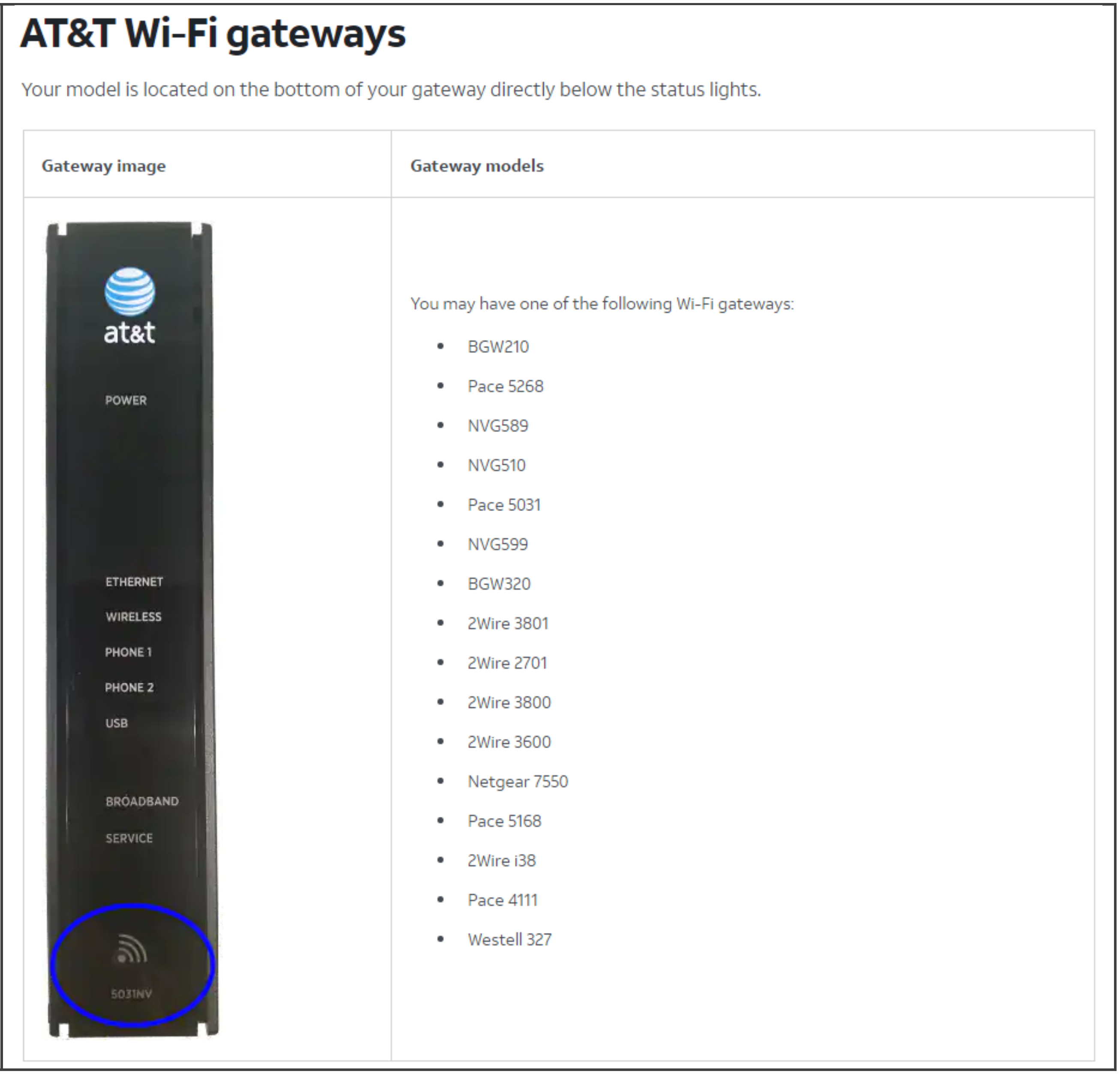
Your Wi-Fi® gateway provides your connection to AT&T Internet or AT&T Fiber. It connects from your home to our broadband network. You also get your Wi-Fi connection from the gateway. We provide the gateway when you set up internet at your home. Common Wi-Fi gateway models include: BGW320, BGW210, Pace 5268, NVG599, and NVG589. If you cancel your internet service, you'll have to return your Wi-Fi gateway and it's power supply.

Good to know: You may have a different Wi-Fi gateway model.

	 **All-Fi™ Hub** Your All-Fi Hub provides your connection to AT&T Internet Air. It connects from your home to our wireless network. You also get your Wi-Fi connection from the hub. We provide the hub when you set up internet at your home. If you cancel your service, you'll have to return your All-Fi Hub and it's power supply.

	 **Wi-Fi extender** If you add Extended Wi-Fi Service to your internet plan, we'll include an AirTies 4971 Wi-Fi extender. This provides Wi-Fi coverage to hard-to-reach areas in your home. If you cancel your internet, you'll have to return any AirTies 4971 extenders and their power supply. You may also have older models, including the AirTies 4920 or 4921. These were available for purchase and won't have to be returned.  **AirTies 4971**  **AirTies 4921**

	 **All-Fi Booster** If you add Extended Wi-Fi Service to your AT&T Internet Air, we'll include an All-Fi Booster. This provides Wi-Fi coverage to hard-to-reach areas in your home. If you cancel your service, you'll have to return any boosters and their power supply. https://www.att.com/support/article/u-verse-high-speed-internet/KM1011652/



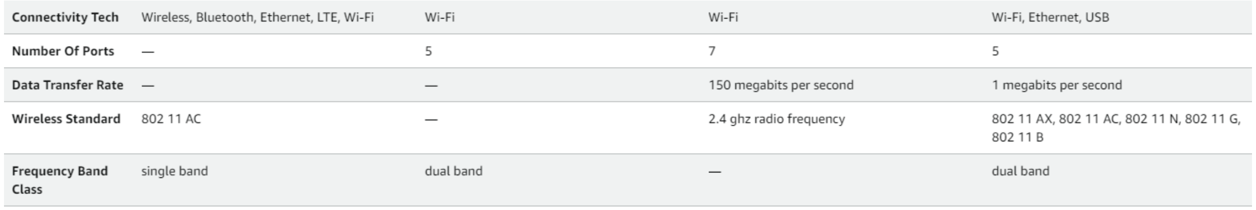
AT&T Wi-Fi gateways

Your model is located on the bottom of your gateway directly below the status lights.

Gateway image	Gateway models
	You may have one of the following Wi-Fi gateways: • BGW210 • Pace 5268 • NVG589 • NVG510 • Pace 5031 • NVG599 • BGW320 • 2Wire 3801 • 2Wire 2701 • 2Wire 3800 • 2Wire 3600 • Netgear 7550 • Pace 5168 • 2Wire i38 • Pace 4111 • Westell 327

https://www.att.com/support/article/dsl-high-speed/KM1047050/

This item: AT&T Wireless Internet WiFi Modem 4G LTE Home Base Router



Connectivity Tech	Wireless, Bluetooth, Ethernet, LTE, Wi-Fi	Wi-Fi	Wi-Fi	Wi-Fi, Ethernet, USB
Number Of Ports	—	5	7	5
Data Transfer Rate	—	—	150 megabits per second	1 megabits per second
Wireless Standard	802 11 AC	—	2.4 ghz radio frequency	802 11 AX, 802 11 AC, 802 11 N, 802 11 G, 802 11 B
Frequency Band Class	single band	dual band	—	dual band

https://www.amazon.com/Wireless-Internet-Hotspot-Antenna-AT/dp/B075JB968D?source=ps-sl-shoppingads-lpcontext&ref_=fplfs&psc=1&smid=A24OVZW9214RO6

"AT&T All-Fi is complimentary to all AT&T Fiber customers, regardless of their fiber internet speed plan . . . Everyone with All-Fi gets the AT&T Wi-Fi Gateway" https://www.att.com/internet/what-is-all-fi/#storyoffer7; *see also* https://www.att.com/legal/terms.wiFiServices.html

"AT&T All-Fi Hub and All-Fi Booster are devices that . . . are actually related to AT&T's wireless internet service—AT&T Internet Air—which allows Wi-Fi service through AT&T's cellular network." https://www.att.com/internet/what-is-all-fi/#storyoffer7

AT&T charges significant sum and invests significant resources to test and confirm 802.11 protocol compatibility within its networks, including up to or more than $50,000 per device. https://iotdevices.att.com/certified-devices.aspx; https://iotdevices.att.com/networkready.aspx; https://iotdevices.att.com/devices.aspx#:~:text=For%20chipset%2Dbased%20device%20designs,while%20ensuring%20ongoing%20network%20compatibility.

“AT&T’s most recent generation of Wi-Fi equipment generally supports Wi-Fi 6 (IEEE 802.11ax) standard and is compatible with older Wi-Fi (IEEE 802.11 a/b/g/n/ac) standards . . . AT&T reserves the right to manage remotely any equiprement used to access any Internet Servic e, whether that equipment is connected via a wired or wireless connection . . . Access to AT&T’s nationwide network of Wi-Fi Hot Spots may be available to use as part of the Service . . . .” https://www.att.com/legal/terms.consumerserviceagreement.html

“AT&T provides a router and management for as little as $1 a day.” https://www.business.att.com/products/att-dedicated-internet.html

“AT&T provides Wi-Fi access at more than 18,000 hot spots in 42 countries globally (including company-owned and roaming locations).” https://www.att.com/gen/general?pid=7462

“Get unlimited access at more than 30,000 AT&T Wi-Fi Hot Spots nationwide.” https://www.att.com/plans/tethering/

“Nationwide Wi-Fi Hotspot Service. AT&T's mass market Wi-Fi broadband internet access service is designed to provide customers with the highest speed available from the network at any given point in time, subject to the many different factors discussed above that can affect network performance. AT&T's Wi-Fi services generally support the IEEE 802.11n/ac standard . . . .” https://about.att.com/sites/broadband/performance#:~:text=Nationwide%20Wi%2DFi%20Hotspot%20Service,access%20services%2C%20please%20click%20here.

“These Terms of Service & Acceptable Use Policy (the “Terms”) govern your use of the AT&T Wi-Fi Services (“Service”) provided to you through premises operators pursuant to contracts with

	AT&T or delivered to you directly by AT&T. . . The Service is provided by AT&T Wi-Fi Services, an affiliate of AT&T Corp. (“AT&T”). In order to provide the Service to Customers, AT&T contracts with owners and operators of popular establishments and businesses who purchase the Service to provide it to their employees, patrons, and invited guests at specific sites or locations (Locations). AT&T also offers the Service for the benefit of AT&T Mobility, AT&T DSL and U-verse subscribers for use in select public venues and for certain events, for example, in a city park or performance concert (“AT&T Hot Zones”) . . . The Service is designed to provide you with the highest speed available from the network at any given point in time, subject to the many different factors discussed above that can affect network performance. The Service generally supports the IEEE 802.11n/ac standard . . . .” https://www.att.com/legal/terms.wiFiServices.html “AT&T Business Wi-Fi helps you deliver a connected full-service experience. Our highly secure solution delivers a fully-integrated, managed Wi-Fi service that connects and protects your business and consumers . . . Professional and self-installation options are available, based on your needs. Select from three flexible management options for equipment and services. If you prefer a capex model, you can purchase the equipment, and AT&T will manage it at a reduced monthly fee per access point . . . AT&T is a preeminent provider of Wi-Fi services, delivering highly reliable and scalable connectivity, **with 24/7 support for both your end users and your employees. We can handle a variety of deployment types and support a wide array of applications. We’ll take care of everything from network design to installation.** Get the high-quality service you want, from a company you trust. AT&T..” https://www.business.att.com/content/dam/attbusiness/briefs/att-business-wi-fi-product-brief.pdf “Use AT&T Wi-Fi Hot Spots to connect your mobile device or laptop to high-speed internet. You can find them in public places like coffee shops, airports, and restaurants. They’re available nationwide . . . Your device automatically connects to our Wi-Fi network when you’re at an AT&T Wi-Fi Hot Spot location.” https://www.att.com/support/article/wireless/KM1103818/ “Enjoy a fully managed Wi-Fi service with a robust Day 0, 1, and 2 support model. From site design to professional installation to ongoing care, we have you covered . . . Choose which equipment option will best suit your needs (Cisco Meraki, Aruba, or Mist). Then decide whether you would like AT&T to professionally install the equipment or you would like to self-install . .

	.No matter which equipment option you choose, all come with Wi-Fi 6 compatible devices. . . . AT&T offers a robust support model with Day 0, 1, and 2 support available. AT&T offers professional services to conduct site surveys, design networks, install equipment, and provide ongoing care and maintenance." https://www.business.att.com/products/business-wifi.html "AT&T Wireless LAN Service - WLAN is an extension of MLAN that includes IEEE 802.11 compliant wireless LAN controllers, Wi-Fi access points and their communication with compatible edge devices. WLAN requires that the Customer's wired LAN also be under AT&T management. AT&T provides design, implementation and remote in band monitoring and management of a Customer's Wi-Fi LAN infrastructure from one of AT&T's Management centers." https://serviceguidenew.att.com/sg_CustomPreviewer?attachmentId=00PPV00000Iw3842AB "AT&T offers a wide variety of AT&T Wi-Fi Services as defined herein. The following Services are available under this Service Guide: • AT&T Wi-Fi Connect Link Base Service (CLB) • AT&T Wi-Fi Connect Link Total Service (CLT) • AT&T Wi-Fi Connect Link Select Service (CLS) • AT&T Wi-Fi Small Site Service (AWSS) • AT&T Business Wi-Fi (formerly known as AT&T Wi-Fi Enterprise) (ABW)" https://serviceguidenew.att.com/sg_CustomPreviewer?attachmentId=00PPV00000Iw3JN2AZ "All AT&T Equipment and Customer Premises Equipment (CPE) that is part of the Wi-Fi Network may be referred to as "Equipment." Equipment may be installed by AT&T to deliver the Service. The Equipment can be either AT&T Equipment or Purchased Equipment. Equipment ownership for a particular Service or installation is specified herein or in an applicable Pricing Schedule. For AT&T Equipment, AT&T grants Customer a limited, non-exclusive, non-transferable license to use the Service during the Term of the Pricing Schedule. For Purchased Equipment, Customer will obtain by its purchase from AT&T a software license for certain third-party software needed for the operation of the Service." https://serviceguidenew.att.com/sg_CustomPreviewer?attachmentId=00PPV00000Iw3JN2AZ "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

	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." 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. An RTS/CTS exchange by VHT STAs also performs fast collision inference on the secondary 20 MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel and helps the VHT STA transmitting the RTS to determine the available bandwidth at the responder. Another advantage of the RTS/CTS mechanism occurs where multiple BSSs utilizing the same channel overlap. The medium reservation mechanism works across the BSS boundaries. The RTS/CTS mechanism might also improve operation in a typical situation in which all STAs are able to receive from the AP, but might not be able to receive from all other STAs in the BSA.

	Except for MPDUs transmitted via the GCR service, the RTS/CTS mechanism cannot be used for MPDUs with a group addressed immediate destination because there are multiple recipients for the RTS frame, and thus potentially multiple concurrent senders of the CTS frame in response. For MPDUs transmitted via the GCR service, an RTS frame may be used if it is directed to a STA within the GCR group (see 10.22.2.11.2 and 10.24.10). The RTS/CTS mechanism is not used for every Data frame transmission. Because the additional RTS and CTS frames add overhead inefficiency, the mechanism is not always justified, especially for short Data frames. The use of the RTS/CTS mechanism is under control of dot11RTSThreshold. This attribute may be set on a per-STA basis. This mechanism allows STAs to be configured to initiate RTS/CTS either always, never, or only on frames longer than a specified length. NOTE—A STA configured not to initiate the RTS/CTS mechanism updates its virtual CS mechanism with the duration information contained in a received RTS or CTS frame, and responds to an RTS frame addressed to it with a CTS frame if permitted by medium access rules. All non-DMG STAs that are members of a BSS are able to receive and transmit at all of the data rates in the BSSBasicRateSet parameter of the MLME-START.request primitive or BSSBasicRateSet parameter of the SelectedBSS parameter of the MLME-JOIN.request primitive; see 6.3.4.2.4 and 6.3.11.2.4. NOTE—A STA's operational rate set does not necessarily contain all the mandatory rates. However a STA has to be capable of receiving using a mandatory rate (as required by the rules in 10.7) even if it is not present in this set. All HT STAs that are members of a BSS are able to receive and transmit using all of the MCSs in the Basic HT-MCS Set field of the HT Operation parameter of the MLME-START.request primitive or Basic HT-MCS Set field of the HT Operation parameter of the SelectedBSS parameter of the MLME-JOIN.request primitive; see 6.3.4.2.4 and 6.3.11.2.4. All VHT STAs that are members of a BSS are able to receive and transmit using all of the <VHT-MCS, NSS> tuples in the basic VHT-MCS and NSS set (see 11.40.7) except as constrained by the rules of 10.7.12.

	All DMG STAs that are members of a BSS are able to receive and transmit using all of the MCSs in the OperationalRateSet parameter of the MLME-START.request primitive or OperationalRateSet parameter of the SelectedBSS parameter of the MLME-JOIN.request primitive; see 6.3.4.2.4 and 6.3.11.2.4. To support the proper operation of the RTS/CTS by non-DMG STAs, RTS/DMG CTS by DMG STAs, and the virtual CS mechanism, a non-DMG STA shall be able to interpret Control frames with the Subtype subfield equal to RTS or CTS, and a DMG STA shall be able to interpret Control frames with the Subtype subfield equal to RTS or DMG CTS. A Data frame sent under the DCF shall have the Type subfield set to Data and the Subtype subfield set to Data or Null. A STA receiving a frame with the Type subfield equal to Data shall not indicate the frame to the LLC when the Subtype subfield is equal to Null, but shall indicate the frame to the LLC when the Subtype subfield is equal to Data, even if the frame body contains zero octets. While in the awake state and operating under DCF but not transmitting, a DMG STA can configure its receive antenna to a quasi-omni pattern in order to receive frames transmitted by any STA that is covered by this antenna pattern.” Pages 1303-1305 of 802.11-2016 “**10.3.2.7 CTS and DMG CTS procedure** A STA that receives an RTS frame addressed to it considers the NAV in determining whether to respond with CTS, unless the NAV was set by a frame originating from the STA sending the RTS frame (see 10.22.2.2). In this subclause, “NAV indicates idle” means that the NAV count is 0 or that the NAV count is nonzero but the nonbandwidth signaling TA obtained from the TA field of the RTS frame matches the saved TXOP holder address.

A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a bandwidth signaling TA and that has the RXVECTOR parameter DYN_BANDWIDTH_IN_NON_HT equal to Static behaves as follows:

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

A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a bandwidth signaling TA and that has the RXVECTOR parameter DYN_BANDWIDTH_IN_NON_HT equal to Dynamic behaves as follows:

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

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

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

The RA field of the CTS frame shall be set to the nonbandwidth signaling TA obtained from the TA field of the RTS frame to which this CTS frame is a response. The Duration field in the CTS

	frame shall be the duration field from the received RTS frame, adjusted by subtraction of aSIFSTime and the number of microseconds required to transmit the CTS frame at a data rate determined by the rules in 10.7. After transmitting an RTS frame, the STA shall wait for a CTSTimeout interval with a value of aSIFSTime + aSlotTime + aRxPHYStartDelay. This interval begins when the MAC receives a PHY-TXEND.confirm primitive. If a PHY-RXSTART.indication primitive does not occur during the CTSTimeout interval, the STA shall conclude that the transmission of the RTS frame has failed, and this STA shall invoke its backoff procedure upon expiration of the CTSTimeout interval. If a PHY-RXSTART.indication primitive does occur during the CTSTimeout interval, the STA shall wait for the corresponding PHY-RXEND.indication primitive to determine whether the RTS frame transmission was successful. The recognition of a valid CTS frame sent by the recipient of the RTS frame, corresponding to this PHY-RXEND.indication primitive, shall be interpreted as successful response, permitting the frame exchange sequence to continue (see Annex G). The recognition of anything else, including any other valid frame, shall be interpreted as failure of the RTS frame transmission. In this instance, the STA shall invoke its backoff procedure at the PHY-RXEND.indication primitive and may process the received frame. A DMG STA follows the procedure defined in this subclause, except that it uses a DMG CTS frame instead of a CTS frame. A non-DMG STA does not transmit DMG CTS frames." 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;	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services 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, AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T and/or AT&T's agents or customers, 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.

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

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

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

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"**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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"**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**

. . .

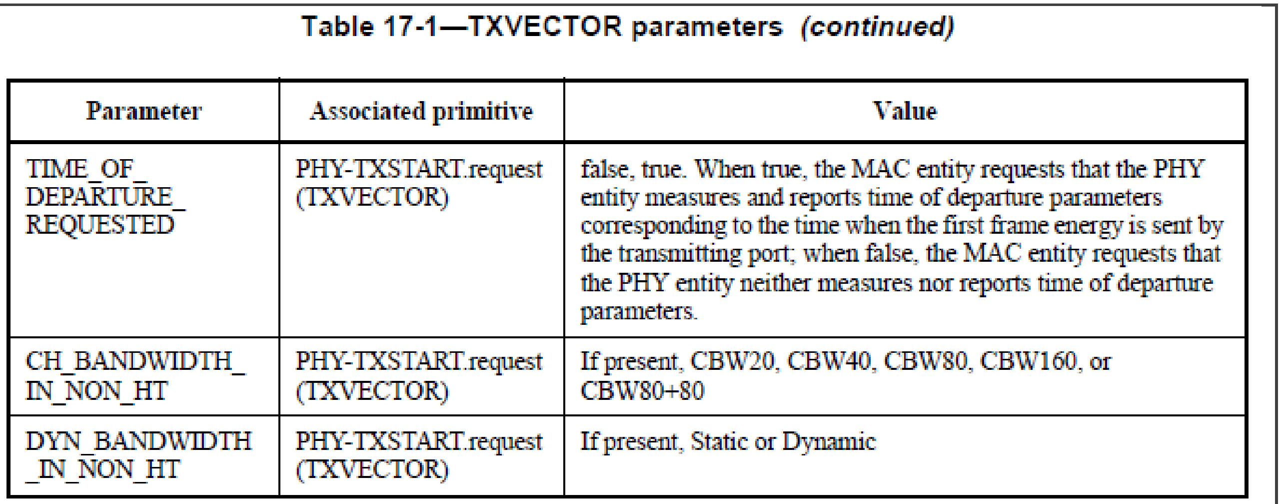

Table 17-1—TXVECTOR parameters *(continued)*

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

. . .

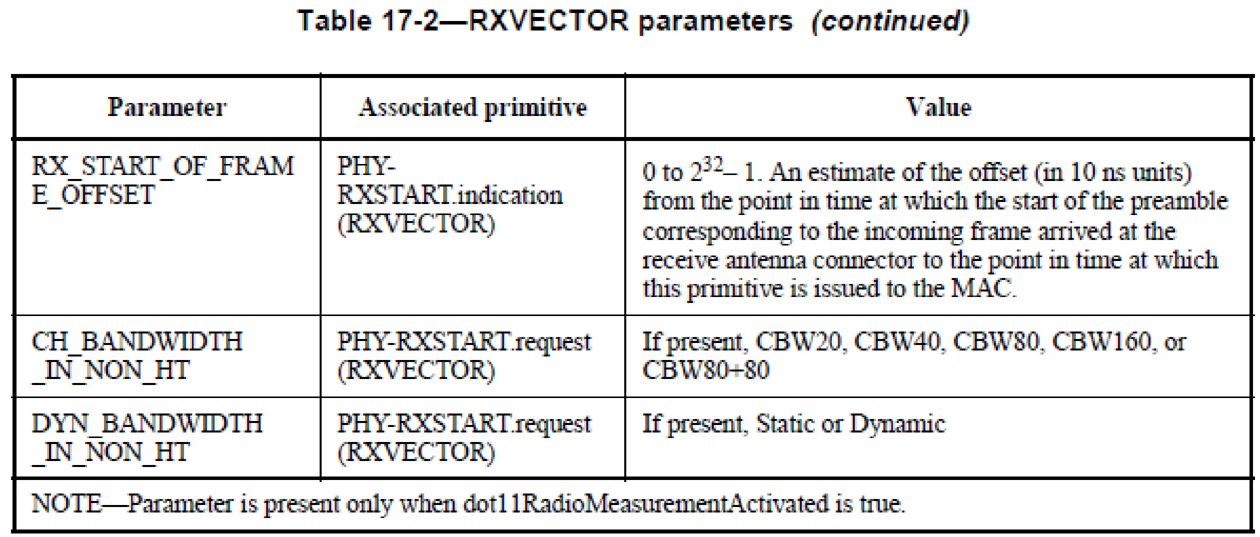

Table 17-2—RXVECTOR parameters *(continued)*

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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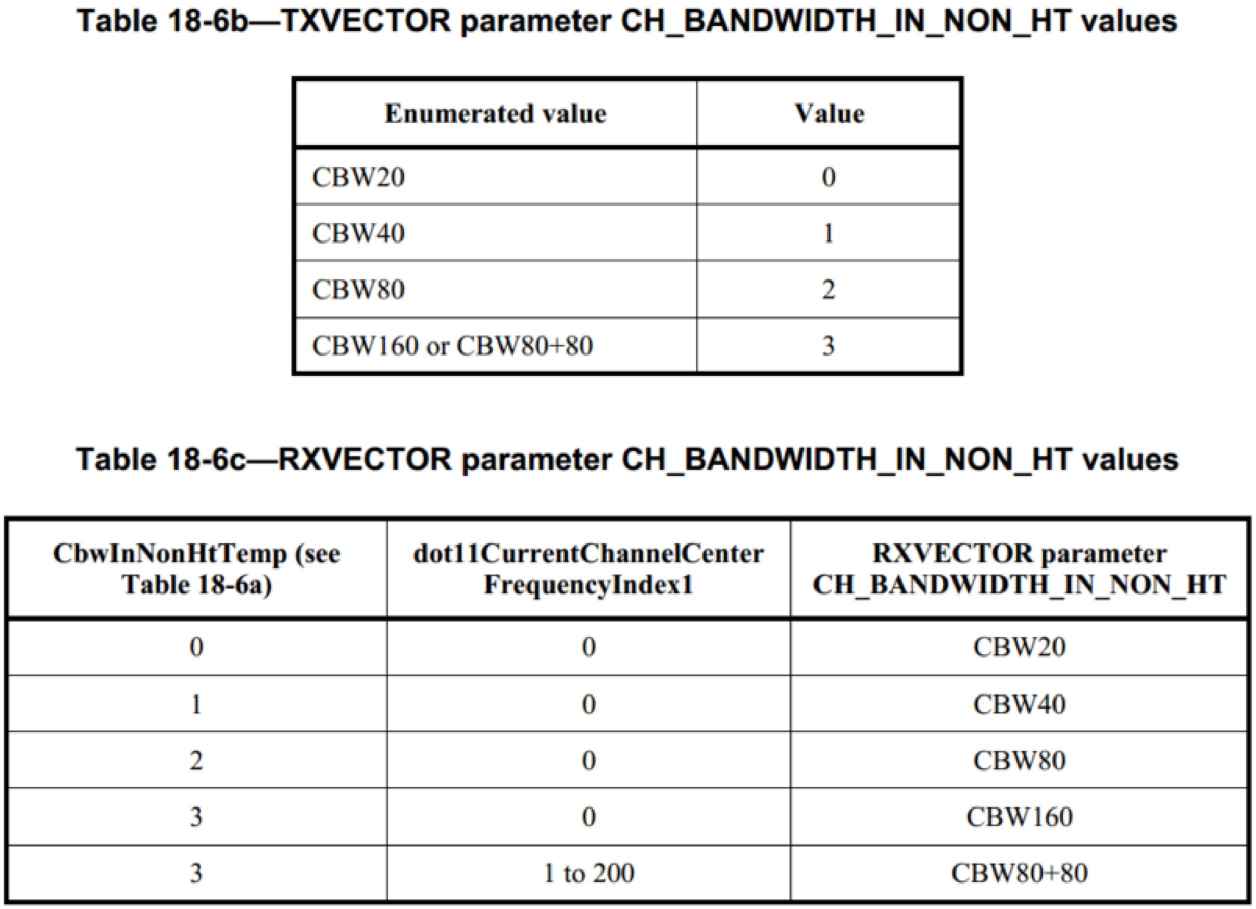

Table 18-6b—TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

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

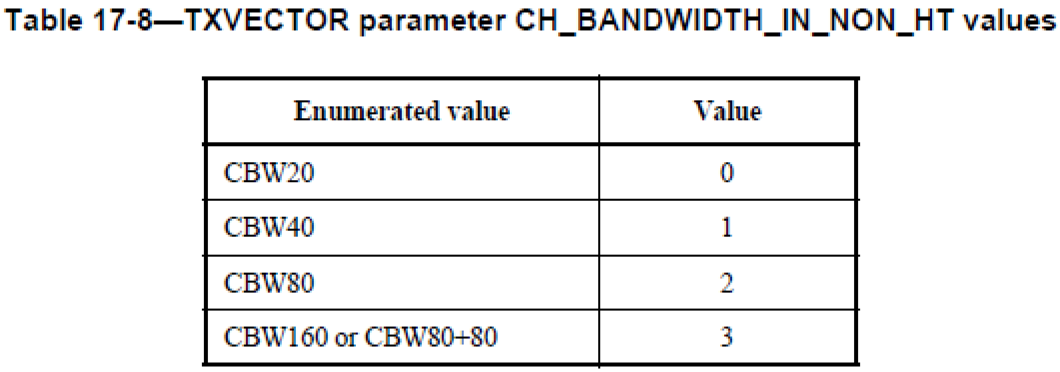

Table 17-8—TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

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.

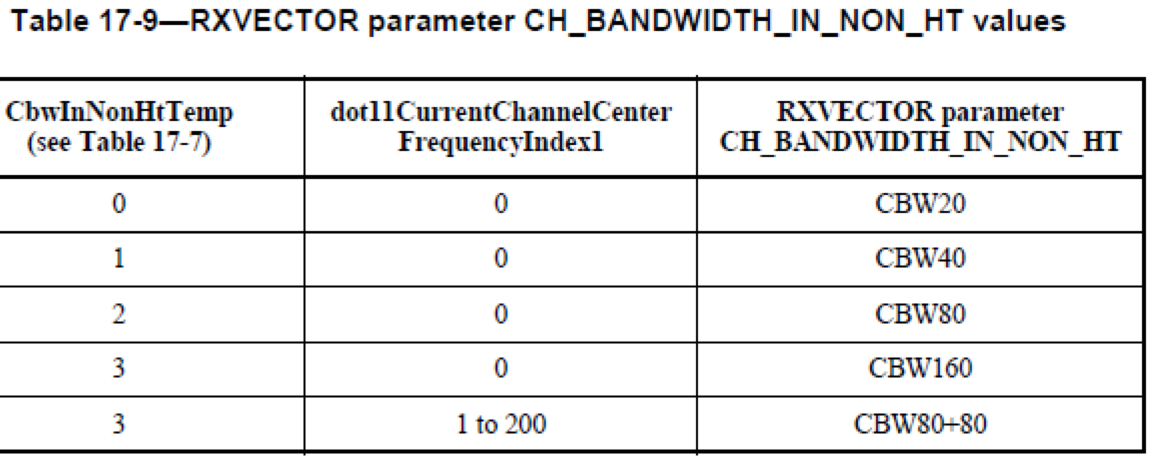

Table 17-9—RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

CbwInNonHtTemp (see Table 17-7)	dot11CurrentChannelCenterFrequencyIndex1	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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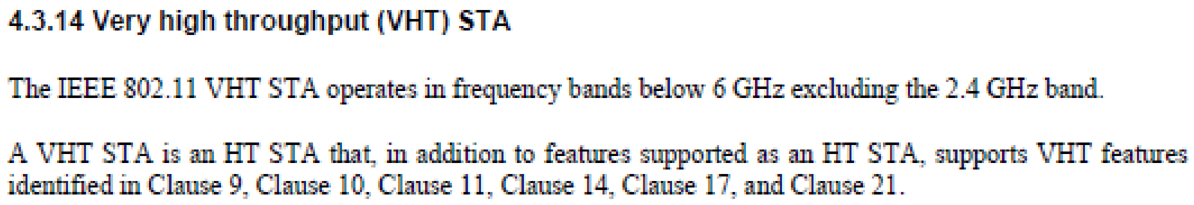
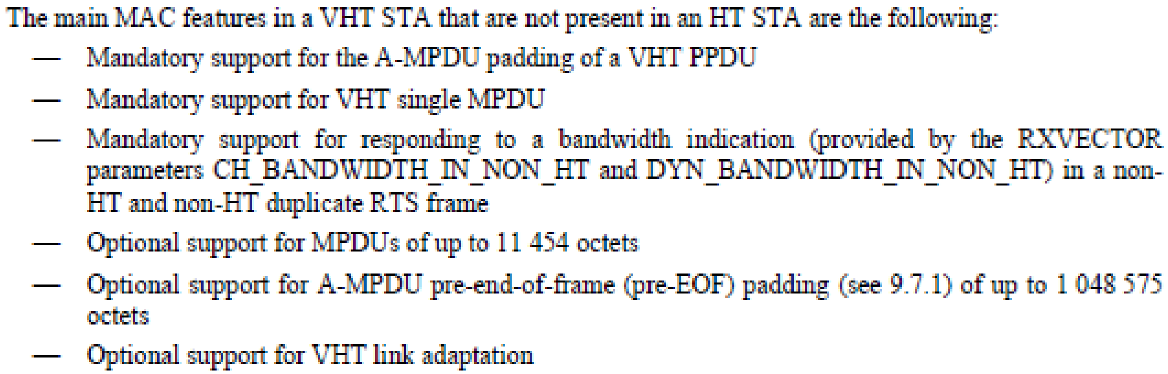
	 **4.3.14 Very high throughput (VHT) STA** The IEEE 802.11 VHT STA operates in frequency bands below 6 GHz excluding the 2.4 GHz band. A VHT STA is an HT STA that, in addition to features supported as an HT STA, supports VHT features identified in Clause 9, Clause 10, Clause 11, Clause 14, Clause 17, and Clause 21. . . .  The main MAC features in a VHT STA that are not present in an HT STA are the following: — Mandatory support for the A-MPDU padding of a VHT PPDU — Mandatory support for VHT single MPDU — Mandatory support for responding to a bandwidth indication (provided by the RXVECTOR parameters CH_BANDWIDTH_IN_NON_HT and DYN_BANDWIDTH_IN_NON_HT) in a non-HT and non-HT duplicate RTS frame — Optional support for MPDUs of up to 11 454 octets — Optional support for A-MPDU pre-end-of-frame (pre-EOF) padding (see 9.7.1) of up to 1 048 575 octets — Optional support for VHT link adaptation Page 197 of 802.11-2016

9.3.1.2 RTS frame format

The frame format for the RTS frame is as defined in Figure 9-20.

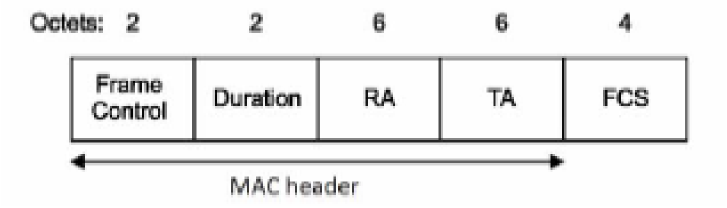
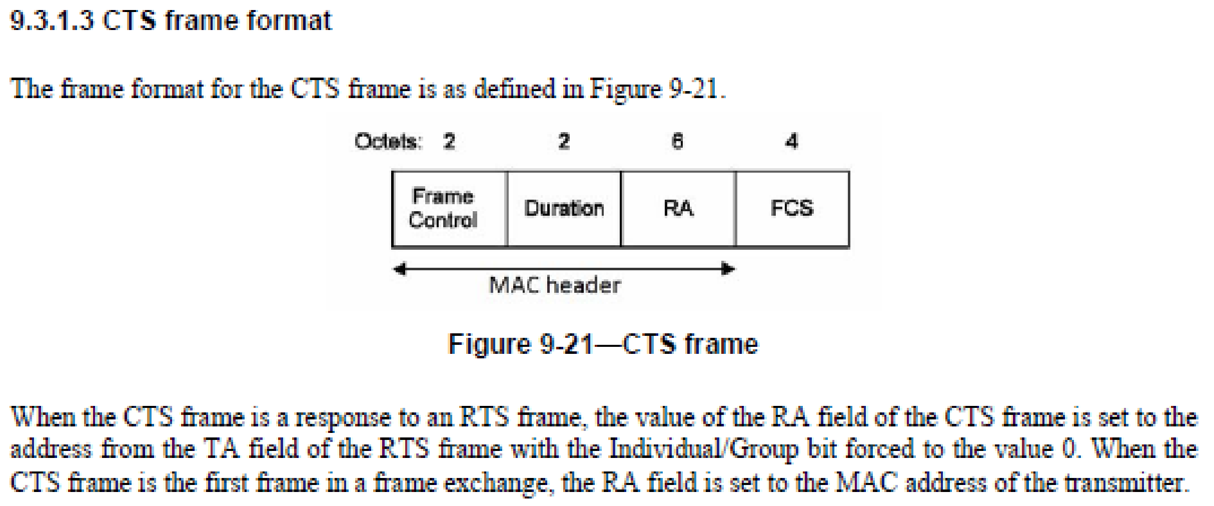


Figure 9-20—RTS frame

The RA field value of the RTS frame is the address of the STA, on the WM, that is the intended immediate recipient of the pending individually addressed Data, Management, or Control frame.

The TA field value is the address of the STA transmitting the RTS frame or the bandwidth signaling TA of the STA transmitting the RTS frame. In an RTS frame transmitted by a VHT STA in a non-HT or non-HT duplicate format and where the scrambling sequence carries the TXVECTOR parameters CH_BANDWIDTH_IN_NON_HT and DYN_BANDWIDTH_IN_NON_HT (see 10.3.2.6), the TA field is a bandwidth signaling TA.



9.3.1.3 CTS frame format

The frame format for the CTS frame is as defined in Figure 9-21.

Figure 9-21—CTS frame

When the CTS frame is a response to an RTS frame, the value of the RA field of the CTS frame is set to the address from the TA field of the RTS frame with the Individual/Group bit forced to the value 0. When the CTS frame is the first frame in a frame exchange, the RA field is set to the MAC address of the transmitter.

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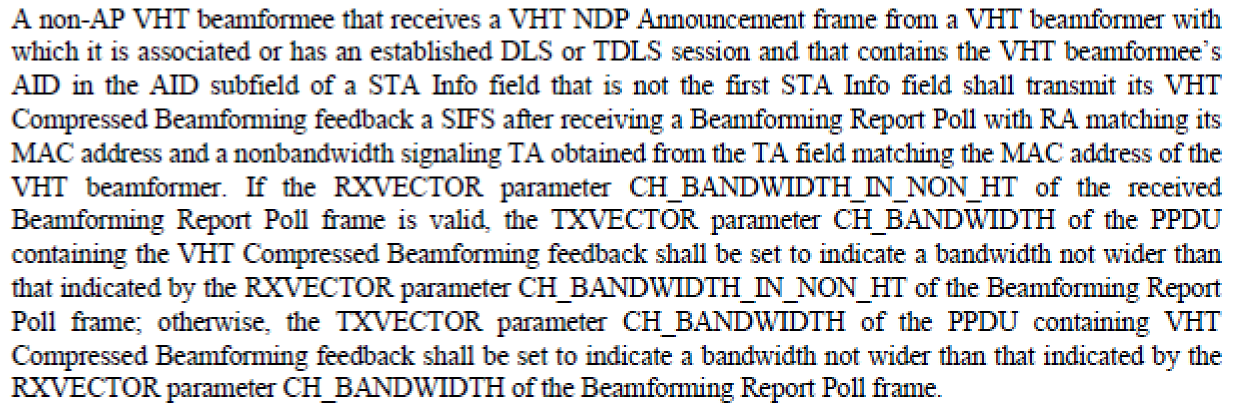
10.34.5.2 Rules for VHT sounding protocol sequences



A non-AP VHT beamformee that receives a VHT NDP Announcement frame from a VHT beamformer with which it is associated or has an established DLS or TDLS session and that contains the VHT beamformee's AID in the AID subfield of a STA Info field that is not the first STA Info field shall transmit its VHT Compressed Beamforming feedback a SIFS after receiving a Beamforming Report Poll with RA matching its MAC address and a nonbandwidth signaling TA obtained from the TA field matching the MAC address of the VHT beamformer. If the RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT of the received Beamforming Report Poll frame is valid, the TXVECTOR parameter CH_BANDWIDTH of the PPDU containing the VHT Compressed Beamforming feedback shall be set to indicate a bandwidth not wider than that indicated by the RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT of the Beamforming Report Poll frame; otherwise, the TXVECTOR parameter CH_BANDWIDTH of the PPDU containing VHT Compressed Beamforming feedback shall be set to indicate a bandwidth not wider than that indicated by the RXVECTOR parameter CH_BANDWIDTH of the Beamforming Report Poll frame.

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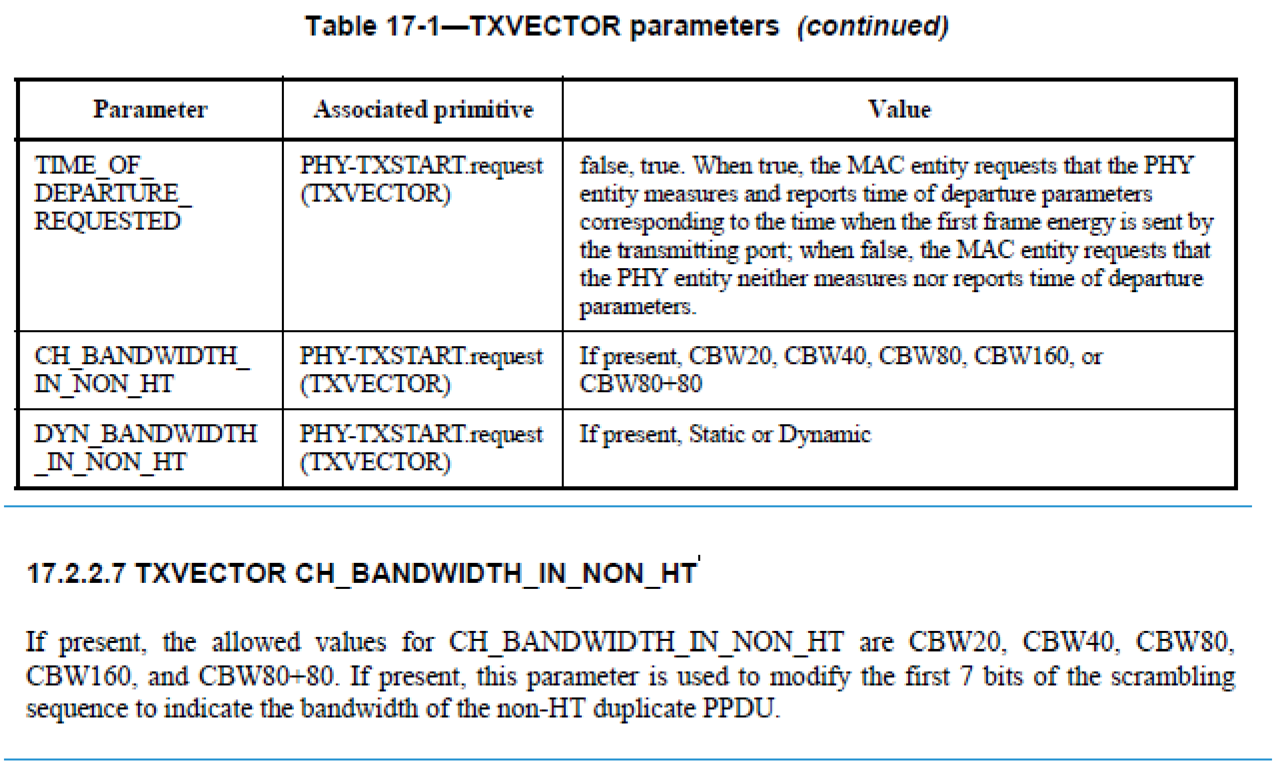


Table 17-1—TXVECTOR parameters *(continued)*

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

17.2.2.7 TXVECTOR 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, this parameter is used to modify the first 7 bits of the scrambling sequence to indicate the bandwidth of the non-HT duplicate PPDU.

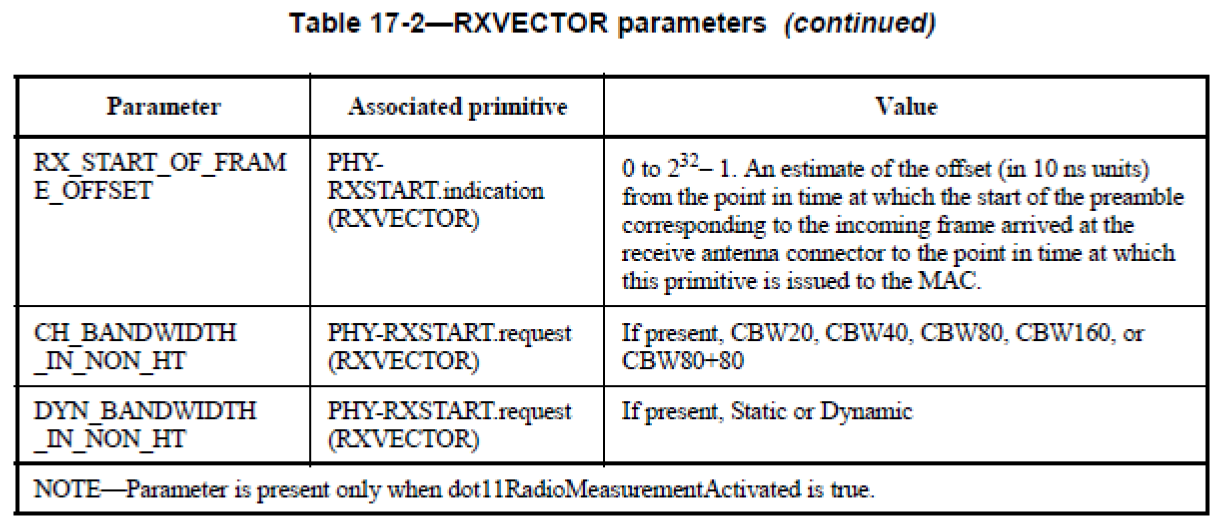
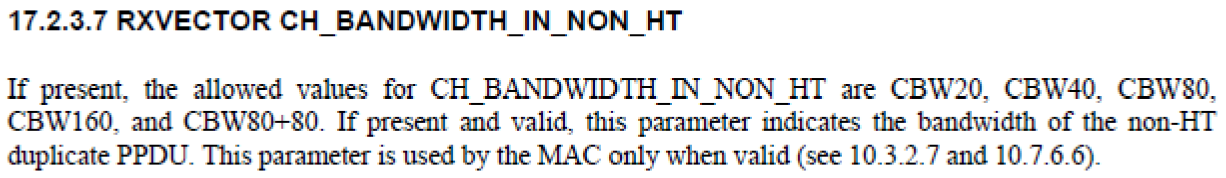


Table 17-2—RXVECTOR parameters *(continued)*

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).

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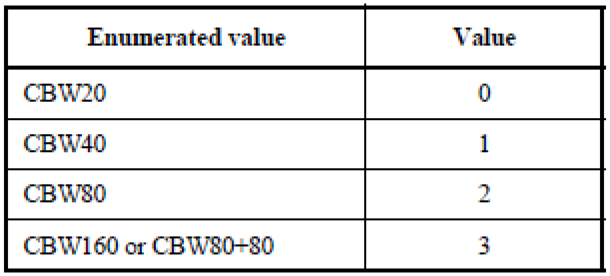
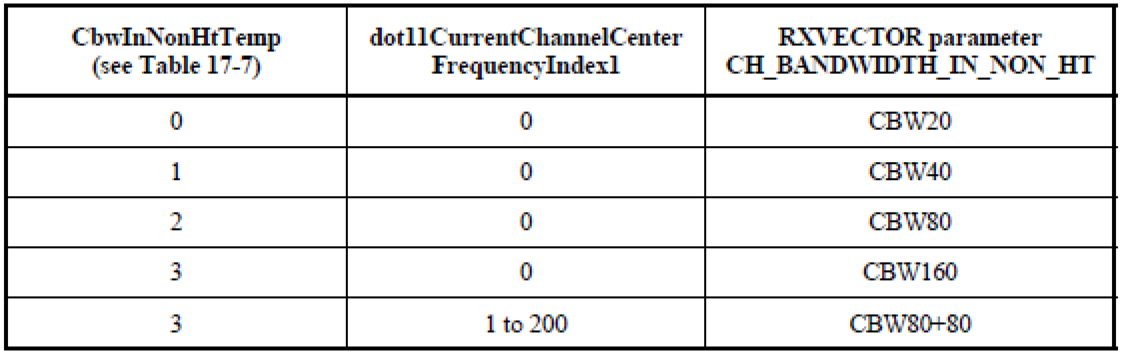
Table 17-8—TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values



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

Table 17-9—RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values



CbwInNonHtTemp (see Table 17-7)	dot11CurrentChannelCenterFrequencyIndex1	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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	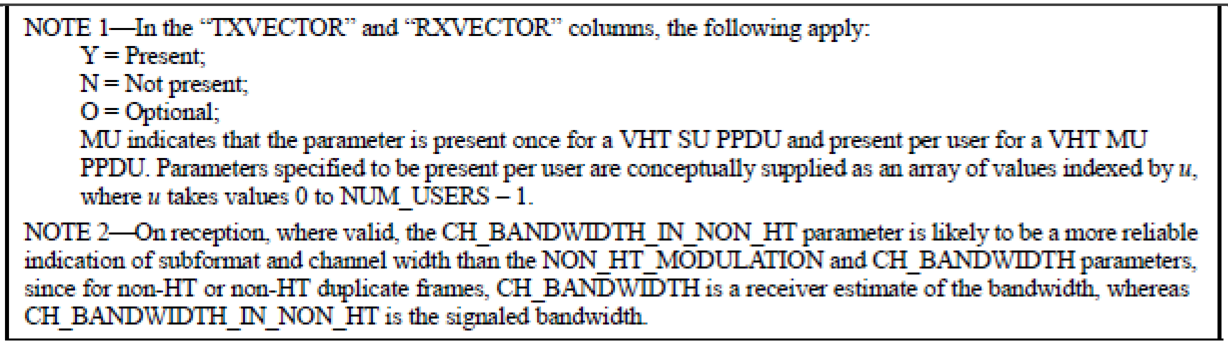 NOTE 1—In the “TXVECTOR” and “RXVECTOR” columns, the following apply: Y = Present; N = Not present; O = Optional; MU indicates that the parameter is present once for a VHT SU PPDU and present per user for a VHT MU PPDU. Parameters specified to be present per user are conceptually supplied as an array of values indexed by *u*, where *u* takes values 0 to NUM_USERS – 1. NOTE 2—On reception, where valid, the CH_BANDWIDTH_IN_NON_HT parameter is likely to be a more reliable indication of subformat and channel width than the NON_HT_MODULATION and CH_BANDWIDTH parameters, since for non-HT or non-HT duplicate frames, CH_BANDWIDTH is a receiver estimate of the bandwidth, whereas CH_BANDWIDTH_IN_NON_HT is the signaled bandwidth. Page 2633 of 802.11-2016
filtering a transmission signal to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided;	When nused by AT&T, AT&T’s agentes or customers, the Accused Instrumentalities and Services 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 AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T and/or AT&T’s agents or customers, require performance of a method that includes filtering a transmission signal (e.g. via a mask PPDU and resulting scrambling, and/or another filtering that results in power (that was used or could be used) being removed, etc.) to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided (e.g. based on the CTS instruction 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.

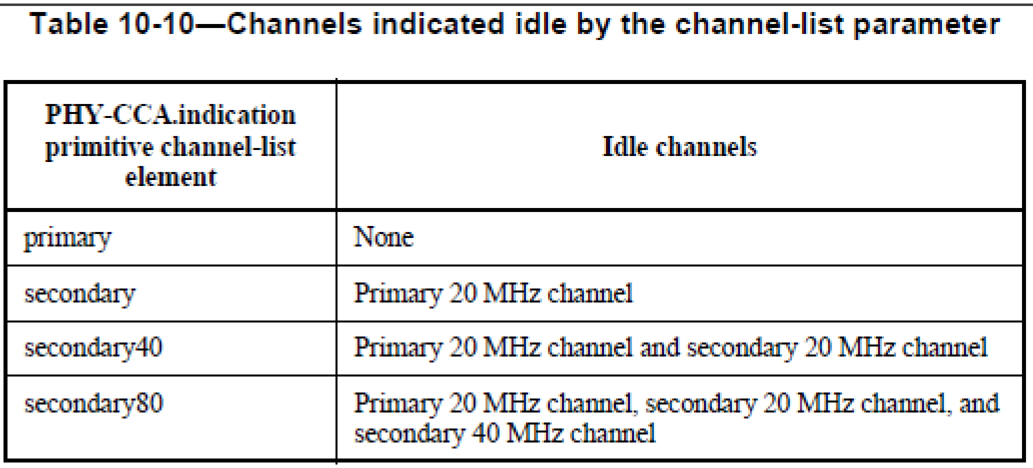

Table 10-10—Channels indicated idle by the channel-list parameter

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:

k) 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.

l) 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.
m) 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.
n) Transmit a 20 MHz mask PPDU on the primary 20 MHz channel.
o) 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

. . .

g) 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:

$$S(x) = x^7 + x^4 + 1 \qquad (17\text{-}14)$$

Replace Figure 18-7 with the following:

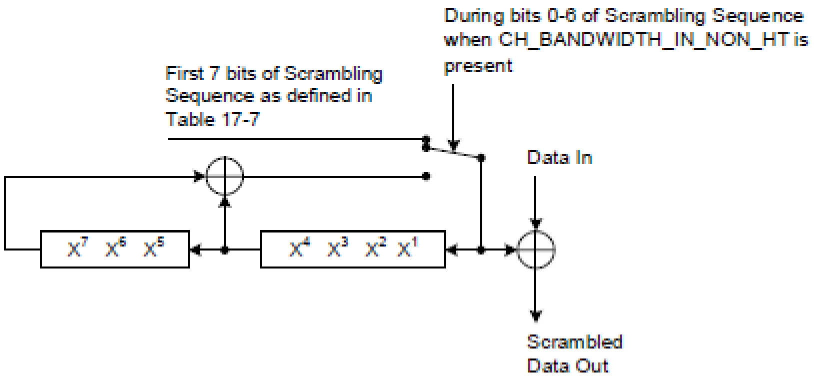

Figure 17-7—Data scrambler

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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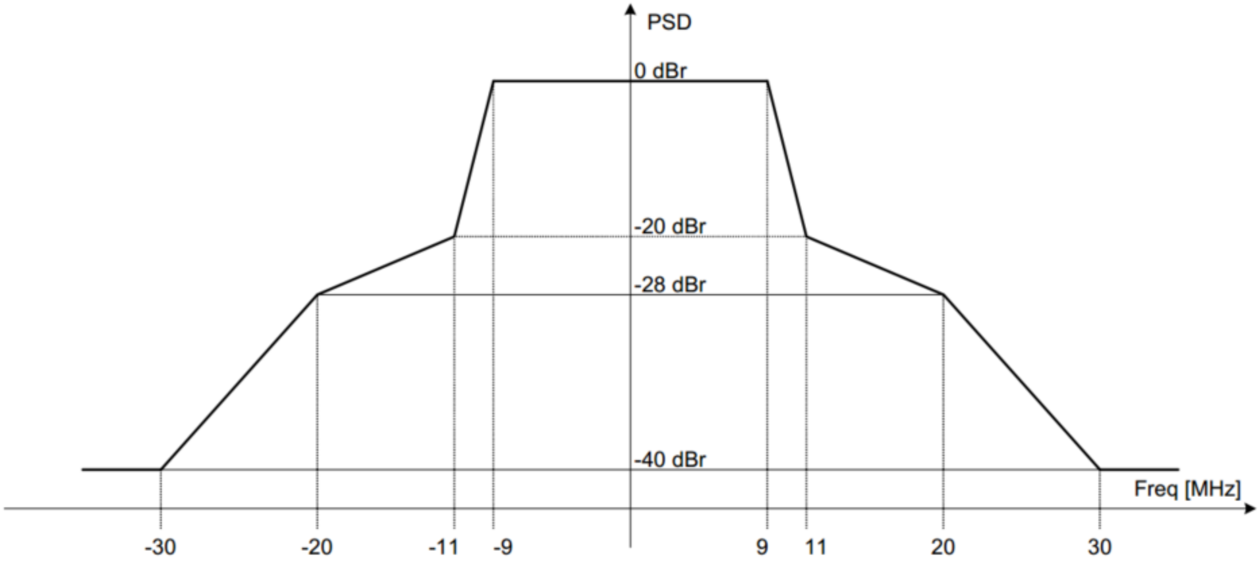
“21.3.17 VHT transmit specification

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 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
transmitting the filtered transmission signal to the second node;	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the step of transmitting the filtered transmission signal to the second node.

For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T and/or AT&T's agents or customers, 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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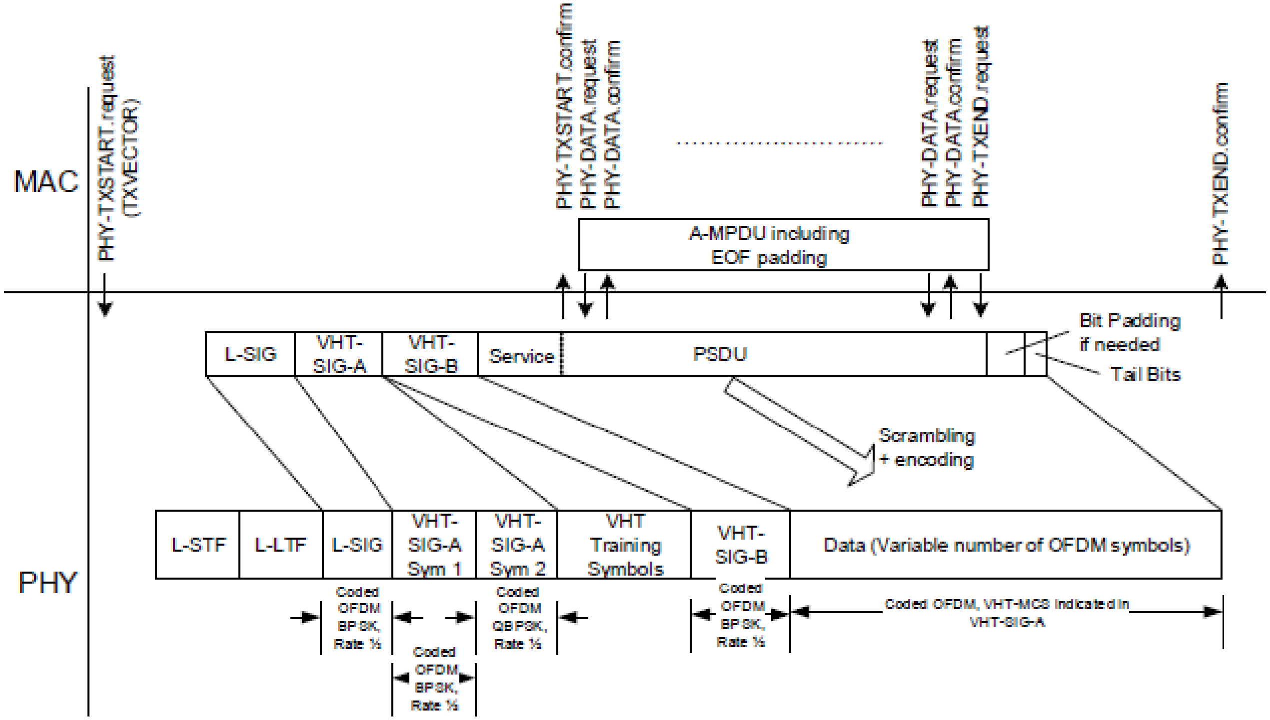

NOTE—This procedure does not describe the operation of optional features, such as MU-MIMO, LDPC or STBC.

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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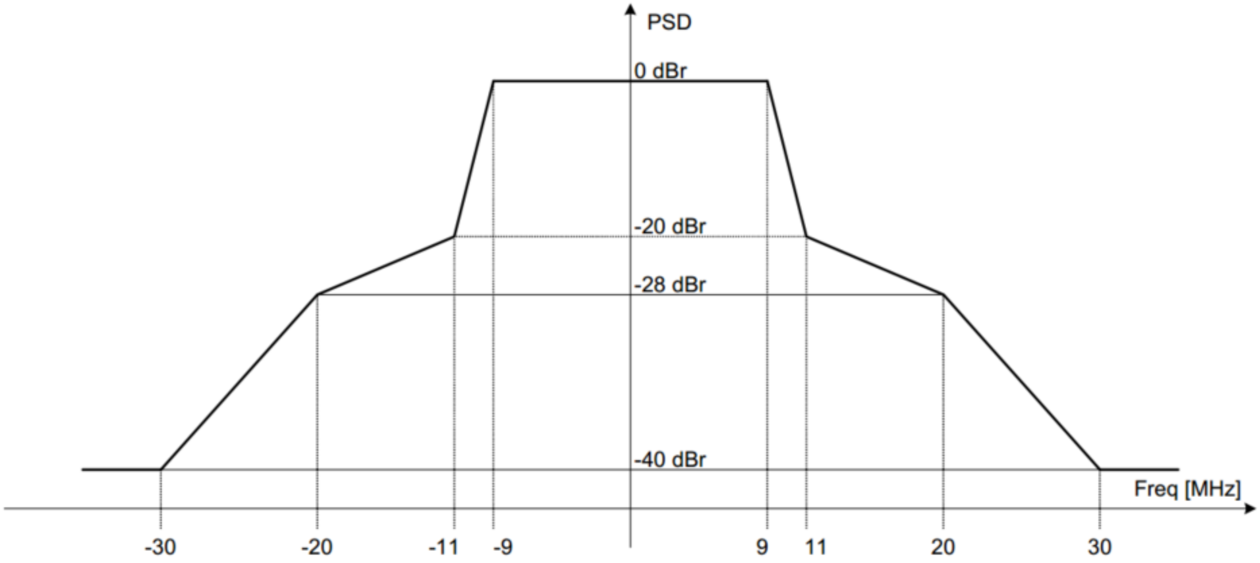
“21.3.17 VHT transmit specification

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
receiving a compressed first feedback from the second node that characterizes receipt of a	The Accused Instrumentalities and Services 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.

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;	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services 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, AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T and/or AT&T's agents or customers, require performance of a method that includes receiving a compressed first feedback (e.g. a first feedback matrix) from the second node that characterizes receipt of a first signal (e.g. a first VHT NDP sounding PPDU) sent from the first node to the second node; and receiving a compressed second feedback (e.g. a second feedback matrix) from a third node that characterizes receipt of a second signal (e.g. a second VHT NDP sounding PPDU) sent from the first node to the third node. **21.3.11.2 Beamforming Feedback Matrix *V*** "Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in Table 21-11 from the measured channel before computing a set of matrices for feedback to the beamformer. The beamforming feedback matrix, $V_{k,u}$, found by the beamformee *u* for subcarrier *k* shall be compressed in the form of angles using the method described in 19.3.12.3.6. The angles, $\varphi(k,v)$ and $\psi(k,u)$, are quantized according to Table 9-68. The number of bits for quantization is chosen by the beamformee, based on the indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DLMU- MIMO beamforming. The compressed beamforming feedback using 19.3.12.3.6 is the only Clause 21 beamforming feedback format defined. The beamformee shall generate the beamforming feedback matrices with the number of rows (*Nr*) equal to the N_{STS} of the NDP. After receiving the angle information, $\varphi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix Q_{k}. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,N_{user}}\text{-}1]$ using $V_{k,u}$ and $SNR_{k,u}$ $(0 \le u \le N_{user}\text{-}1)$ 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. An explicit feedback mechanism is used where the VHT beamformee directly measures the channel from the training symbols transmitted by the VHT beamformer and sends back a transformed estimate of the channel state to the VHT beamformer. The VHT beamformer then uses this estimate, perhaps combining estimates from multiple VHT beamformees, to derive the steering matrix. If dot11VHTSUBeamformerOptionImplemented is true, a STA shall set the SU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTSUBeamformeeOptionImplemented is true, a STA shall set the SU Beamformee Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set the MU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set the MU Beamformee Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set dot11VHTSUBeamformerOptionImplemented to true. If

dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set dot11VHTSUBeamformeeOptionImplemented to true.

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

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

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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,

	Nc is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field, *Nr* is the number of rows in a compressed beamforming feedback matrix determined by the Nr 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;	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services 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 AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T and/or AT&T's agents or customers, require performance of a method that includes: decompressing the compressed first feedback (e.g. the first feedback matrix) resulting in a decompressed first feedback; and decompressing the compressed second feedback (e.g. the second feedback matrix) resulting in a decompressed second feedback. "**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 x 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:	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the prior steps listed above, wherein the filtered transmission signal is a filtered first transmission signal (e.g. a first one of multiple disjoint subsets of space-time streams, or any other signal, intended for reception at a first one of different STAs, etc.) 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 AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T and/or AT&T's agents or customers, require performance of a method, wherein the filtered transmission signal is a filtered first transmission signal that is transmitted to the second node using an 802.11-based orthogonal frequency-division multiplexing (OFDM) protocol via at least one antenna (e.g. one or more antennas) of a plurality of antennas, using a first power (e.g. per one or more respective steering matrices) that is based on the decompressed first feedback (e.g. first feedback matrix). • IEEE 802.11-2016: **21.3.11 SU-MIMO and DL-MU-MIMO Beamforming** and **21.3.11.1 General** specifies the steering matrix Q_k for DL-MU-MIMO, where k is one of the subcarriers, and Q_k is consisted of sub-matrices $Q_{k,u}$, each corresponding to one receiving STA u. • IEEE 802.11-2016: **21.3.11.2 Beamforming Feedback Matrix *V*** further specifies that $Q_{k,u}$ is dependent on the feedback matrix $V_{k,u}$ provided by each STA u, which is based on the actual channel measurement by each STA u. • IEEE 802.11-2016: Figure 10-53 (below) illustrates that each STA (beamformee) is getting a different polling packet, based on which the feedback matrix $V_{k,u}$ is measured and should be different from STA to STA.

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

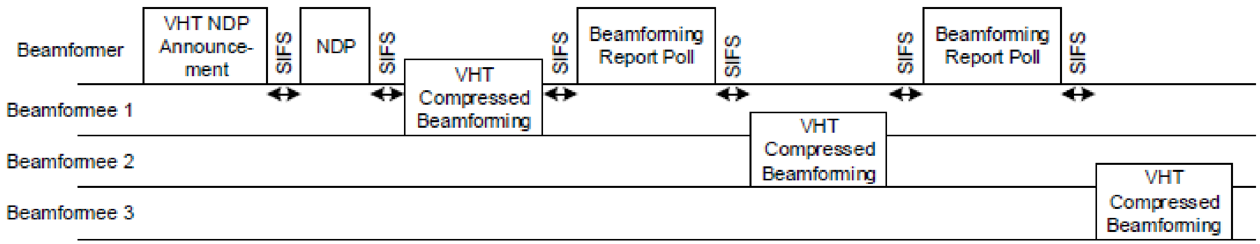

Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

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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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1] \text{ x } x_k + n$$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions
$N_{RXu} \text{ x } N_{TX}$

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 $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1]$ 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 $u = 0, 1, \ldots, N_{user}$ -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)."

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"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, $Q_{steer,k} = Q_kV_k$, with V_k found from H_kQ_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, $H_{eff,k} = H_kQ_k$, 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.	When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform steps of a method as articulated above, comprising transmitting, using the 802.11-based OFDM protocol, a filtered second transmission signal (e.g. a second one of multiple disjoint subsets of space-time streams, or any other signal, intended for reception at a second one of different STAs, etc.), 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 AT&T makes, uses, or sells 802.11ac-compliant access points (AP) which, when operated by AT&T and/or AT&T’s agents or customers, require performance of a method that includes transmitting, using the 802.11-based OFDM protocol, a filtered second transmission signal, simultaneously with the filtered first transmission signal [e.g. via multiple-user-multiple-input-multiple-output (MU-MIMO) technology], to the third node, using a second power (e.g. per one or more respective steering matrices) that is based on the decompressed second feedback (e.g. second feedback matrix)**.** **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, where k is one of

the subcarriers, and Q_k is consisted of sub-matrices $Q_{k,u}$, each corresponding to one receiving STA u.

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

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

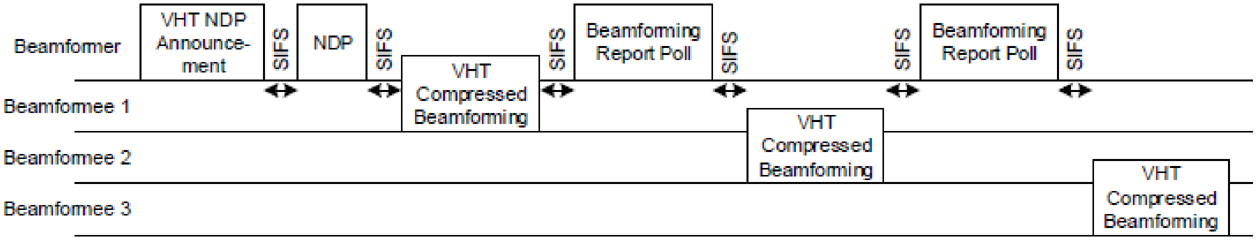


Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

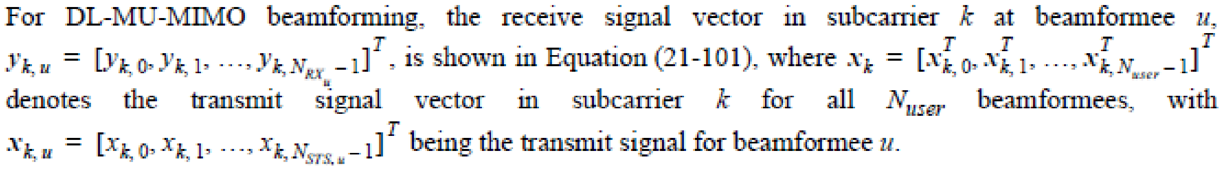
Pages 1490-2579 of 802.11-2016

“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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1] \text{ x } x_k + n$$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions
N_{RXu} x 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 $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}$-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 $u = 0, 1, \ldots, N_{user}$ -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

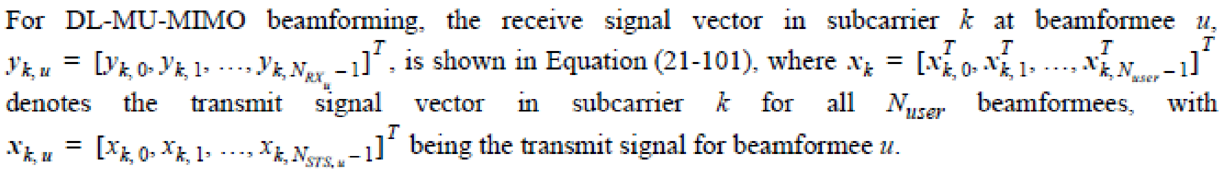
	MU transmission is signaled using the Group ID field in VHT-SIG-A (see 21.3.8.3.3 and 21.3.11.4)." Pages 2578-2579 of 802.11-2016 "**19.3.12.3 Explicit feedback beamforming** **19.3.12.3.1 General** In explicit beamforming, in order for STA A to transmit a beamformed packet to STA B, STA B measures the 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
54. The method of claim 53, wherein the instruction includes a first instruction, and further comprising: receiving at the first node in the radio communications network a second instruction transmitted from the third node to avoid using a different plurality of	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "**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

frequencies to transmit to the third node; and	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." Pages 1313-1314 of 802.11-2016
filtering a second transmission signal to remove power from the second transmission signal at each frequency in the different plurality of frequencies to be avoided, resulting in the filtered second transmission signal.	<u>**Note**</u>: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "**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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0},\ Q_{k,l} \ldots,\ Q_{k,Nuser}-1] \text{ x } x_k + n$$

where

$H_{k,u}$	is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions N_{RXu} x 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

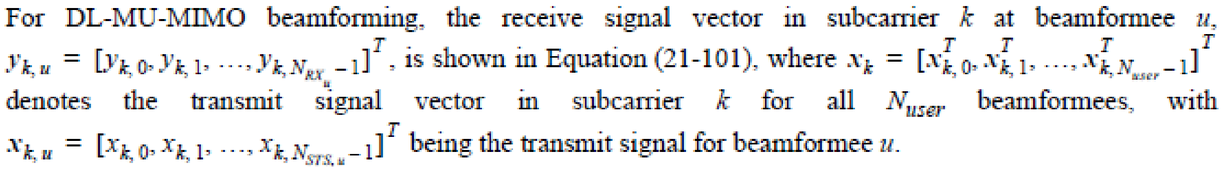
	The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,Nuser}-1]$ can be determined by the beamformer using the beamforming feedback matrices for subcarrier *k* from beamformee *u*, $V_{k,u}$, and SNR information for subcarrier *k* from beamformee *u*, $SNR_{k,u}$, where $u = 0, 1, \ldots, N_{user} -1$. 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, $Q_{steer,k} = Q_kV_k$, with V_k found from H_kQ_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, $H_{eff,k} = H_kQ_k$, 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
55. The method of claim 53, wherein the first power and the second power are the same.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):

“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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0},\ Q_{k,l} \ldots,\ Q_{k,Nuser}\text{-}1] \text{ x } x_k + n$$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions
N_{RXu} x 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 $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,N_{user}}-1]$ 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 $u = 0, 1, \ldots, N_{user} -1$. 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)."

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"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."

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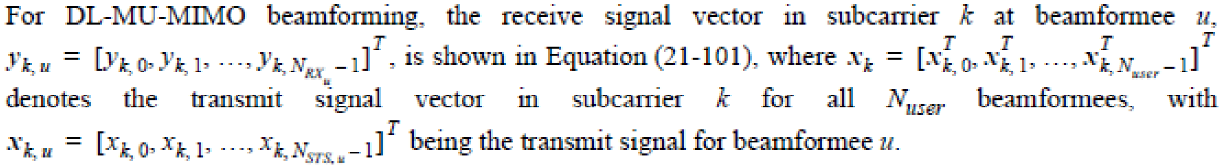
56. The method of claim 53, wherein the first power and the second power are different.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "**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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u. $Y_{k,u} = H_{k,u}$ x $[Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}-1]$ x $x_k + n$ where $H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions N_{RXu} x 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 $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,N_{user}}$-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 $u = 0, 1, \ldots, N_{user}$ -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)."

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"**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
57. The method of claim 53, and further comprising: generating a first data structure based on the decompressed first feedback, where the first power is based on the first data structure; and generating a second data structure based on the decompressed second feedback, where the second power is based on the second data structure.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): **21.3.11.2 Beamforming Feedback Matrix *V*** "Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in Table 21-11 from the measured channel before computing a set of matrices for feedback to the beamformer. The beamforming feedback matrix, $V_{k,u}$, found by the beamformee *u* for subcarrier *k* shall be compressed in the form of angles using the method described in 19.3.12.3.6. The angles, $\varphi(k,v)$ and $\psi(k,u)$, are quantized according to Table 9-68. The number of bits for quantization is chosen by the beamformee, based on the indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DLMU- MIMO beamforming. The compressed beamforming feedback using 19.3.12.3.6 is the only Clause 21 beamforming feedback format defined. The beamformee shall generate the beamforming feedback matrices with the number of rows (*Nr*) equal to the N_{STS} of the NDP. After receiving the angle information, $\varphi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,Nuser}-1]$ 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. An explicit feedback mechanism is used where the VHT beamformee directly measures the channel from the training symbols transmitted by the VHT beamformer and sends back a transformed estimate of the channel state to the VHT beamformer. The VHT beamformer then uses this estimate, perhaps combining estimates from multiple VHT beamformees, to derive the steering matrix. If dot11VHTSUBeamformerOptionImplemented is true, a STA shall set the SU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTSUBeamformeeOptionImplemented is true, a STA shall set the SU Beamformee Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set the MU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set the MU Beamformee Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set dot11VHTSUBeamformerOptionImplemented to true. If dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set dot11VHTSUBeamformeeOptionImplemented to true.

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

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

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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,

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

	Nr is the number of rows in a compressed beamforming feedback matrix determined by the Nr Index field of the VHT MIMO Control field.” Pages 764-765 of 802.11-2016
58. The method of claim 57, wherein the first data structure and the second data structure are different.	When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,N_{user}}$-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 $u = 0, 1, \ldots, N_{user}$ -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).” Page 2579 of 802.11-2016
60. The method of claim 57, wherein the first data structure is unique to the second node, and the second data structure is unique to the third node.	When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,N_{user}}$-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 $u = 0, 1, \ldots, N_{user}$ -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).” Page 2579 of 802.11-2016
61. The method of claim 57, wherein the first data structure is a first profile, and the second data structure is a second profile.	When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): **21.3.11.2 Beamforming Feedback Matrix *V*** “Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in Table 21-11 from the measured channel before computing a set of matrices for feedback to the beamformer. The beamforming feedback matrix, $V_{k,u}$, found by the beamformee u for subcarrier k shall be compressed in the form of angles using the method described in 19.3.12.3.6. The angles, $\varphi(k,v)$ and $\psi(k,u)$, are quantized according to Table 9-68. The number of bits for quantization is chosen by the beamformee, based on the indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DLMU- MIMO beamforming. The compressed beamforming feedback using 19.3.12.3.6 is the only Clause 21 beamforming feedback format defined. The beamformee shall generate the beamforming feedback matrices with the number of rows (Nr) equal to the N_{STS} of the NDP. After receiving the angle information, $\varphi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,N_{user}}-1]$ using $V_{k,u}$ and $SNR_{k,u}$ $(0 \le u \le N_{user}-1)$ 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. An explicit feedback mechanism is used where the VHT beamformee directly measures the channel from the training symbols transmitted by the VHT beamformer and sends back a transformed estimate of the channel state to the VHT beamformer. The VHT beamformer then uses this estimate, perhaps combining estimates from multiple VHT beamformees, to derive the steering matrix. If dot11VHTSUBeamformerOptionImplemented is true, a STA shall set the SU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTSUBeamformeeOptionImplemented is true, a STA shall set the SU Beamformee Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set the MU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set the MU Beamformee Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set dot11VHTSUBeamformerOptionImplemented to true. If dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set dot11VHTSUBeamformeeOptionImplemented to true.

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

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

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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,

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

	Nr is the number of rows in a compressed beamforming feedback matrix determined by the Nr Index field of the VHT MIMO Control field.” Pages 764-765 of 802.11-2016
62. The method of claim 57, wherein the first data structure is a first optimal waveform profile.	When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): **21.3.11.2 Beamforming Feedback Matrix *V*** “Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in Table 21-11 from the measured channel before computing a set of matrices for feedback to the beamformer. The beamforming feedback matrix, $V_{k,u}$, found by the beamformee *u* for subcarrier *k* shall be compressed in the form of angles using the method described in 19.3.12.3.6. The angles, $\varphi(k,v)$ and $\psi(k,u)$, are quantized according to Table 9-68. The number of bits for quantization is chosen by the beamformee, based on the indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DLMU- MIMO beamforming. The compressed beamforming feedback using 19.3.12.3.6 is the only Clause 21 beamforming feedback format defined. The beamformee shall generate the beamforming feedback matrices with the number of rows (*Nr*) equal to the N_{STS} of the NDP. After receiving the angle information, $\varphi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1} ..., Q_{k,Nuser}-1]$ using $V_{k,u}$ and $SNR_{k,u}$ $(0 \le u \le N_{user}-1)$ 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. An explicit feedback mechanism is used where the VHT beamformee directly measures the channel from the training symbols transmitted by the VHT beamformer and sends back a transformed estimate of the channel state to the VHT beamformer. The VHT beamformer then uses this estimate, perhaps combining estimates from multiple VHT beamformees, to derive the steering matrix. If dot11VHTSUBeamformerOptionImplemented is true, a STA shall set the SU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTSUBeamformeeOptionImplemented is true, a STA shall set the SU Beamformee Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set the MU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set the MU Beamformee Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set dot11VHTSUBeamformerOptionImplemented to true. If dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set dot11VHTSUBeamformeeOptionImplemented to true.

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

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

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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,

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

	Nr is the number of rows in a compressed beamforming feedback matrix determined by the Nr Index field of the VHT MIMO Control field.” Pages 764-765 of 802.11-2016
63. The method of claim 53, and further comprising: generating a single data structure based on the decompressed first feedback and the decompressed second feedback, where both the first power and the second power are based on the single data structure.	When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): “**10.34.5 VHT sounding protocol** **10.34.5.1 General** Transmit beamforming and DL-MU-MIMO require knowledge of the channel state to compute a steering matrix that is applied to the transmitted signal to optimize reception at one or more receivers. The STA transmitting using the steering matrix is called the VHT beamformer, and a STA for which reception is optimized is called a VHT beamformee. An explicit feedback mechanism is used where the VHT beamformee directly measures the channel from the training symbols transmitted by the VHT beamformer and sends back a transformed estimate of the channel state to the VHT beamformer. The VHT beamformer then uses this estimate, perhaps combining estimates from multiple VHT beamformees, to derive the steering matrix. Page 1488 of 802.11-2016 “$Q_{k,0}$ 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 $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,N_{user}}-1]$ 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 $u = 0, 1, \ldots, N_{user} -1$. 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
64. The method of claim 53, wherein the filtered second transmission signal is transmitted simultaneously with the filtered first transmission signal via the same plurality of antennas.	When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in 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, where k is one of the subcarriers, and Q_k is consisted of sub-matrices $Q_{k,u}$, each corresponding to one receiving STA *u*. • IEEE 802.11-2016: **21.3.11.2 Beamforming Feedback Matrix *V*** further specifies that $Q_{k,u}$ is dependent on the feedback matrix $V_{k,u}$ provided by each STA *u*, which is based on the actual channel measurement by each STA *u*. • IEEE 802.11-2016: Figure 10-53 (below) illustrates that each STA (beamformee) is getting a different polling packet, based on which the feedback matrix $V_{k,u}$ is measured and should be different from STA to STA.

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

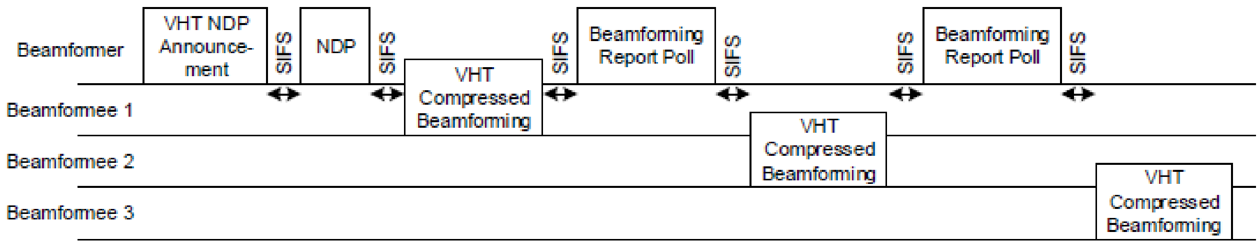

Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

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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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$Y_{k,u} = H_{k,u}$ x $[Q_{k,0}, Q_{k,1} \ldots, Q_{k,Nuser}$-1] x $x_k + n$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions
N_{RXu} x 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 $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,Nuser}$-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 $u = 0, 1, \ldots, N_{user}$ -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)."

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"**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 MU-MIMO technology further changed the rules of wireless engagement, enabling an AP or router to use its separate spatial streams to talk to multiple endpoints or users concurrently. MIMO. Both the transmitting device and the receiving client(s) can send and receive multiple streams using multiple antennas. Alternatively, the transmitting device has multiple antennas that it uses to simultaneously transmit to multiple clients, some or all of which have only one receiving antenna each. https://www.techtarget.com/searchnetworking/feature/5-things-to-know-about-MU-MIMO-technology-in-Wi-Fi-networks
65. The method of claim 53, wherein the filtered second transmission signal is transmitted simultaneously with the filtered first transmission signal via at least one different antenna of the plurality of antennas.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in 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, where k is one of the subcarriers, and Q_k is consisted of sub-matrices $Q_{k,u}$, each corresponding to one receiving STA u.

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

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

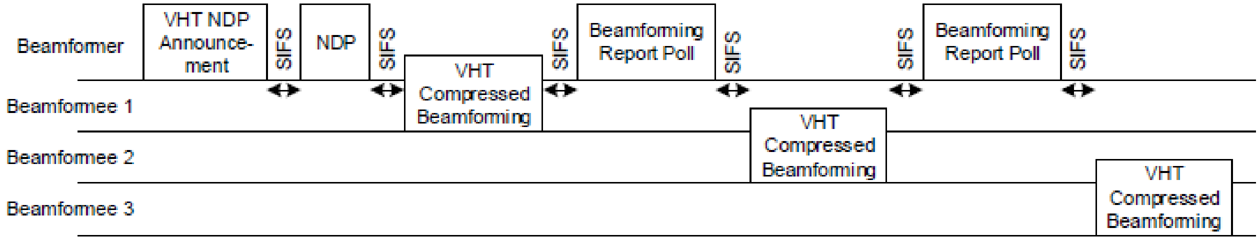

Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

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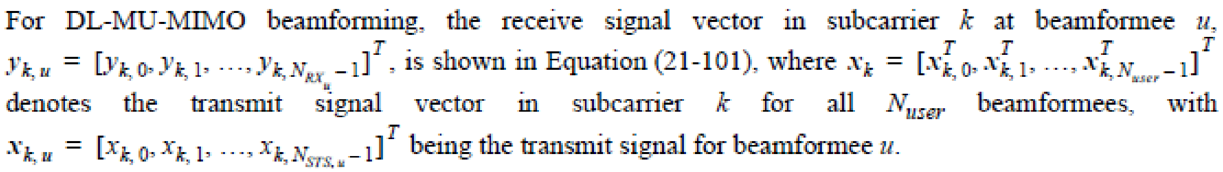
“**21.3.11 SU-MIMO and DL-MU-MIMO Beamforming**

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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0},\ Q_{k,l} \ldots,\ Q_{k,Nuser}\text{-}1] \text{ x } x_k + n$$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions N_{RXu} x N_{TX}

N_{RXu} is the number of receive antennas at beamformee u

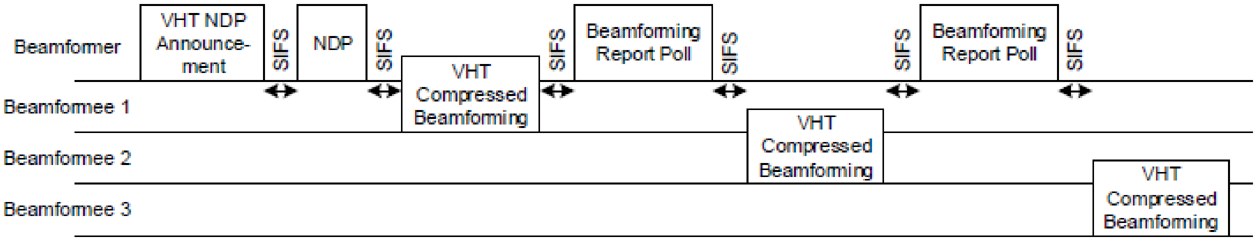
$Q_{k,0}$ is a steering matrix for beamformee u in subcarrier k with dimensions

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

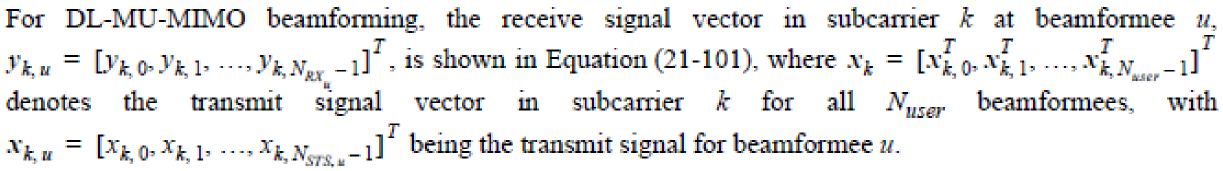
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0},\ Q_{k,l} \ldots,\ Q_{k,Nuser}\text{-}1]$ can be determined by the beamformer using the beamforming feedback matrices for subcarrier k from beamformee u, $V_{k,u}$, and SNR information for subcarrier k from beamformee u, $SNR_{k,u}$, where $u = 0, 1, \ldots, N_{user}$ -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 MU-MIMO technology further changed the rules of wireless engagement, enabling an AP or router to use its separate spatial streams to talk to multiple endpoints or users concurrently. MIMO. Both the transmitting device and the receiving client(s) can send and receive multiple streams using multiple antennas. Alternatively, the transmitting device has multiple antennas that it uses to simultaneously transmit to multiple clients, some or all of which have only one receiving antenna each. https://www.techtarget.com/searchnetworking/feature/5-things-to-know-about-MU-MIMO-technology-in-Wi-Fi-networks
66. The method of claim 53, wherein the filtered second transmission signal is	When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below:

transmitted simultaneously with the filtered first transmission signal via the at least one antenna of the plurality of antennas.	**Note**: See evidence cited earlier in 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, where k is one of the subcarriers, and Q_k is consisted of sub-matrices $Q_{k,u}$, each corresponding to one receiving STA u. • IEEE 802.11-2016: **21.3.11.2 Beamforming Feedback Matrix *V*** further specifies that $Q_{k,u}$ is dependent on the feedback matrix $V_{k,u}$ provided by each STA u, which is based on the actual channel measurement by each STA u. • IEEE 802.11-2016: Figure 10-53 (below) illustrates that each STA (beamformee) is getting a different polling packet, based on which the feedback matrix $V_{k,u}$ is measured and should be different from STA to STA. An example of the VHT sounding protocol with more than one VHT beamformee is shown in Figure 10-8.  **Figure 10-53—Example of the sounding protocol with more than one VHT beamformee** 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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1] \text{ x } x_k + n$$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions
N_{RXu} x 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 $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1]$ 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 $u = 0, 1, \ldots, N_{user}$ -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

MU-MIMO technology further changed the rules of wireless engagement, enabling an AP or router to use its separate spatial streams to talk to multiple endpoints or users concurrently.

MIMO. Both the transmitting device and the receiving client(s) can send and receive multiple streams using multiple antennas. Alternatively, the transmitting device has multiple antennas that it uses to simultaneously transmit to multiple clients, some or all of which have only one receiving antenna each.

	https://www.techtarget.com/searchnetworking/feature/5-things-to-know-about-MU-MIMO-technology-in-Wi-Fi-networks “Wi-Fi 6 has five key technologies . . . Multi-user multiple-input, multiple-output (MU-MIMO) allows more data to be transferred at once, enabling an access point to handle a larger number of concurrent users. This contributes to the efficiency of the spectrum and massive device connectivity.” https://www.business.att.com/content/dam/attbusiness/briefs/att-will-5g-replace-wifi-general-business-brief.pdf “Enjoy a fully managed Wi-Fi service with a robust Day 0, 1, and 2 support model. From site design to professional installation to ongoing care, we have you covered . . . Choose which equipment option will best suit your needs (Cisco Meraki, Aruba, or Mist). Then decide whether you would like AT&T to professionally install the equipment or you would like to self-install . . .No matter which equipment option you choose, all come with Wi-Fi 6 compatible devices. . . . AT&T offers a robust support model with Day 0, 1, and 2 support available. AT&T offers professional services to conduct site surveys, design networks, install equipment, and provide ongoing care and maintenance.” https://www.business.att.com/products/business-wifi.html “AT&T’s most recent generation of Wi-Fi equipment generally supports Wi-Fi 6 (IEEE 802.11ax) standard and is compatible with older Wi-Fi (IEEE 802.11 a/b/g/n/ac) standards . . . AT&T reserves the right to manage remotely any equiprement used to access any Internet Servic e, whether that equipment is connected via a wired or wireless connection . . . Access to AT&T’s nationwide network of Wi-Fi Hot Spots may be available to use as part of the Service . . . .” https://www.att.com/legal/terms.consumerserviceagreement.html
67. The method of claim 53, wherein an update of the compressed first feedback is repeatedly received, and the first power is repeatedly updated based on an updated decompressed first feedback; and	When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in 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

an update of the compressed second feedback is repeatedly received, and the second power is repeatedly updated based on an updated decompressed second feedback.	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 $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,Nuser}$-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 $u = 0, 1, \ldots, N_{user}$ -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
68. The method of claim 53, wherein an update of the compressed first feedback is repeatedly received in real-time, and the first power is repeatedly updated in real-time based on an updated decompressed first feedback; and an update of the compressed second feedback is repeatedly received in real-time, and the second power is repeatedly updated in real-time based on an updated decompressed second feedback.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in 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 The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,Nuser}$-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 $u = 0, 1, \ldots, N_{user}$ -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 "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." https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html
69. The method of claim 53, wherein an update of the compressed first feedback is repeatedly received at time periods of less than one second, and the first power is repeatedly updated based on an updated decompressed first feedback at time periods of less than one second; and an update of the compressed second feedback is repeatedly received at time periods of less than one second, and the second power is repeatedly updated based on an updated decompressed second feedback at time periods of less than one second.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in 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 The DL-MU-MIMO steering matrix Q_k = [$Q_{k,0}$, $Q_{k,1}$ …, $Q_{k,N_{user}}$-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 $u = 0, 1, \ldots, N_{user} -1$. 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

	“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.” https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html
70. The method of claim 53, wherein the filtered first transmission signal and the filtered second transmission signal are sent via the same transceiver.	When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):

AT&T Fiber® with AT&T All-Fi™

Powerful Wi-Fi you can rely on

Our next-generation Wi-Fi® delivers more coverage to more corners of your home than ever before.

Compatible gateway with Wi-Fi 6 subject to availability. Optimal performance requires Wi-Fi 6 enabled devices. Whole-home Wi-Fi connectivity may require AT&T Smart Wi-Fi® Extenders for an additional monthly charge.

AT&T All-Fi

A top-of-the-line Wi-Fi experience

Complete Wi-Fi coverage without dead zones

Up to 5,000 sq. ft. with mesh extender technology.

$10/mo. for up to five extenders. Number of extenders determined at the sole discretion of AT&T.

Speeds up to 5 GIG

Enjoy our fastest speeds, so you can enjoy more of what you love—on more devices.

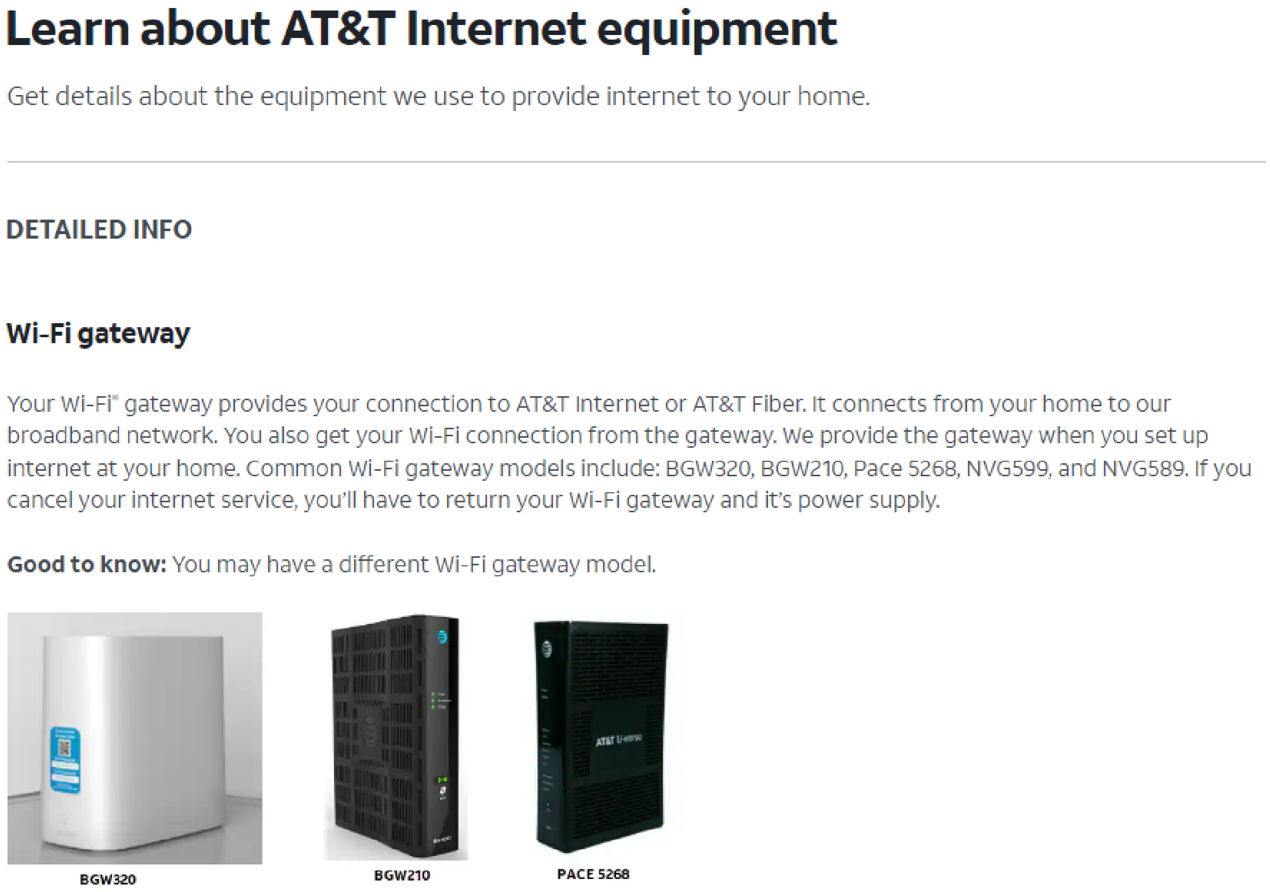
Ltd. avail/areas. Speeds based on wired connection Actual speeds may vary. Single device wired speed maximum 4.7Gbps. For more info, go to www.att.com/speed101.

AT&T ActiveArmor℠

24/7 security that helps block threats before they reach your devices.

Guards against known threats only. AT&T Smart Home Manager app required. Security features must be enabled.

	 **Easy 1-2-3 self-installation** If you qualify for an easy self-install kit, no technician is needed. 1 **Unpack the AT&T Wi-Fi gateway** Plug the AT&T Wi-Fi gateway into an outlet. 2 **Make the connection** Connect your AT&T Wi-Fi gateway to your computer using the provided cables. 3 **Sign in, register & get online** Follow the easy on-screen steps—and you're good to go. If you are unable to install the AT&T Wi-Fi Gateway, call 800.288.2020 to schedule a technician for a professional installation. https://www.att.com/wi-fi/



Learn about AT&T Internet equipment

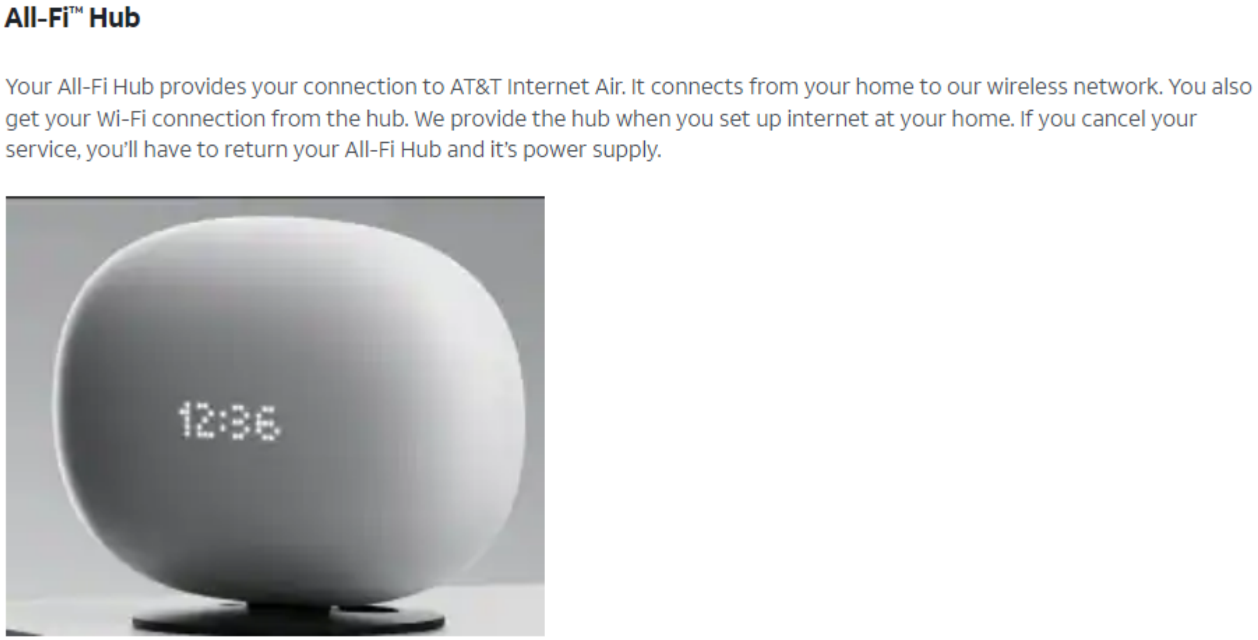
Get details about the equipment we use to provide internet to your home.

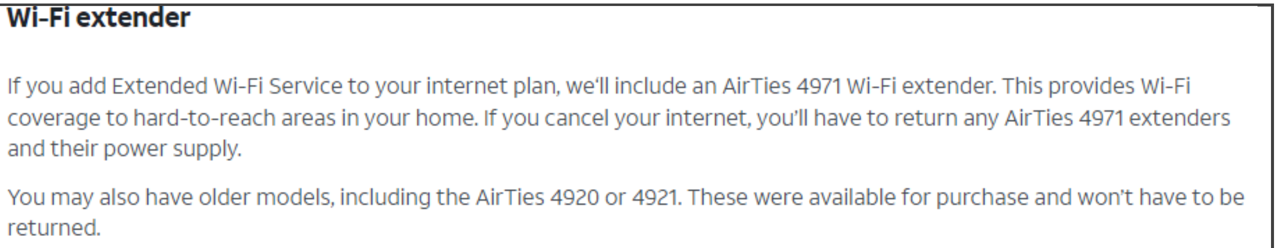
DETAILED INFO

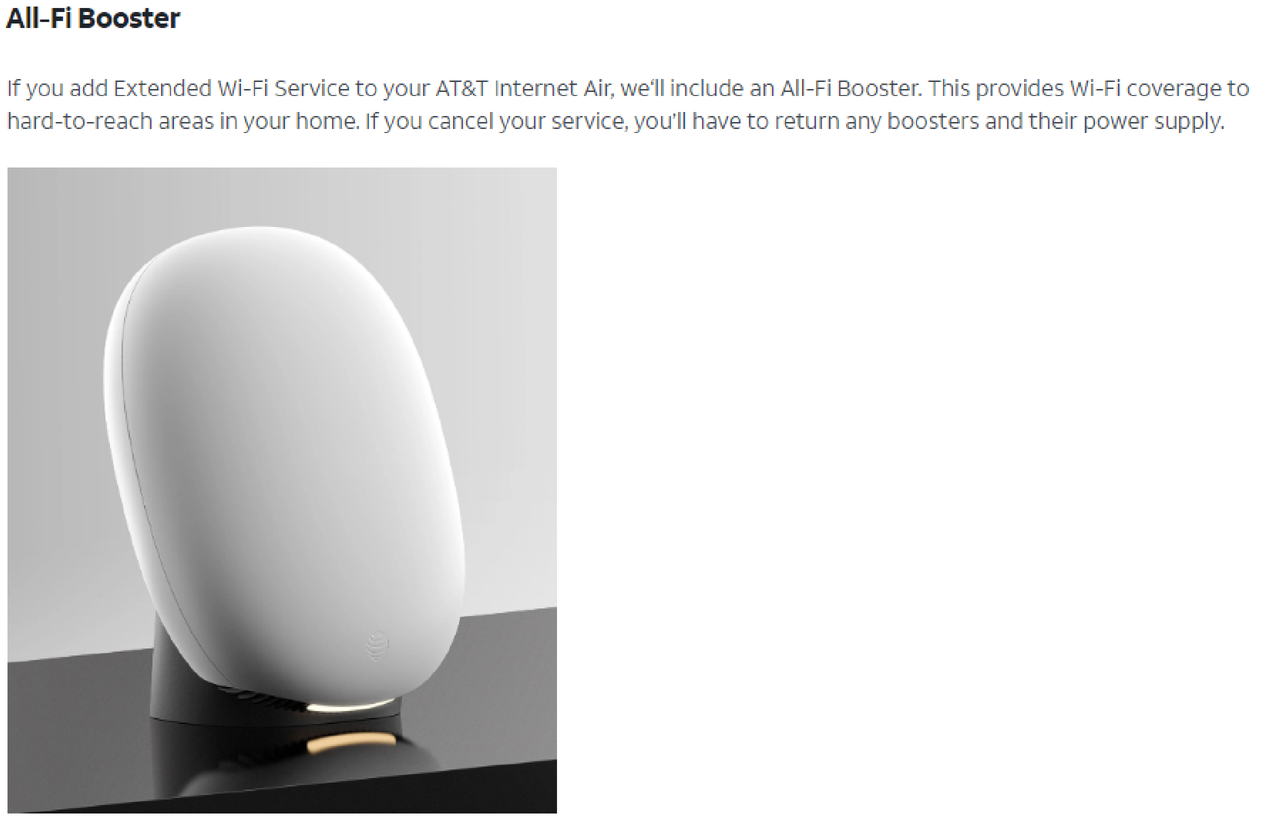
Wi-Fi gateway

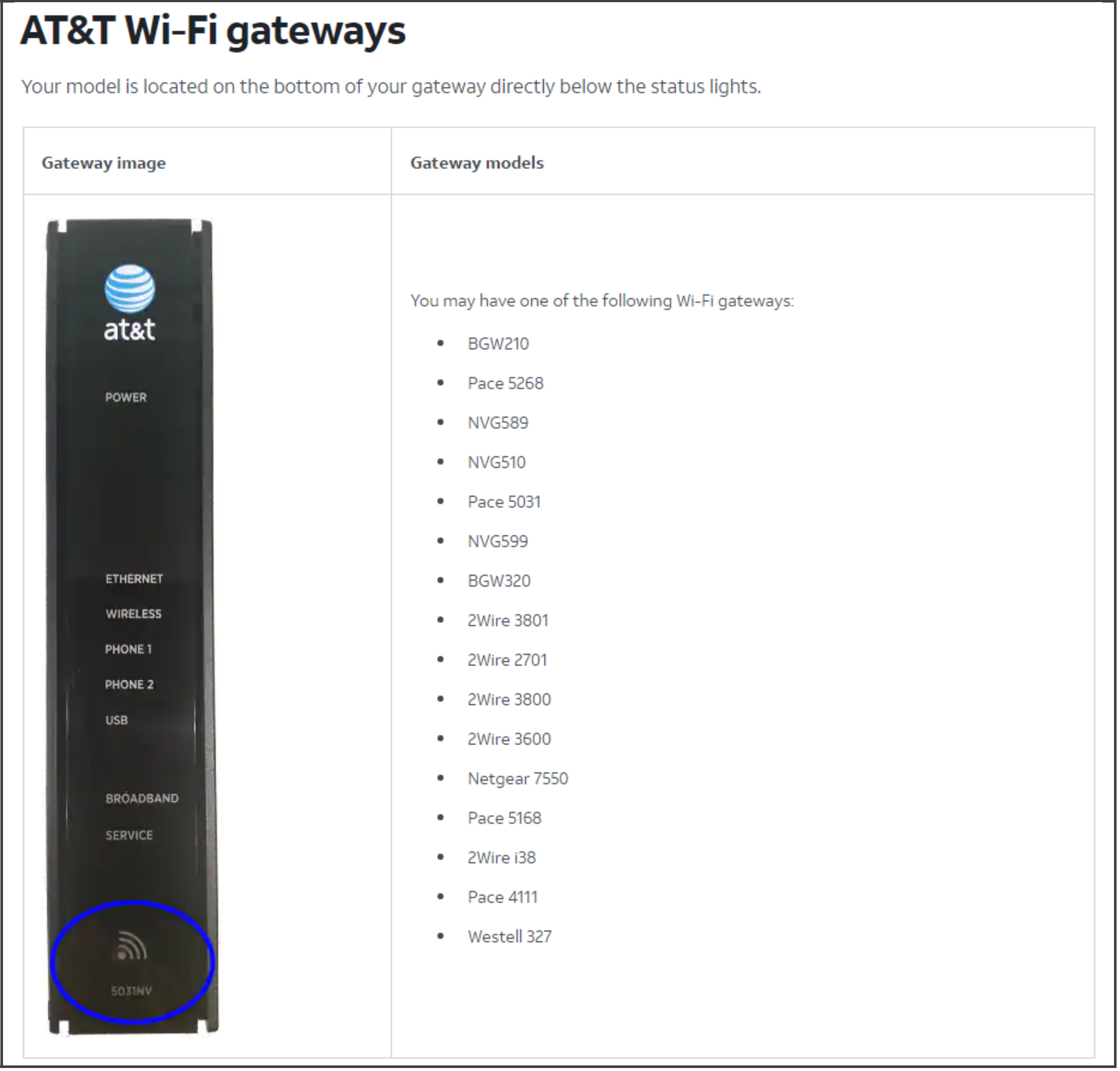
Your Wi-Fi® gateway provides your connection to AT&T Internet or AT&T Fiber. It connects from your home to our broadband network. You also get your Wi-Fi connection from the gateway. We provide the gateway when you set up internet at your home. Common Wi-Fi gateway models include: BGW320, BGW210, Pace 5268, NVG599, and NVG589. If you cancel your internet service, you'll have to return your Wi-Fi gateway and it's power supply.

Good to know: You may have a different Wi-Fi gateway model.

	 **All-Fi™ Hub** Your All-Fi Hub provides your connection to AT&T Internet Air. It connects from your home to our wireless network. You also get your Wi-Fi connection from the hub. We provide the hub when you set up internet at your home. If you cancel your service, you'll have to return your All-Fi Hub and it's power supply.

	 **Wi-Fi extender** If you add Extended Wi-Fi Service to your internet plan, we'll include an AirTies 4971 Wi-Fi extender. This provides Wi-Fi coverage to hard-to-reach areas in your home. If you cancel your internet, you'll have to return any AirTies 4971 extenders and their power supply. You may also have older models, including the AirTies 4920 or 4921. These were available for purchase and won't have to be returned.  **AirTies 4971**  **AirTies 4921**

	 **All-Fi Booster** If you add Extended Wi-Fi Service to your AT&T Internet Air, we'll include an All-Fi Booster. This provides Wi-Fi coverage to hard-to-reach areas in your home. If you cancel your service, you'll have to return any boosters and their power supply. https://www.att.com/support/article/u-verse-high-speed-internet/KM1011652/

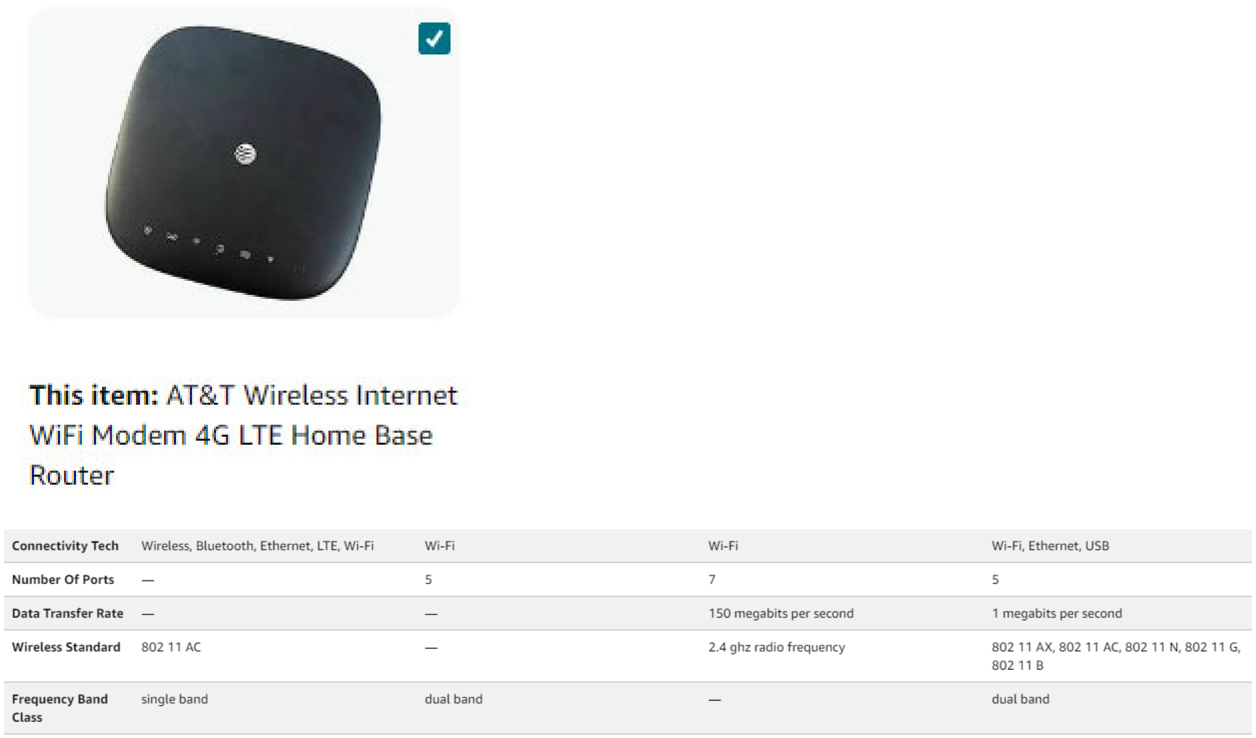


AT&T Wi-Fi gateways

Your model is located on the bottom of your gateway directly below the status lights.

Gateway image	Gateway models
	You may have one of the following Wi-Fi gateways: • BGW210 • Pace 5268 • NVG589 • NVG510 • Pace 5031 • NVG599 • BGW320 • 2Wire 3801 • 2Wire 2701 • 2Wire 3800 • 2Wire 3600 • Netgear 7550 • Pace 5168 • 2Wire i38 • Pace 4111 • Westell 327

https://www.att.com/support/article/dsl-high-speed/KM1047050/



☑

This item: AT&T Wireless Internet WiFi Modem 4G LTE Home Base Router

Connectivity Tech	Wireless, Bluetooth, Ethernet, LTE, Wi-Fi	Wi-Fi	Wi-Fi	Wi-Fi, Ethernet, USB
Number Of Ports	—	5	7	5
Data Transfer Rate	—	—	150 megabits per second	1 megabits per second
Wireless Standard	802 11 AC	—	2.4 ghz radio frequency	802 11 AX, 802 11 AC, 802 11 N, 802 11 G, 802 11 B
Frequency Band Class	single band	dual band	—	dual band

https://www.amazon.com/Wireless-Internet-Hotspot-Antenna-AT/dp/B075JB968D?source=ps-sl-shoppingads-lpcontext&ref_=fplfs&psc=1&smid=A24OVZW9214RO6

"AT&T All-Fi is complimentary to all AT&T Fiber customers, regardless of their fiber internet speed plan . . . Everyone with All-Fi gets the AT&T Wi-Fi Gateway" https://www.att.com/internet/what-is-all-fi/#storyoffer7; *see also* https://www.att.com/legal/terms.wiFiServices.html

	"AT&T All-Fi Hub and All-Fi Booster are devices that . . . are actually related to AT&T's wireless internet service—AT&T Internet Air—which allows Wi-Fi service through AT&T's cellular network." https://www.att.com/internet/what-is-all-fi/#storyoffer7 AT&T charges significant sum and invests significant resources to test and confirm 802.11 protocol compatibility within its networks, including up to or more than $50,000 per device. https://iotdevices.att.com/certified-devices.aspx; https://iotdevices.att.com/networkready.aspx; https://iotdevices.att.com/devices.aspx#:~:text=For%20chipset%2Dbased%20device%20designs,while%20ensuring%20ongoing%20network%20compatibility. "AT&T's most recent generation of Wi-Fi equipment generally supports Wi-Fi 6 (IEEE 802.11ax) standard and is compatible with older Wi-Fi (IEEE 802.11 a/b/g/n/ac) standards . . . AT&T reserves the right to manage remotely any equiprement used to access any Internet Servic e, whether that equipment is connected via a wired or wireless connection . . . Access to AT&T's nationwide network of Wi-Fi Hot Spots may be available to use as part of the Service . . . ." https://www.att.com/legal/terms.consumerserviceagreement.html "AT&T provides a router and management for as little as $1 a day." https://www.business.att.com/products/att-dedicated-internet.html "AT&T provides Wi-Fi access at more than 18,000 hot spots in 42 countries globally (including company-owned and roaming locations)." https://www.att.com/gen/general?pid=7462 "Get unlimited access at more than 30,000 AT&T Wi-Fi Hot Spots nationwide." https://www.att.com/plans/tethering/ "Nationwide Wi-Fi Hotspot Service. AT&T's mass market Wi-Fi broadband internet access service is designed to provide customers with the highest speed available from the network at any given point in time, subject to the many different factors discussed above that can affect network performance. AT&T's Wi-Fi services generally support the IEEE 802.11n/ac standard . . . ." https://about.att.com/sites/broadband/performance#:~:text=Nationwide%20Wi%2DFi%20Hotspot%20Service,access%20services%2C%20please%20click%20here.

"These Terms of Service & Acceptable Use Policy (the "Terms") govern your use of the AT&T Wi-Fi Services ("Service") provided to you through premises operators pursuant to contracts with AT&T or delivered to you directly by AT&T. . . The Service is provided by AT&T Wi-Fi Services, an affiliate of AT&T Corp. ("AT&T"). In order to provide the Service to Customers, AT&T contracts with owners and operators of popular establishments and businesses who purchase the Service to provide it to their employees, patrons, and invited guests at specific sites or locations (Locations). AT&T also offers the Service for the benefit of AT&T Mobility, AT&T DSL and U-verse subscribers for use in select public venues and for certain events, for example, in a city park or performance concert ("AT&T Hot Zones") . . . The Service is designed to provide you with the highest speed available from the network at any given point in time, subject to the many different factors discussed above that can affect network performance. The Service generally supports the IEEE 802.11n/ac standard . . . ."
https://www.att.com/legal/terms.wiFiServices.html

"AT&T Business Wi-Fi helps you deliver a connected full-service experience. Our highly secure solution delivers a fully-integrated, managed Wi-Fi service that connects and protects your business and consumers . . . Professional and self-installation options are available, based on your needs. Select from three flexible management options for equipment and services. If you prefer a capex model, you can purchase the equipment, and AT&T will manage it at a reduced monthly fee per access point . . . AT&T is a preeminent provider of Wi-Fi services, delivering highly reliable and scalable connectivity, **with 24/7 support for both your end users and your employees. We can handle a variety of deployment types and support a wide array of applications. We'll take care of everything from network design to installation.** Get the high-quality service you want, from a company you trust. AT&T.."
https://www.business.att.com/content/dam/attbusiness/briefs/att-business-wi-fi-product-brief.pdf

"Use AT&T Wi-Fi Hot Spots to connect your mobile device or laptop to high-speed internet. You can find them in public places like coffee shops, airports, and restaurants. They're available nationwide . . . Your device automatically connects to our Wi-Fi network when you're at an AT&T Wi-Fi Hot Spot location." https://www.att.com/support/article/wireless/KM1103818/

	"Enjoy a fully managed Wi-Fi service with a robust Day 0, 1, and 2 support model. From site design to professional installation to ongoing care, we have you covered . . . Choose which equipment option will best suit your needs (Cisco Meraki, Aruba, or Mist). Then decide whether you would like AT&T to professionally install the equipment or you would like to self-install . . .No matter which equipment option you choose, all come with Wi-Fi 6 compatible devices. . . . AT&T offers a robust support model with Day 0, 1, and 2 support available. AT&T offers professional services to conduct site surveys, design networks, install equipment, and provide ongoing care and maintenance." https://www.business.att.com/products/business-wifi.html "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 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." 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.
71. The method of claim 53, wherein the filtered first transmission signal and the filtered second transmission signal are sent via different transceivers.	**Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):

AT&T Fiber® with AT&T All-Fi™

Powerful Wi-Fi you can rely on

Our next-generation Wi-Fi® delivers more coverage to more corners of your home than ever before.

Compatible gateway with Wi-Fi 6 subject to availability. Optimal performance requires Wi-Fi 6 enabled devices. Whole-home Wi-Fi connectivity may require AT&T Smart Wi-Fi® Extenders for an additional monthly charge.

AT&T All-Fi

A top-of-the-line Wi-Fi experience

Complete Wi-Fi coverage without dead zones

Up to 5,000 sq. ft. with mesh extender technology.

$10/mo. for up to five extenders. Number of extenders determined at the sole discretion of AT&T.

Speeds up to 5 GIG

Enjoy our fastest speeds, so you can enjoy more of what you love—on more devices.

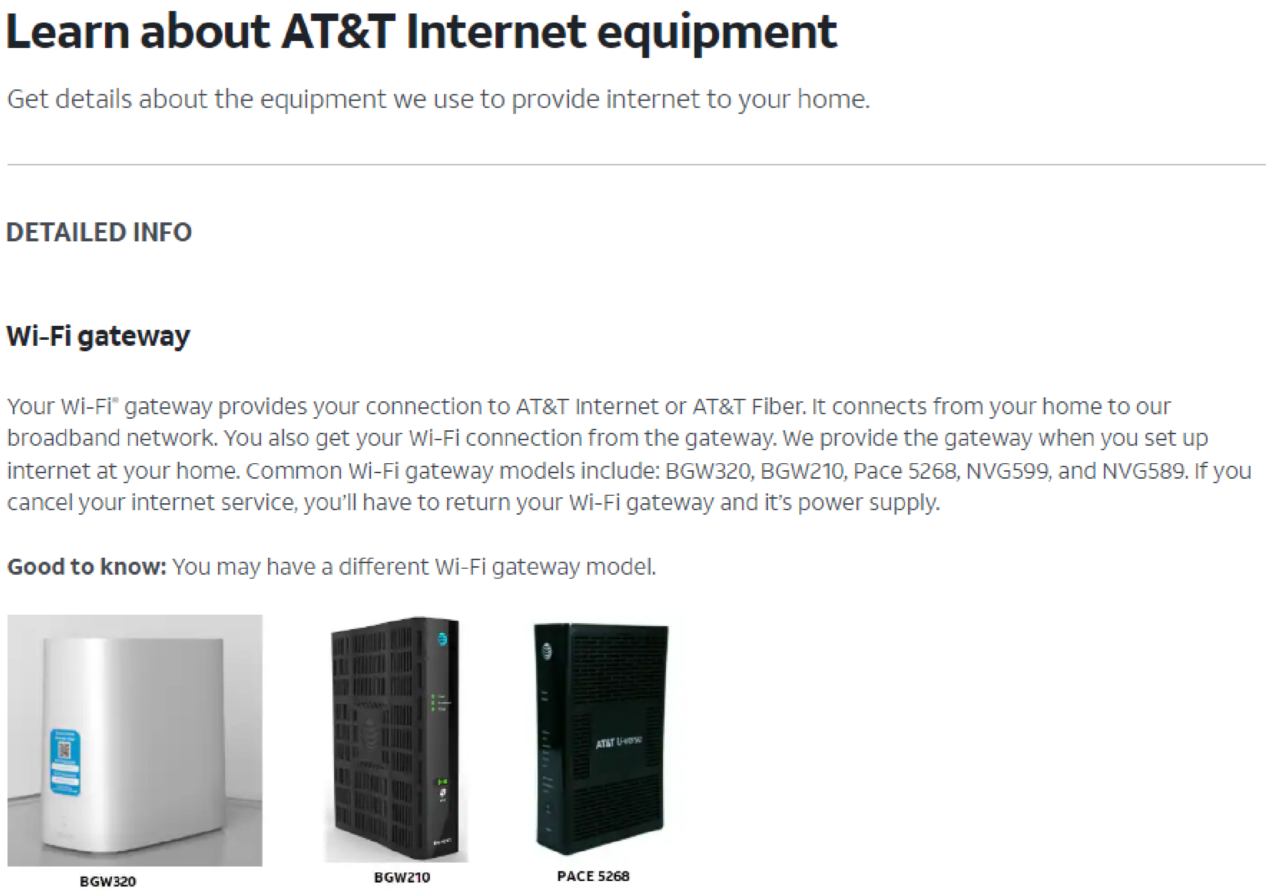
Ltd. avail/areas. Speeds based on wired connection Actual speeds may vary. Single device wired speed maximum 4.7Gbps. For more info, go to www.att.com/speed101.

AT&T ActiveArmor℠

24/7 security that helps block threats before they reach your devices.

Guards against known threats only. AT&T Smart Home Manager app required. Security features must be enabled.

	 **Easy 1-2-3 self-installation** If you qualify for an easy self-install kit, no technician is needed. 1 **Unpack the AT&T Wi-Fi gateway** Plug the AT&T Wi-Fi gateway into an outlet. 2 **Make the connection** Connect your AT&T Wi-Fi gateway to your computer using the provided cables. 3 **Sign in, register & get online** Follow the easy on-screen steps—and you're good to go. If you are unable to install the AT&T Wi-Fi Gateway, call 800.288.2020 to schedule a technician for a professional installation. https://www.att.com/wi-fi/



Learn about AT&T Internet equipment

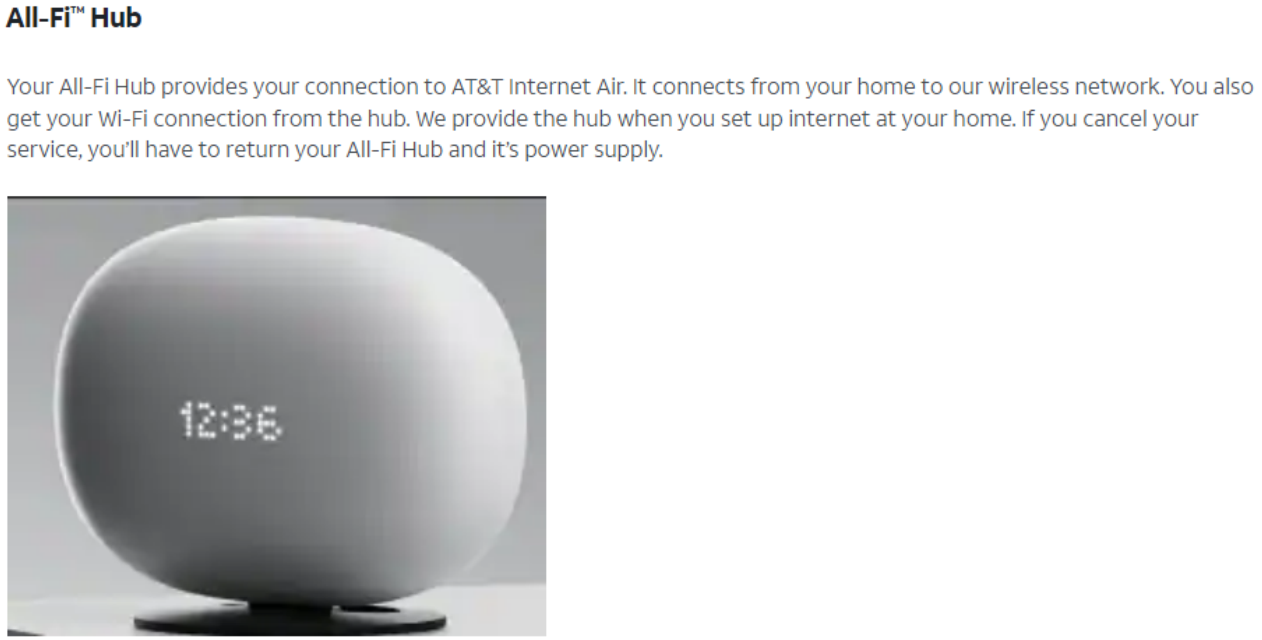
Get details about the equipment we use to provide internet to your home.

DETAILED INFO

Wi-Fi gateway

Your Wi-Fi® gateway provides your connection to AT&T Internet or AT&T Fiber. It connects from your home to our broadband network. You also get your Wi-Fi connection from the gateway. We provide the gateway when you set up internet at your home. Common Wi-Fi gateway models include: BGW320, BGW210, Pace 5268, NVG599, and NVG589. If you cancel your internet service, you'll have to return your Wi-Fi gateway and it's power supply.

Good to know: You may have a different Wi-Fi gateway model.

<table>
<tr>
<td></td>
<td>


All-Fi™ Hub

Your All-Fi Hub provides your connection to AT&T Internet Air. It connects from your home to our wireless network. You also get your Wi-Fi connection from the hub. We provide the hub when you set up internet at your home. If you cancel your service, you'll have to return your All-Fi Hub and it's power supply.

</td>
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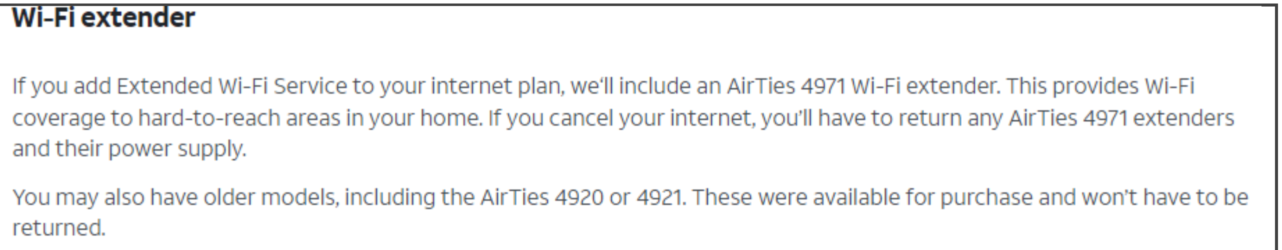
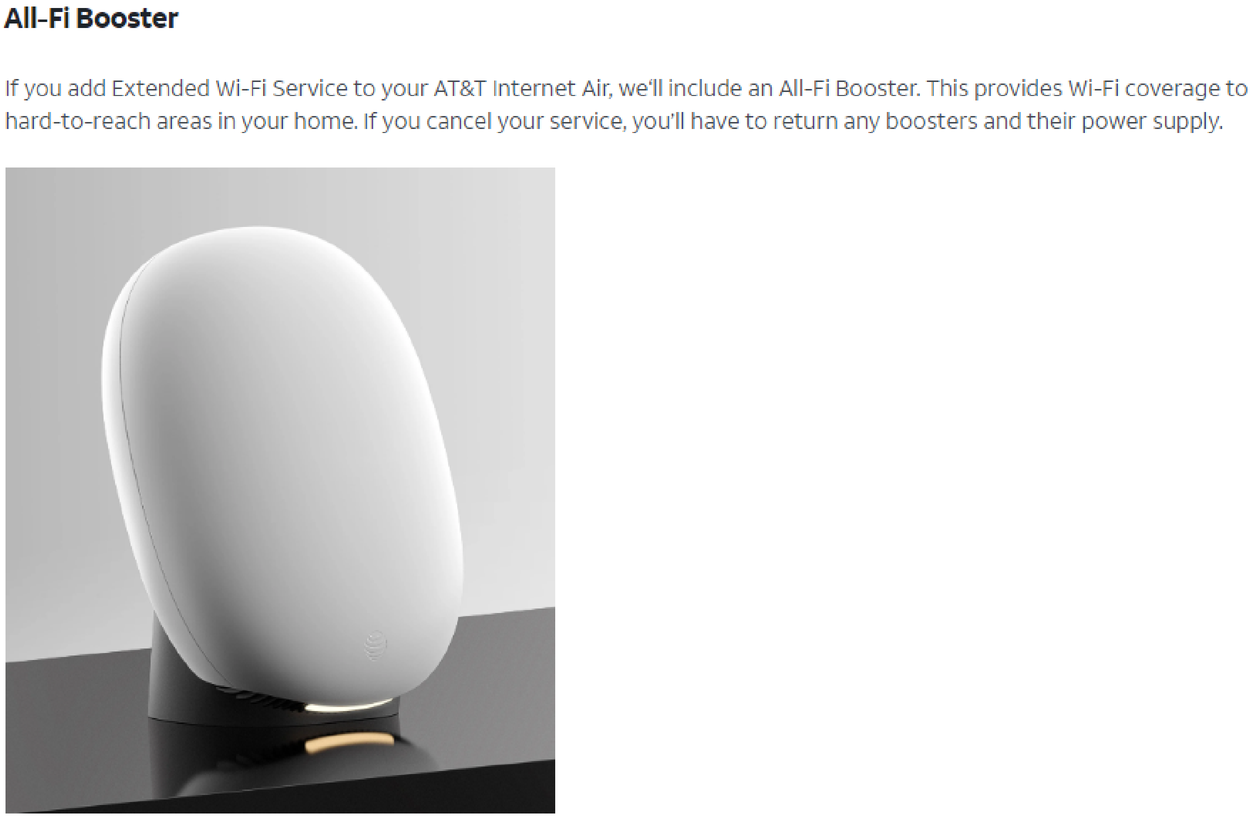
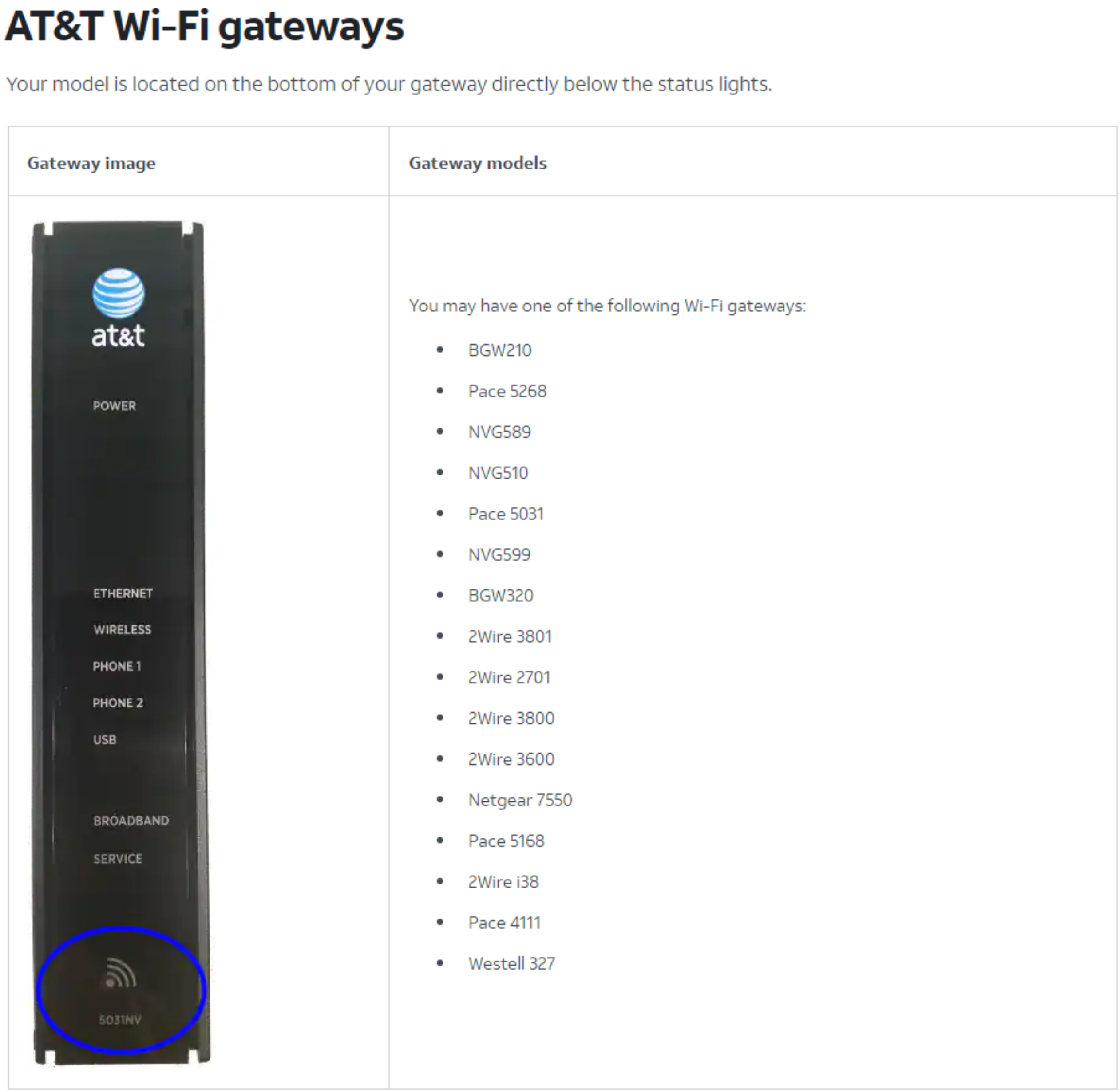
	 **Wi-Fi extender** If you add Extended Wi-Fi Service to your internet plan, we'll include an AirTies 4971 Wi-Fi extender. This provides Wi-Fi coverage to hard-to-reach areas in your home. If you cancel your internet, you'll have to return any AirTies 4971 extenders and their power supply. You may also have older models, including the AirTies 4920 or 4921. These were available for purchase and won't have to be returned.  **AirTies 4971**  **AirTies 4921**

	 **All-Fi Booster** If you add Extended Wi-Fi Service to your AT&T Internet Air, we'll include an All-Fi Booster. This provides Wi-Fi coverage to hard-to-reach areas in your home. If you cancel your service, you'll have to return any boosters and their power supply. https://www.att.com/support/article/u-verse-high-speed-internet/KM1011652/



AT&T Wi-Fi gateways

Your model is located on the bottom of your gateway directly below the status lights.

Gateway image	Gateway models
	You may have one of the following Wi-Fi gateways: • BGW210 • Pace 5268 • NVG589 • NVG510 • Pace 5031 • NVG599 • BGW320 • 2Wire 3801 • 2Wire 2701 • 2Wire 3800 • 2Wire 3600 • Netgear 7550 • Pace 5168 • 2Wire i38 • Pace 4111 • Westell 327

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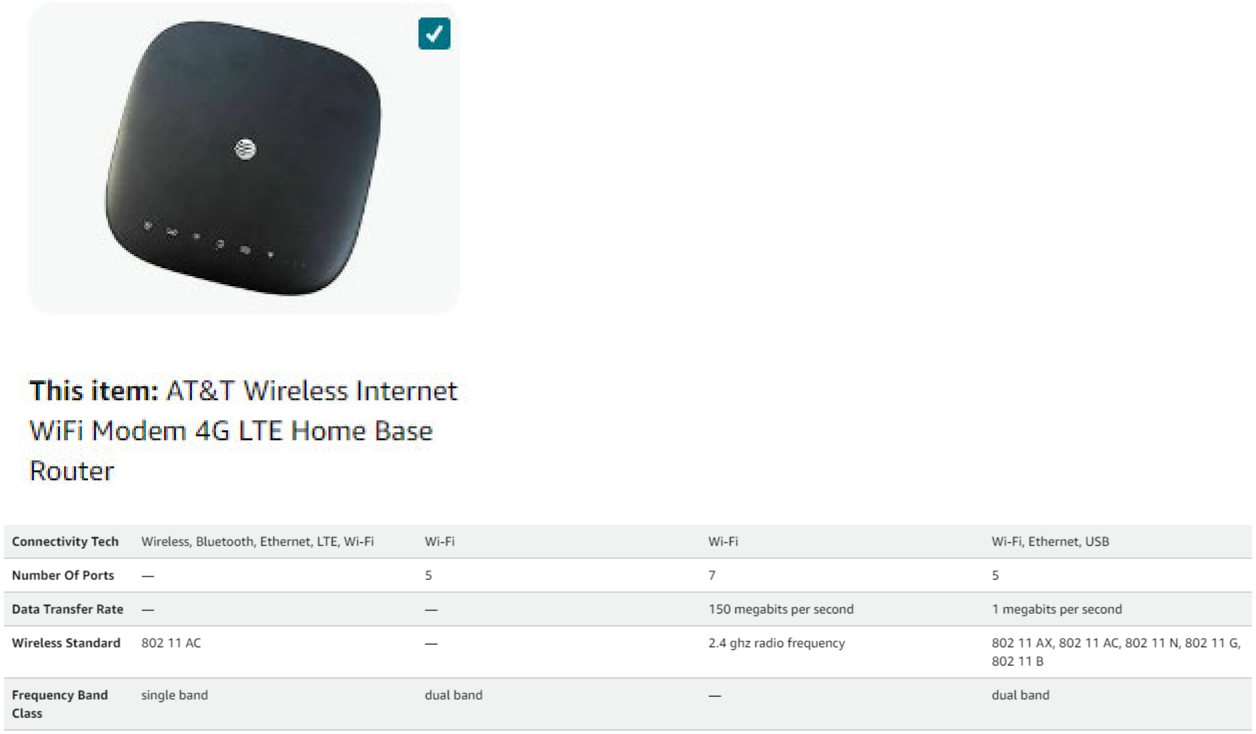
https://www.att.com/support/article/dsl-high-speed/KM1047050/

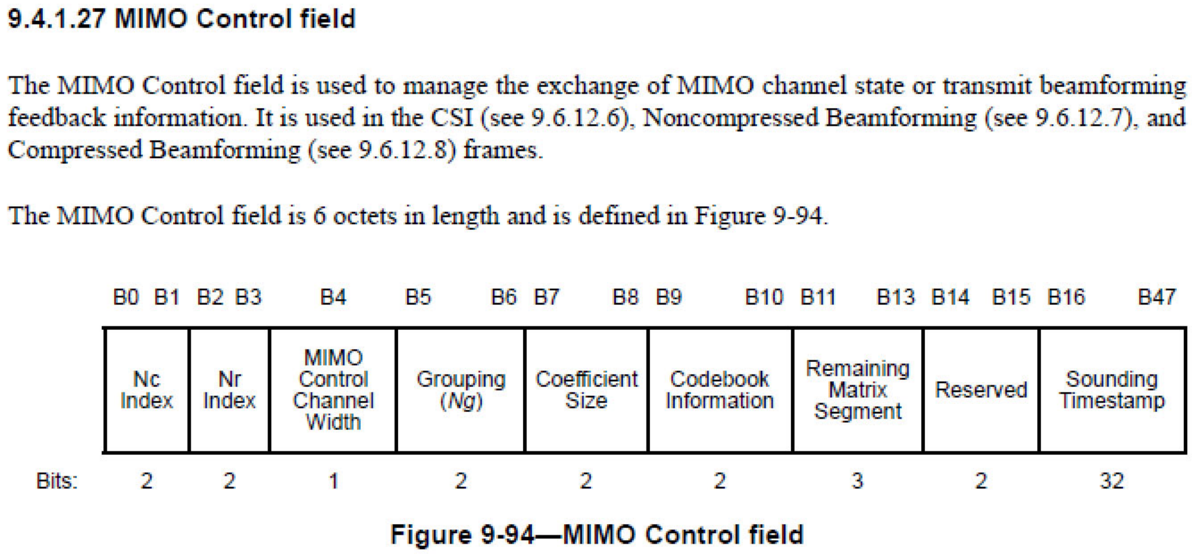


This item: AT&T Wireless Internet WiFi Modem 4G LTE Home Base Router

<table>
<tr><td>**Connectivity Tech**</td><td>Wireless, Bluetooth, Ethernet, LTE, Wi-Fi</td><td>Wi-Fi</td><td>Wi-Fi</td><td>Wi-Fi, Ethernet, USB</td></tr>
<tr><td>**Number Of Ports**</td><td>—</td><td>5</td><td>7</td><td>5</td></tr>
<tr><td>**Data Transfer Rate**</td><td>—</td><td>—</td><td>150 megabits per second</td><td>1 megabits per second</td></tr>
<tr><td>**Wireless Standard**</td><td>802 11 AC</td><td>—</td><td>2.4 ghz radio frequency</td><td>802 11 AX, 802 11 AC, 802 11 N, 802 11 G, 802 11 B</td></tr>
<tr><td>**Frequency Band Class**</td><td>single band</td><td>dual band</td><td>—</td><td>dual band</td></tr>
</table>

https://www.amazon.com/Wireless-Internet-Hotspot-Antenna-AT/dp/B075JB968D?source=ps-sl-shoppingads-lpcontext&ref_=fplfs&psc=1&smid=A24OVZW9214RO6
</td>
</tr>
<tr>
<td>72. The method of claim 53, wherein the compressed first feedback and the compressed second feedback are received utilizing a dedicated channel.</td>
<td>
When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below:

Note: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
</td>
</tr>
</table>

<table>
<tr>
<td></td>
<td>


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.

<table>
<tr><td></td><td>B0 B1</td><td>B2 B3</td><td>B4</td><td>B5 B6</td><td>B7 B8</td><td>B9 B10</td><td>B11 B13</td><td>B14 B15</td><td>B16 B47</td></tr>
<tr><td></td><td>Nc Index</td><td>Nr Index</td><td>MIMO Control Channel Width</td><td>Grouping (<i>Ng</i>)</td><td>Coefficient Size</td><td>Codebook Information</td><td>Remaining Matrix Segment</td><td>Reserved</td><td>Sounding Timestamp</td></tr>
<tr><td>Bits:</td><td>2</td><td>2</td><td>1</td><td>2</td><td>2</td><td>2</td><td>3</td><td>2</td><td>32</td></tr>
</table>

Figure 9-94—MIMO Control field

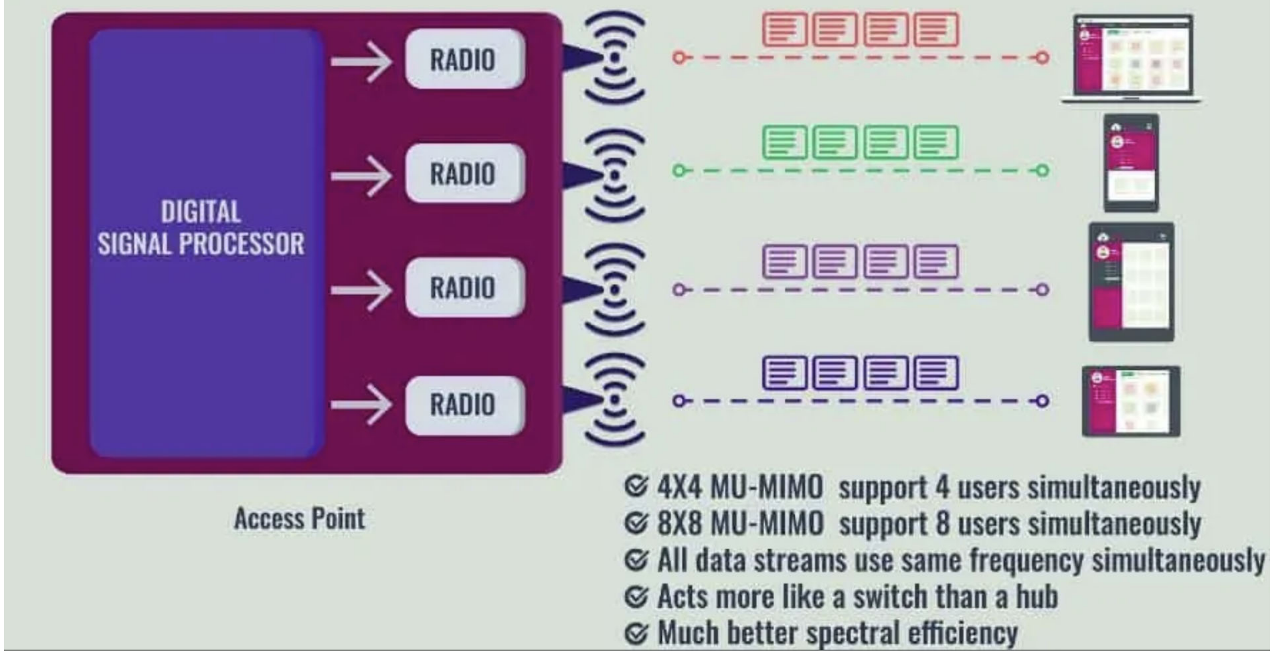
Page 745 of 802.11-2016
</td>
</tr>
<tr>
<td>73. The method of claim 53, wherein the compressed first feedback and the compressed second feedback are received via an antenna configured for omnidirectional communication.</td>
<td>
When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below:

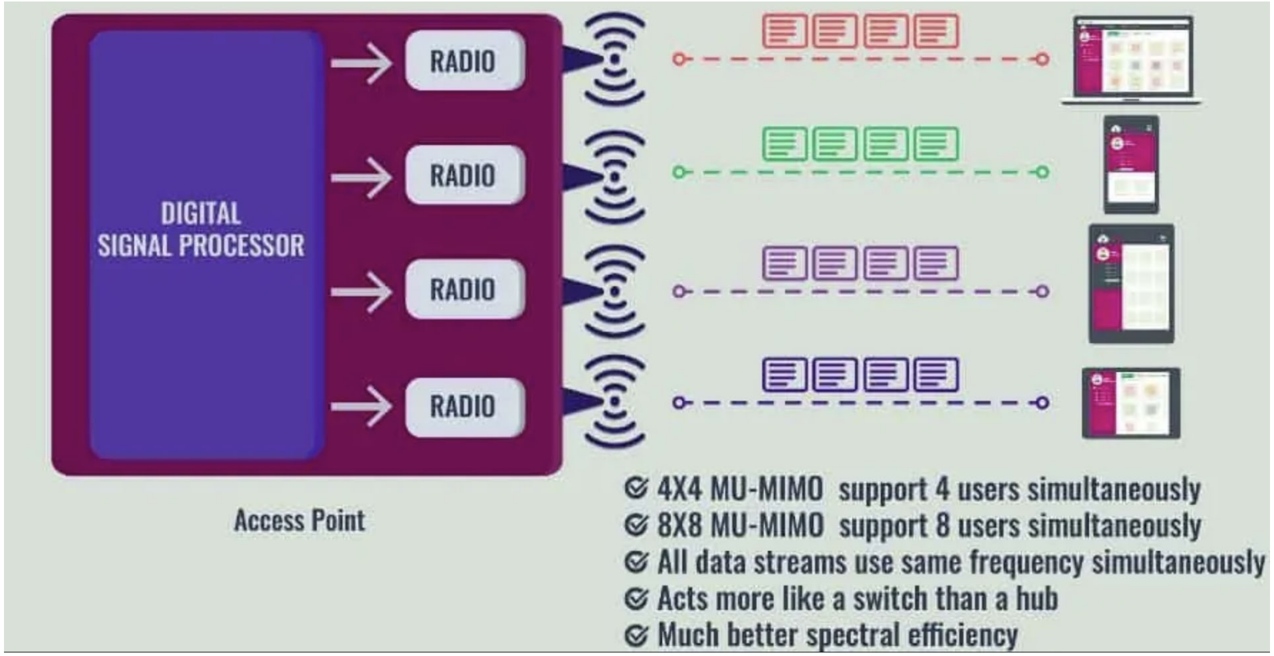
<u>Note</u>: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):

"If the STA has multiple antennas, it shall transmit using an approximation to an omnidirectional pattern."

Page 1787 of 802.11-2016
</td>
</tr>
<tr>
<td>74. The method of claim 53, wherein the decompressed first feedback and the decompressed second feedback are used to</td>
<td>
When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below:

<u>Note</u>: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
</td>
</tr>
</table>

increase spatial separation among transmissions.	“In very high density environments, such as sports arenas and stadiums, high density coverage is typically achieved by using highly directional antennas to divide up the area into very small sectors, which may not provide the spatial separation that MU-MIMO requires.” http://www.emperorwifi.com/2015/04/a-simplified-explanation-of-80211nac.html  https://www.comparitech.com/net-admin/what-is-mu-mimo/
75. The method of claim 53, wherein the decompressed first feedback and the decompressed second feedback are used to increase spatial separation among transmissions at the same frequency.	When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):

	"In very high density environments, such as sports arenas and stadiums, high density coverage is typically achieved by using highly directional antennas to divide up the area into very small sectors, which may not provide the spatial separation that MU-MIMO requires." http://www.emperorwifi.com/2015/04/a-simplified-explanation-of-80211nac.html  https://www.comparitech.com/net-admin/what-is-mu-mimo/
76. The method of claim 53, and further comprising: receiving a compressed third feedback from a fourth node that characterizes receipt of a third signal sent from the first node to the fourth node, the fourth node being a legacy node;	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): **21.3.11.2 Beamforming Feedback Matrix *V***

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

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

After receiving the angle information, $\varphi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,N_{user}}\text{-}1]$ using $V_{k,u}$ and $SNR_{k,u}$ $(0 \leq u \leq N_{user}\text{-}1)$ 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."

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"**10.34.5 VHT sounding protocol**

10.34.5.1 General

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

If dot11VHTSUBeamformerOptionImplemented is true, a STA shall set the SU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTSUBeamformeeOptionImplemented is true, a STA shall set the SU Beamformee Capable field in the VHT Capabilities element to 1.

If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set the MU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set the MU Beamformee Capable field in the VHT Capabilities element to 1.

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

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

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

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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, *Nc* is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field, *Nr* is the number of rows in a compressed beamforming feedback matrix determined by the Nr Index field of the VHT MIMO Control field." Pages 764-765 of 802.11-2016
decompressing the compressed third feedback resulting in a decompressed third feedback;	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "**19.3.12.3.6 Compressed beamforming feedback matrix**

	In compressed beamforming feedback matrix, the beamformee shall remove the space-time stream CSD in Table 19-10 from the measured channel before computing a set of matrices for feedback to the beamformer. The beamforming feedback matrices, *V(k)*, found by the beamformee are compressed in the form of angles, which are sent to the beamformer. The beamformer might use these angles to decompress the matrices and determine the steering matrices Q_k. The matrix per tone shall be compressed as follows: The N_r x 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, using a third frequency and another 802.11-based OFDM protocol, the third transmission signal to the fourth node using a third power that is based on the decompressed third feedback.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in 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, where k is one of the subcarriers, and Q_k is consisted of sub-matrices $Q_{k,u}$, each corresponding to one receiving STA *u*. • IEEE 802.11-2016: **21.3.11.2 Beamforming Feedback Matrix *V*** further specifies that $Q_{k,u}$ is dependent on the feedback matrix $V_{k,u}$ provided by each STA *u*, which is based on the actual channel measurement by each STA *u*. • IEEE 802.11-2016: Figure 10-53 (below) illustrates that each STA (beamformee) is getting a different polling packet, based on which the feedback matrix $V_{k,u}$ is measured and should be different from STA to STA.

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

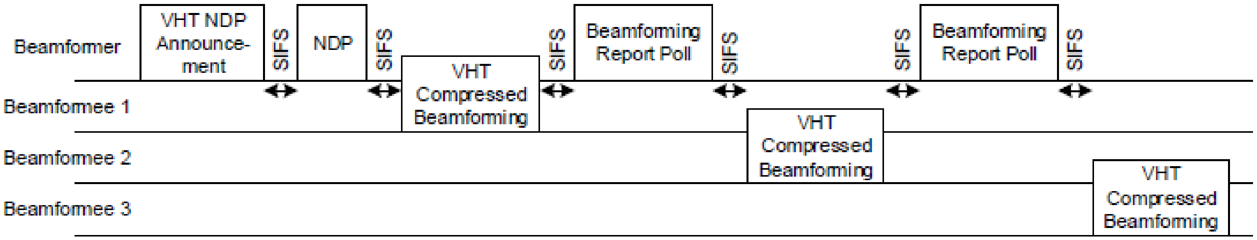

Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

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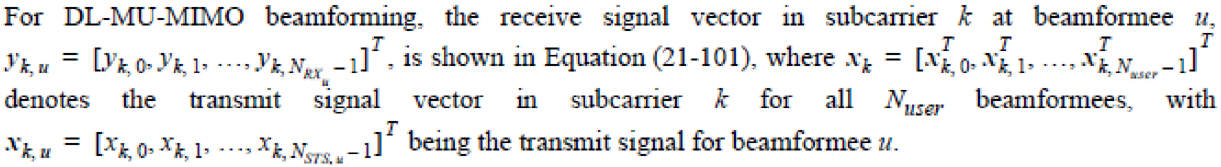
“21.3.11 SU-MIMO and DL-MU-MIMO Beamforming

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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0}, \; Q_{k,l} \ldots, \; Q_{k,Nuser}\text{-}1] \text{ x } x_k + n$$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions
N_{RXu} x 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 $Q_k = [Q_{k,0}, \; Q_{k,l} \ldots, \; Q_{k,Nuser}\text{-}1]$ 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 $u = 0, 1, \ldots, N_{user}$ -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)."

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"**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, $Q_{steer,k} = Q_kV_k$, with V_k found from H_kQ_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, $H_{eff,k} = H_kQ_k$, 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
77. The method of claim 53, wherein the compressed first feedback is based on a received power and one or more frequencies via which the first signal is communicated.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): **21.3.11.2 Beamforming Feedback Matrix *V*** "Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in Table 21-11 from the measured channel before computing a set of matrices for feedback to the beamformer. The beamforming feedback matrix, $V_{k,u}$, found by the beamformee *u* for subcarrier *k* shall be compressed in the form of angles using the method described in 19.3.12.3.6. The angles, $\varphi(k,v)$ and $\psi(k,u)$, are quantized according to Table 9-68. The number of bits for quantization is chosen by the beamformee, based on the indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DLMU- MIMO beamforming. The compressed beamforming feedback using 19.3.12.3.6 is the only Clause 21 beamforming feedback format defined. The beamformee shall generate the beamforming feedback matrices with the number of rows (*Nr*) equal to the N_{STS} of the NDP.

After receiving the angle information, $\varphi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,N_{user}}-1]$ 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."

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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.

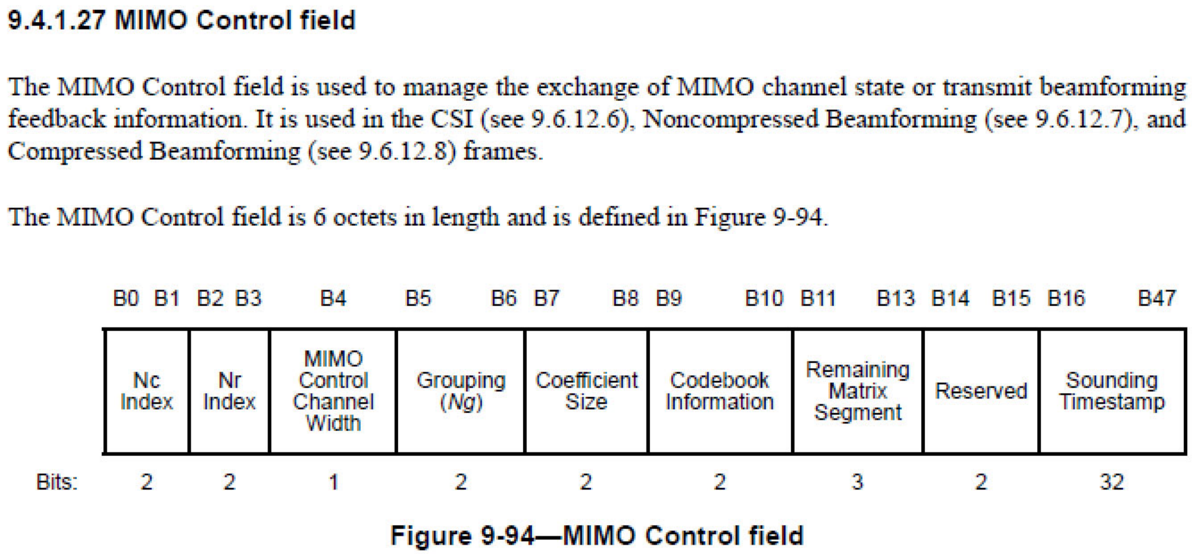
The size of the VHT Compressed Beamforming Report field depends on the values in the VHT MIMO Control field. The VHT Compressed Beamforming Report field contains VHT Compressed Beamforming Report information or successive (possibly zero-length) portions thereof in the case of segmented VHT Compressed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

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

Nr is the number of rows in a compressed beamforming feedback matrix determined by the Nr 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.

	B0 B1	B2 B3	B4	B5 B6	B7 B8	B9 B10	B11 B13	B14 B15	B16 B47
	Nc Index	Nr Index	MIMO Control Channel Width	Grouping (*Ng*)	Coefficient Size	Codebook Information	Remaining Matrix Segment	Reserved	Sounding Timestamp
Bits:	2	2	1	2	2	2	3	2	32

Figure 9-94—MIMO Control field

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"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."
https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html

78. The method of claim 53, wherein the compressed first feedback is based on a received power at a plurality of frequencies via which the first signal is communicated.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): **21.3.11.2 Beamforming Feedback Matrix *V*** "Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in Table 21-11 from the measured channel before computing a set of matrices for feedback to the beamformer. The beamforming feedback matrix, $V_{k,u}$, found by the beamformee u for subcarrier k shall be compressed in the form of angles using the method described in 19.3.12.3.6. The angles, $\varphi(k,v)$ and $\psi(k,u)$, are quantized according to Table 9-68. The number of bits for quantization is chosen by the beamformee, based on the indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DLMU- MIMO beamforming. The compressed beamforming feedback using 19.3.12.3.6 is the only Clause 21 beamforming feedback format defined. The beamformee shall generate the beamforming feedback matrices with the number of rows (Nr) equal to the N_{STS} of the NDP. After receiving the angle information, $\varphi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix $\mathrm{Q_k}$. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,N_{user}}\text{-}1]$ using $V_{k,u}$ and $SNR_{k,u}$ $(0 \le u \le N_{user}\text{-}1)$ 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.

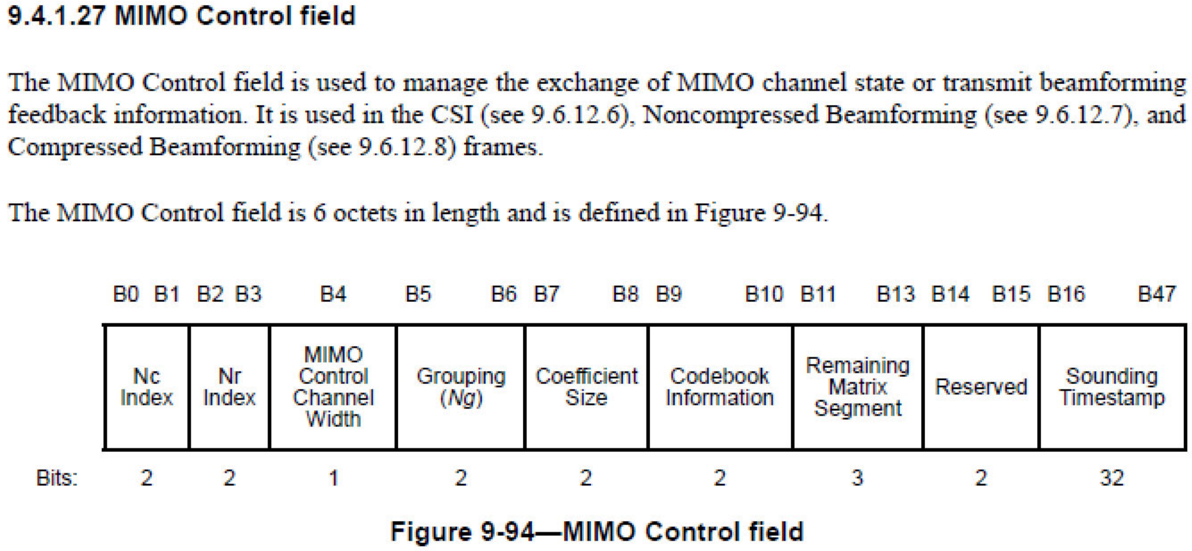
The size of the VHT Compressed Beamforming Report field depends on the values in the VHT MIMO Control field. The VHT Compressed Beamforming Report field contains VHT Compressed Beamforming Report information or successive (possibly zero-length) portions thereof in the case of segmented VHT Compressed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

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

Nr is the number of rows in a compressed beamforming feedback matrix determined by the Nr Index field of the VHT MIMO Control field.”

Pages 764-765 of 802.11-2016

<table>
<tr>
<td></td>
<td>


9.4.1.27 MIMO Control field

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

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<tr><td></td><td>Nc Index</td><td>Nr Index</td><td>MIMO Control Channel Width</td><td>Grouping (<i>Ng</i>)</td><td>Coefficient Size</td><td>Codebook Information</td><td>Remaining Matrix Segment</td><td>Reserved</td><td>Sounding Timestamp</td></tr>
<tr><td>Bits:</td><td>2</td><td>2</td><td>1</td><td>2</td><td>2</td><td>2</td><td>3</td><td>2</td><td>32</td></tr>
</table>

Figure 9-94—MIMO Control field

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“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.”
https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html
</td>
</tr>
<tr>
<td>79. The method of claim 53, wherein the compressed first feedback is based on a series of power values as a function of frequency.</td>
<td>
When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below:

<u>Note</u>: See evidence cited earlier in 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> <i>V</i>
</td>
</tr>
</table>

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

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

After receiving the angle information, $\varphi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,N_{user}}\text{-}1]$ using $V_{k,u}$ and $SNR_{k,u}$ $(0 \leq u \leq N_{user}\text{-}1)$ 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.”

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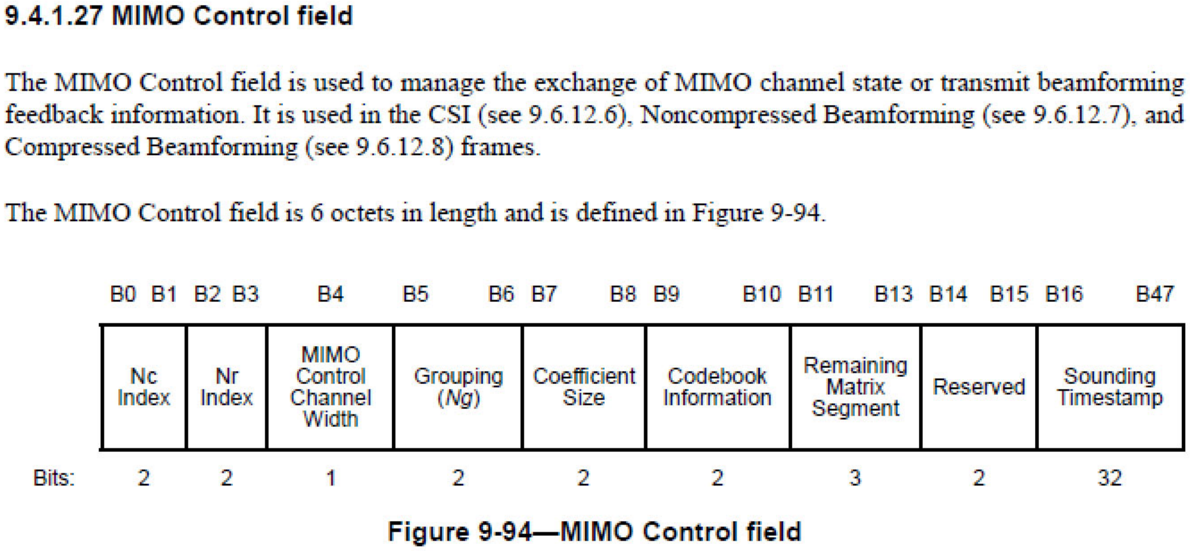
“**9.4.1.49 VHT Compressed Beamforming Report field**

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, *Nc* is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field, *Nr* is the number of rows in a compressed beamforming feedback matrix determined by the Nr Index field of the VHT MIMO Control field.” Pages 764-765 of 802.11-2016

<table>
<tr>
<td></td>
<td>

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.

<table>
<tr><td></td><td>B0 B1</td><td>B2 B3</td><td>B4</td><td>B5 B6</td><td>B7 B8</td><td>B9 B10</td><td>B11 B13</td><td>B14 B15</td><td>B16 B47</td></tr>
<tr><td></td><td>Nc Index</td><td>Nr Index</td><td>MIMO Control Channel Width</td><td>Grouping (<i>Ng</i>)</td><td>Coefficient Size</td><td>Codebook Information</td><td>Remaining Matrix Segment</td><td>Reserved</td><td>Sounding Timestamp</td></tr>
<tr><td>Bits:</td><td>2</td><td>2</td><td>1</td><td>2</td><td>2</td><td>2</td><td>3</td><td>2</td><td>32</td></tr>
</table>
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.”
https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html
</td>
</tr>
<tr>
<td>80. The method of claim 53, wherein the compressed first feedback includes a data structure that is based on a series of power values as a function of frequency.</td>
<td>
When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below:

<u>Note</u>: See evidence cited earlier in 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> <i>V</i>
</td>
</tr>
</table>

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

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

After receiving the angle information, $\varphi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1]$ 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, *Nc* is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field, *Nr* is the number of rows in a compressed beamforming feedback matrix determined by the Nr 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." https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html
81. The method of claim 53, wherein the instruction is received prior to the receipt of the compressed first feedback.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):

9.3.1.2 RTS frame format

The frame format for the RTS frame is as defined in Figure 9-20.

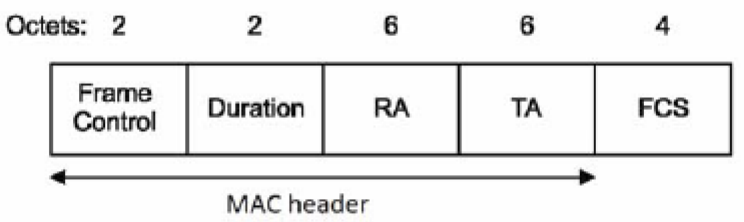


Figure 9-20—RTS frame

9.3.1.3 CTS frame format

The frame format for the CTS frame is as defined in Figure 9-21.

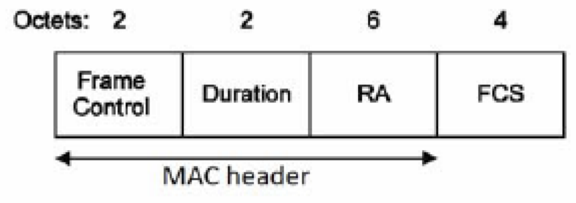


Figure 9-21—CTS frame

Page 670 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, *Nc* is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field, *Nr* is the number of rows in a compressed beamforming feedback matrix determined by the Nr Index field of the VHT MIMO Control field." Pages 764-765 of 802.11-2016
82. The method of claim 53, wherein the instruction is received separately with respect to the receipt of the compressed first feedback.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):

9.3.1.2 RTS frame format

The frame format for the RTS frame is as defined in Figure 9-20.

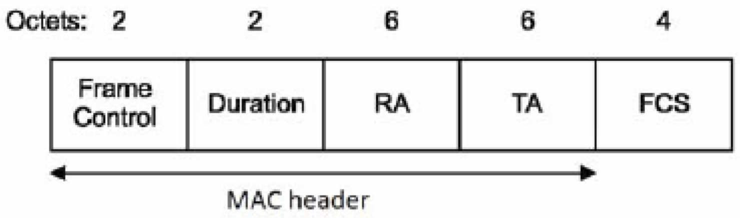


Figure 9-20—RTS frame

9.3.1.3 CTS frame format

The frame format for the CTS frame is as defined in Figure 9-21.

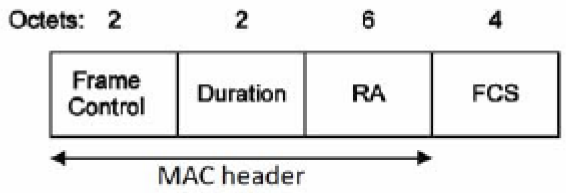


Figure 9-21—CTS frame

Page 670 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, *Nc* is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field, *Nr* is the number of rows in a compressed beamforming feedback matrix determined by the Nr Index field of the VHT MIMO Control field." Pages 764-765 of 802.11-2016
83. The method of claim 53, wherein at least three transmission signals are capable of being simultaneously transmitted to at least three different devices, using the same multiple antennas.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "The 11ac standard only allowed up to four clients in a MU-MIMO group, so an AP or wireless router was limited to simultaneously sending to four devices at a time." https://www.wifisurveyors.com/wifi-mu-mimo • IEEE 802.11-2016: **21.3.11 SU-MIMO and DL-MU-MIMO Beamforming** and **21.3.11.1 General** specifies the steering matrix Q_k for DL-MU-MIMO, where k is one of

the subcarriers, and Q_k is consisted of sub-matrices $Q_{k,u}$, each corresponding to one receiving STA u.

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

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

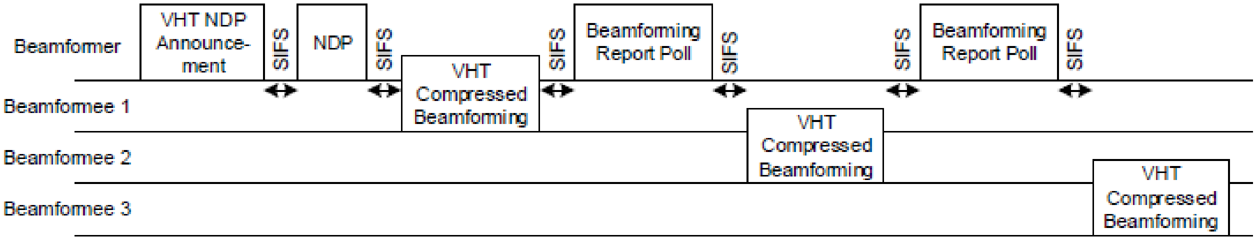


Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

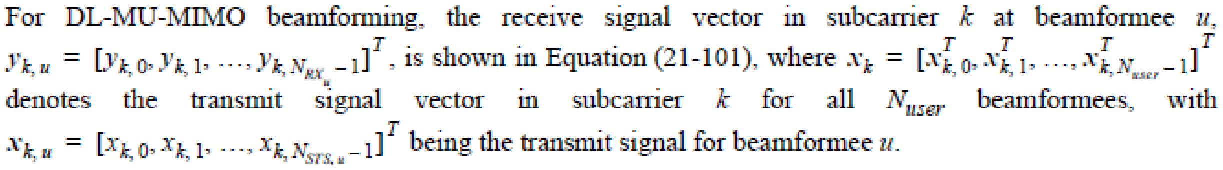
Pages 1490-2579 of 802.11-2016

"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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0},\ Q_{k,l} \ldots,\ Q_{k,Nuser}\text{-}1] \text{ x } x_k + n$$

where

$H_{k,u}$	is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions N_{RXu} x 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 $Q_k = [Q_{k,0},\ Q_{k,l} \ldots,\ Q_{k,Nuser}\text{-}1]$ 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 $u = 0, 1, \ldots, N_{user} -1$. 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, $Q_{steer,k} = Q_kV_k$, with V_k found from H_kQ_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, $H_{eff,k} = H_kQ_k$, 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 MU-MIMO technology further changed the rules of wireless engagement, enabling an AP or router to use its separate spatial streams to talk to multiple endpoints or users concurrently. MIMO. Both the transmitting device and the receiving client(s) can send and receive multiple streams using multiple antennas. Alternatively, the transmitting device has multiple antennas that it uses to simultaneously transmit to multiple clients, some or all of which have only one receiving antenna each. https://www.techtarget.com/searchnetworking/feature/5-things-to-know-about-MU-MIMO-technology-in-Wi-Fi-networks

	“AT&T’s most recent generation of Wi-Fi equipment generally supports Wi-Fi 6 (IEEE 802.11ax) standard and is compatible with older Wi-Fi (IEEE 802.11 a/b/g/n/ac) standards . . . AT&T reserves the right to manage remotely any equiprement used to access any Internet Servic e, whether that equipment is connected via a wired or wireless connection . . . Access to AT&T’s nationwide network of Wi-Fi Hot Spots may be available to use as part of the Service . . . .” https://www.att.com/legal/terms.consumerserviceagreement.html “Enjoy a fully managed Wi-Fi service with a robust Day 0, 1, and 2 support model. From site design to professional installation to ongoing care, we have you covered . . . Choose which equipment option will best suit your needs (Cisco Meraki, Aruba, or Mist). Then decide whether you would like AT&T to professionally install the equipment or you would like to self-install . . .No matter which equipment option you choose, all come with Wi-Fi 6 compatible devices. . . . AT&T offers a robust support model with Day 0, 1, and 2 support available. AT&T offers professional services to conduct site surveys, design networks, install equipment, and provide ongoing care and maintenance.” https://www.business.att.com/products/business-wifi.html “Wi-Fi 6 has five key technologies . . . Multi-user multiple-input, multiple-output (MU-MIMO) allows more data to be transferred at once, enabling an access point to handle a larger number of concurrent users. This contributes to the efficiency of the spectrum and massive device connectivity.” https://www.business.att.com/content/dam/attbusiness/briefs/att-will-5g-replace-wifi-general-business-brief.pdf
84. The method of claim 53, wherein at least three transmission signals are capable of being simultaneously transmitted to at least three different devices, using at least one different antenna.	When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): “The 11ac standard only allowed up to four clients in a MU-MIMO group, so an AP or wireless router was limited to simultaneously sending to four devices at a time.” https://www.wifisurveyors.com/wifi-mu-mimo

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

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

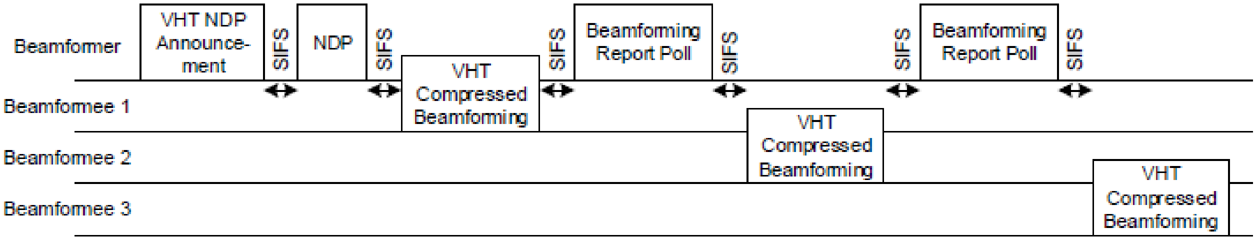


Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

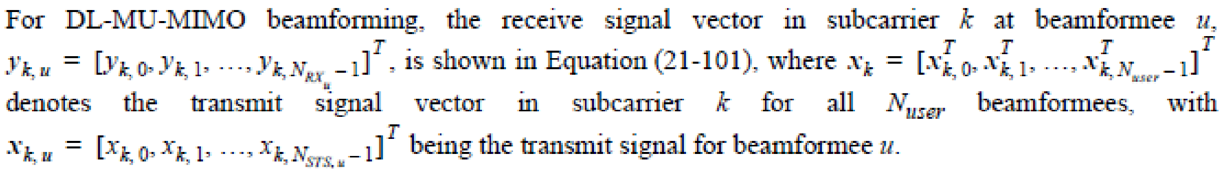
Pages 1490-2579 of 802.11-2016

“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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1] \text{ x } x_k + n$$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions N_{RXu} x 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 $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1]$ 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 $u = 0, 1, \ldots, N_{user}$ -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.”

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MU-MIMO technology further changed the rules of wireless engagement, enabling an AP or router to use its separate spatial streams to talk to multiple endpoints or users concurrently.

MIMO. Both the transmitting device and the receiving client(s) can send and receive multiple streams using multiple antennas. Alternatively, the transmitting device has multiple antennas that it uses to simultaneously transmit to multiple clients, some or all of which have only one receiving antenna each.
https://www.techtarget.com/searchnetworking/feature/5-things-to-know-about-MU-MIMO-technology-in-Wi-Fi-networks

85. The method of claim 53, wherein the instruction includes a request to send (RTS) instruction.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **<u>Note</u>**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "**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. <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>" Page 1304 of 802.11-2016
86. The method of claim 53, wherein the instruction includes a 802.11 clear to send (CTS) instruction.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **<u>Note</u>**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "**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
87. The method of claim 53, wherein the filtered first transmission signal is transmitted using a frequency band that is selected based on the instruction and the filtered second transmission signal is transmitted using the frequency band that is selected based on another instruction received from the third node, where the filtered first transmission signal is transmitted using a first frequency in the frequency band and the filtered second transmission signal is transmitted using a second frequency in the frequency band.	When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): “**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 “**primary 20 MHz channel**: In a 40 MHz, 80 MHz, 160 MHz, or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 20 MHz channel that is used to transmit 20 MHz physical layer (PHY) protocol data units (PPDUs). In a VHT BSS, the primary 20 MHz channel is also the primary channel.

	primary 40 MHz channel: In an 80 MHz, 160 MHz, or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 40 MHz channel that is used to transmit 40 MHz physical layer (PHY) protocol data units (PPDUs). **primary 80 MHz channel**: In a 160 MHz or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 80 MHz channel that is used to transmit 80 MHz physical layer (PHY) protocol data units (PPDUs). **primary access category (AC)**: The access category (AC) associated with the enhanced distributed channel access function (EDCAF) that gains channel access. . . . **secondary 20 MHz channel**: In a 40 MHz very high throughput (VHT) basic service set (BSS), the 20 MHz channel adjacent to the primary 20 MHz channel that together form the 40 MHz channel of the 40 MHz VHT BSS. In an 80 MHz VHT BSS, the 20 MHz channel adjacent to the primary 20 MHz channel that together form the primary 40 MHz channel of the 80 MHz VHT BSS. In a 160 MHz or 80+80 MHz VHT BSS, the 20 MHz channel adjacent to the primary 20 MHz channel that together form the primary 40 MHz channel of the 160 MHz or 80+80 MHz VHT BSS. In a VHT BSS, the secondary 20 MHz channel is also the secondary channel. **secondary 40 MHz channel**: In an 80 MHz very high throughput (VHT) basic service set (BSS), the 40 MHz channel adjacent to the primary 40 MHz channel that together form the 80 MHz channel of the 80 MHz VHT BSS. In a 160 or 80+80 MHz VHT BSS, the 40 MHz channel adjacent to the primary 40 MHz channel that together form the primary 80 MHz channel. **secondary 80 MHz channel**: In a 160 MHz or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 80 MHz channel not including the primary 20 MHz channel, that together with the primary 80 MHz channel forms the 160 MHz or 80+80 MHz channel of the 160 MHz or 80+80 MHz VHT BSS.

	secondary access category (AC): An access category (AC) that is not associated with the enhanced distributed channel access function (EDCAF) that gains channel access. NOTE—Traffic associated with a secondary AC can be included in a multi-user (MU) physical layer (PHY) protocol data unit (MU PPDU) that includes traffic associated with the primary AC. There could be multiple secondary ACs at a given time.” Pages 161-163 of 802.11-2016
88. The method of claim 53, wherein the filtered first transmission signal is transmitted using a first frequency and the filtered second transmission signal is transmitted using a second frequency.	When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in 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, where k is one of the subcarriers, and Q_k is consisted of sub-matrices $Q_{k,u}$, each corresponding to one receiving STA *u*. • IEEE 802.11-2016: **21.3.11.2 Beamforming Feedback Matrix *V*** further specifies that $Q_{k,u}$ is dependent on the feedback matrix $V_{k,u}$ provided by each STA *u*, which is based on the actual channel measurement by each STA *u*. • IEEE 802.11-2016: Figure 10-53 (below) illustrates that each STA (beamformee) is getting a different polling packet, based on which the feedback matrix $V_{k,u}$ is measured and should be different from STA to STA.

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

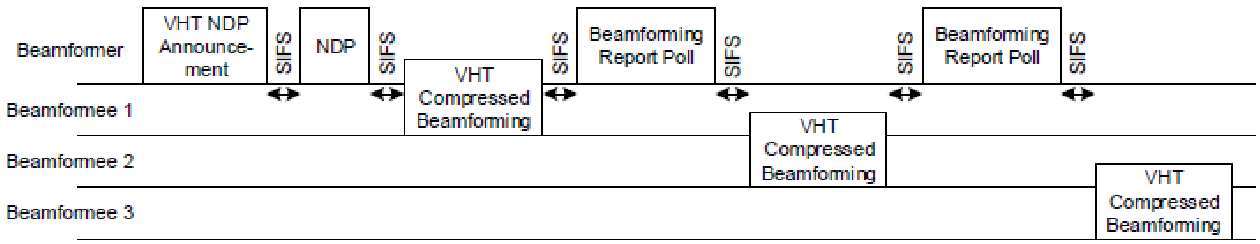

Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

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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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0},\ Q_{k,1} \ldots,\ Q_{k,Nuser}\text{-}1] \text{ x } x_k + n$$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions
N_{RXu} x 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 $Q_k = [Q_{k,0},\ Q_{k,1} \ldots,\ Q_{k,Nuser}\text{-}1]$ 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 $u = 0, 1, \ldots, N_{user} -1$. 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)."

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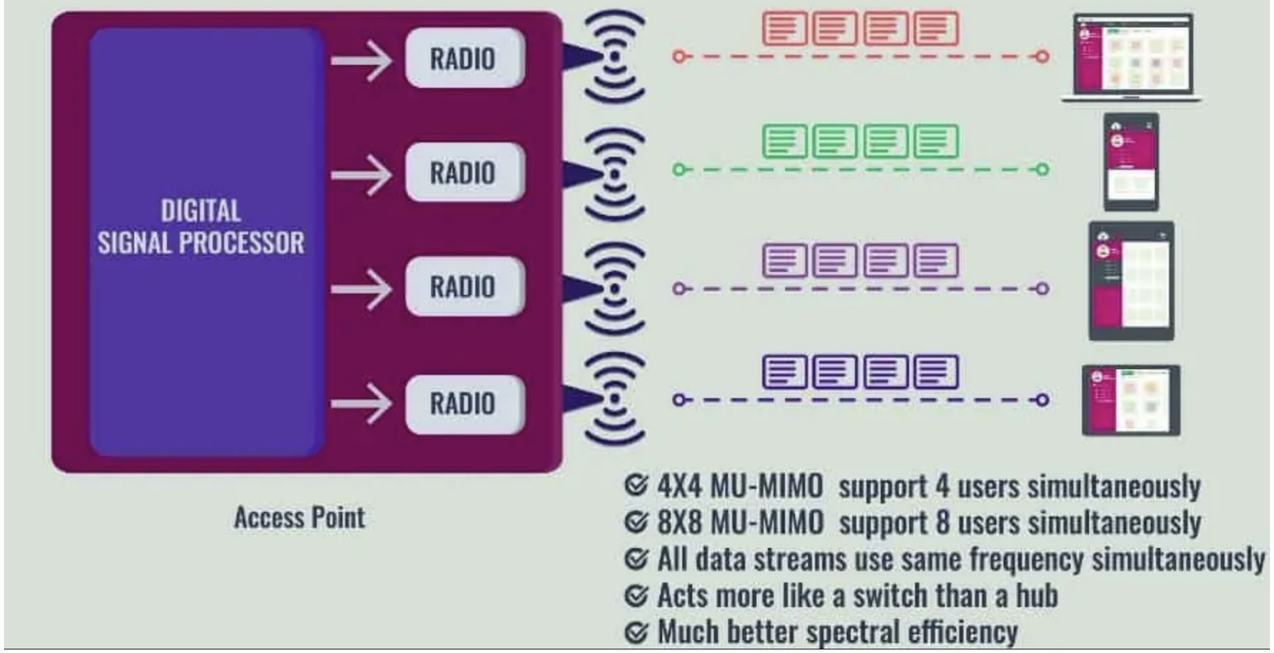
"**19.3.12.3 Explicit feedback beamforming**

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
89. The method of claim 53, wherein the filtered first transmission signal and the filtered second transmission signal are transmitted using the same one or more frequencies.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "The MU-MIMO enabled access point depicted in the diagram in Figure 2.0 below has four radio transceivers, and four antennas, each transmitting four different streams of data in parallel on the same frequency."



https://www.comparitech.com/net-admin/what-is-mu-mimo/

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

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

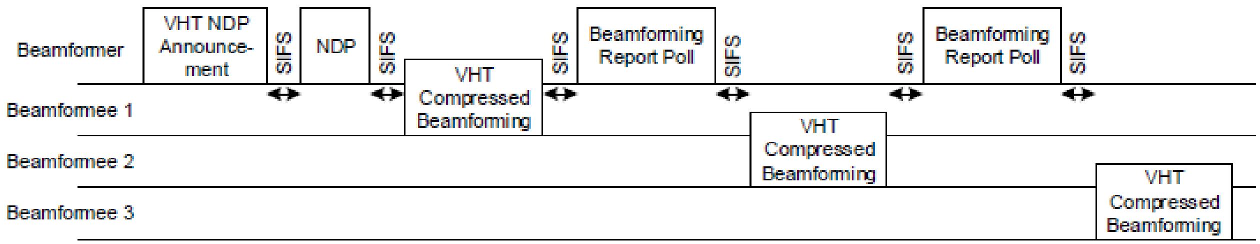


Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$Y_{k,u} = H_{k,u}$ x $[Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1]$ x $x_k + n$

where

$H_{k,u}$	is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions N_{RXu} x 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 $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1]$ 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 $u = 0, 1, \ldots, N_{user}$ -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)."

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"**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
90. The method of claim 53, wherein the filtered first transmission signal and the filtered second transmission signal are transmitted using the same frequency band.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "Another advantage of the RTS/CTS mechanism occurs where multiple BSSs utilizing the same channel overlap." Page 1304 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.“

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“**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
91. The method of claim 53, wherein the filtered first transmission signal is transmitted using a first frequency that is based on the instruction and the filtered second transmission signal is transmitted using a second frequency that is based on another instruction received from the third node.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **<u>Note</u>**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "**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. <u>An RTS/CTS exchange by VHT STAs also performs fast collision inference on the secondary 20</u>

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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“**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
92. The method of claim 53, wherein the filtered first transmission signal is transmitted using a frequency that is based on the instruction and the filtered second transmission signal is transmitted using the frequency that is based on another instruction received from the third node.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **<u>Note</u>**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "**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. <u>An RTS/CTS exchange by VHT STAs also performs fast collision inference on the secondary 20</u>

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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“**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
93. The method of claim 53, wherein the filtered first transmission signal is transmitted using a frequency band that is selected based on the instruction and the filtered second transmission signal is transmitted using the frequency band that is selected based on another instruction received from the third node.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **<u>Note</u>**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "**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. <u>An RTS/CTS exchange by VHT STAs also performs fast collision inference on the secondary 20</u>

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

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

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

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

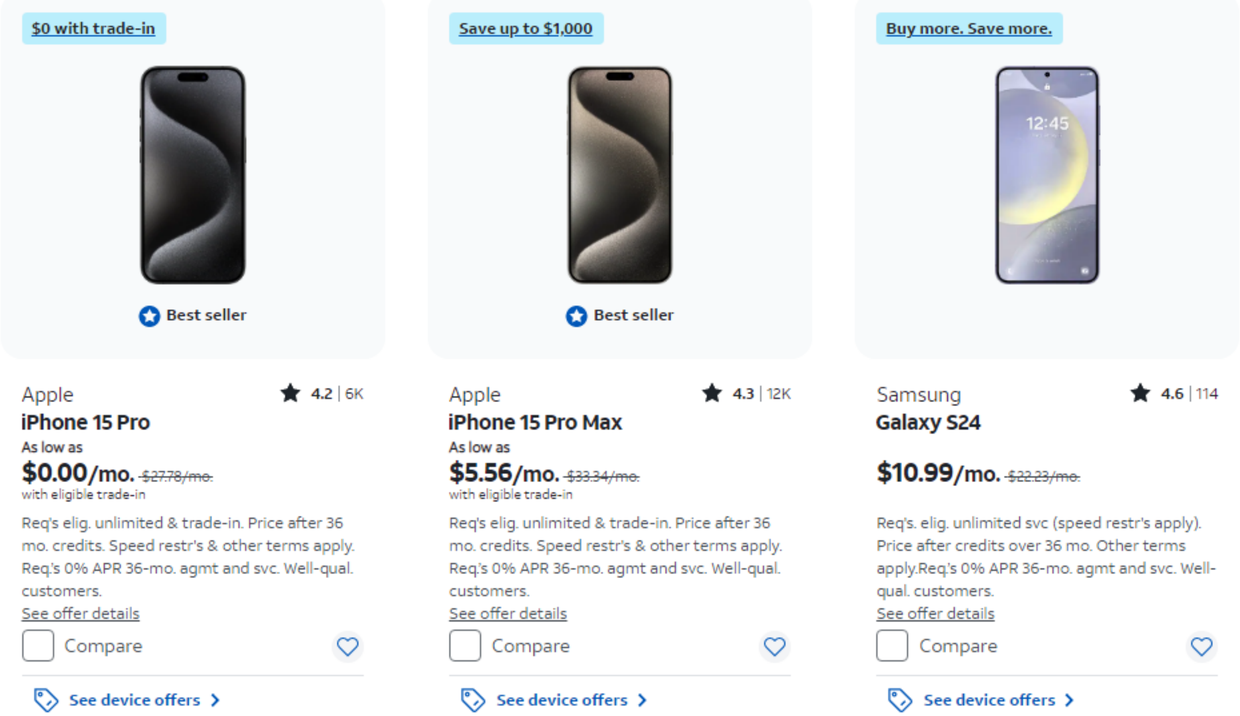
primary access category (AC): The access category (AC) associated with the enhanced distributed channel access function (EDCAF) that gains channel access.

. . .

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

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

	40 MHz channel adjacent to the primary 40 MHz channel that together form the 80 MHz channel of the 80 MHz VHT BSS. In a 160 or 80+80 MHz VHT BSS, the 40 MHz channel adjacent to the primary 40 MHz channel that together form the primary 80 MHz channel. **secondary 80 MHz channel**: In a 160 MHz or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 80 MHz channel not including the primary 20 MHz channel, that together with the primary 80 MHz channel forms the 160 MHz or 80+80 MHz channel of the 160 MHz or 80+80 MHz VHT BSS. **secondary access category (AC)**: An access category (AC) that is not associated with the enhanced distributed channel access function (EDCAF) that gains channel access. NOTE—Traffic associated with a secondary AC can be included in a multi-user (MU) physical layer (PHY) protocol data unit (MU PPDU) that includes traffic associated with the primary AC. There could be multiple secondary ACs at a given time." Pages 161-163 of 802.11-2016
95. A method for managing interference in a radio communications network, comprising the steps of:	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform a method for managing interference in a radio communications network. For example, as evidenced below, AT&T makes, uses, or sells 802.11ac-compliant stations (STA) (including, but not limited to Phone Devices, etc.) which, when operated by AT&T, AT&T's employees, agents and/or AT&T's customers, require performance of a method for managing interference in a radio communications network (e.g., a 802.11ac-compliant network).

	 $0 with trade-in Best seller Apple ★ 4.2 | 6K **iPhone 15 Pro** As low as **$0.00/mo.** ~~$27.78/mo.~~ with eligible trade-in Req's elig. unlimited & trade-in. Price after 36 mo. credits. Speed restr's & other terms apply. Req's 0% APR 36-mo. agmt and svc. Well-qual. customers. See offer details ☐ Compare See device offers › Save up to $1,000 Best seller Apple ★ 4.3 | 12K **iPhone 15 Pro Max** As low as **$5.56/mo.** ~~$33.34/mo.~~ with eligible trade-in Req's elig. unlimited & trade-in. Price after 36 mo. credits. Speed restr's & other terms apply. Req's 0% APR 36-mo. agmt and svc. Well-qual. customers. See offer details ☐ Compare See device offers › Buy more. Save more. Samsung ★ 4.6 | 114 **Galaxy S24** **$10.99/mo.** ~~$22.23/mo.~~ Req's. elig. unlimited svc (speed restr's apply). Price after credits over 36 mo. Other terms apply.Req's 0% APR 36-mo. agmt and svc. Well-qual. customers. See offer details ☐ Compare See device offers › https://www.att.com/buy/phones/[12]

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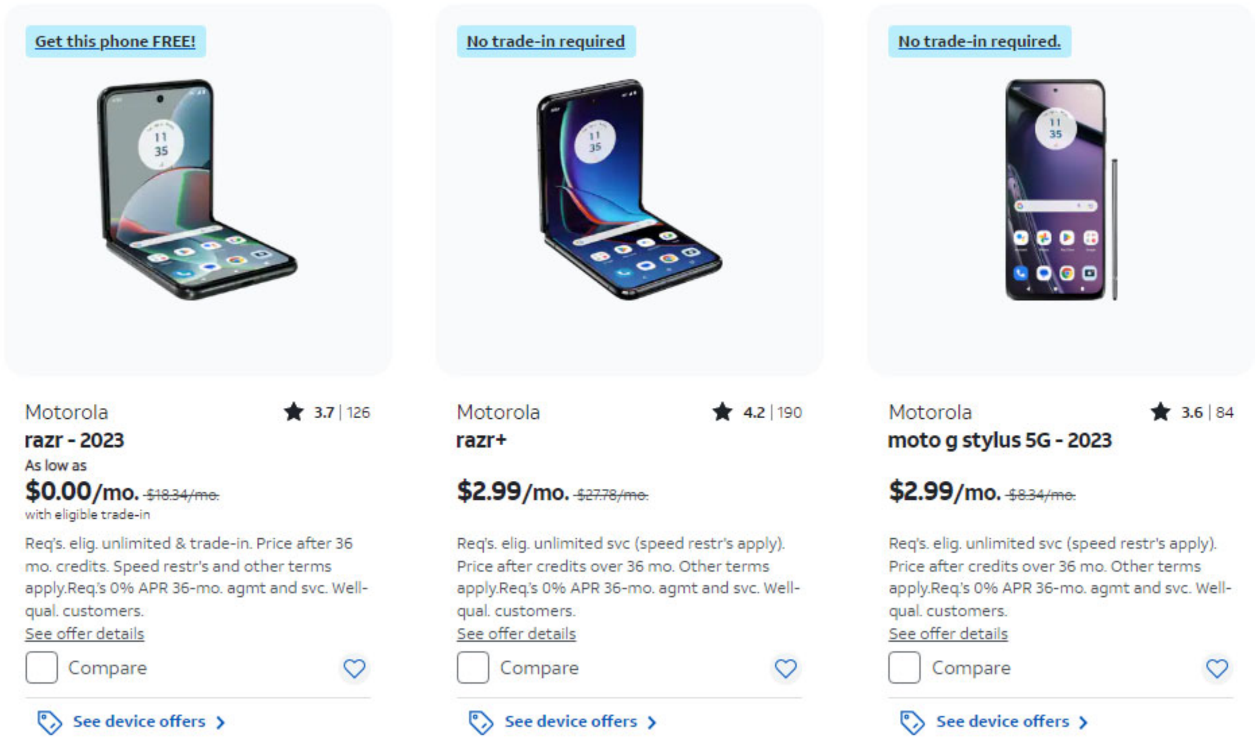
[12] For the avoidance of doubt, the Samsung Galaxy S24 is not an Accused Instrumentality.



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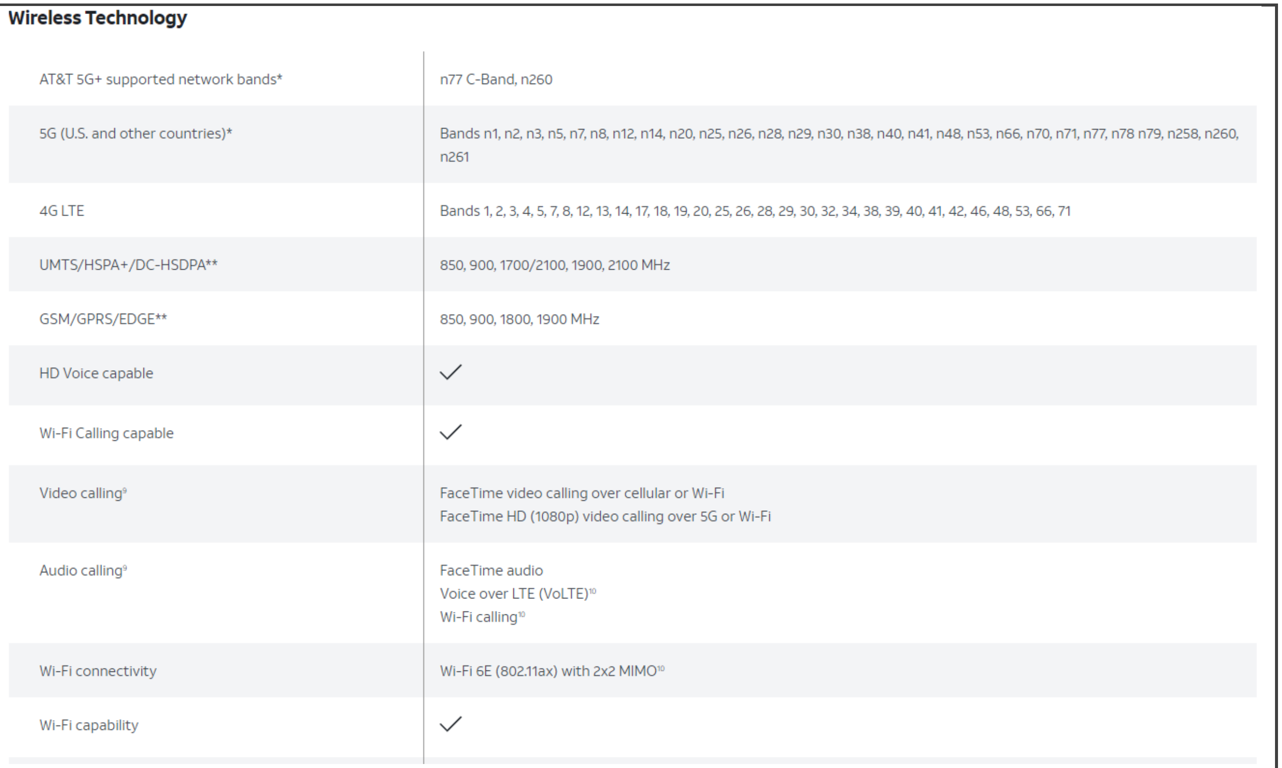
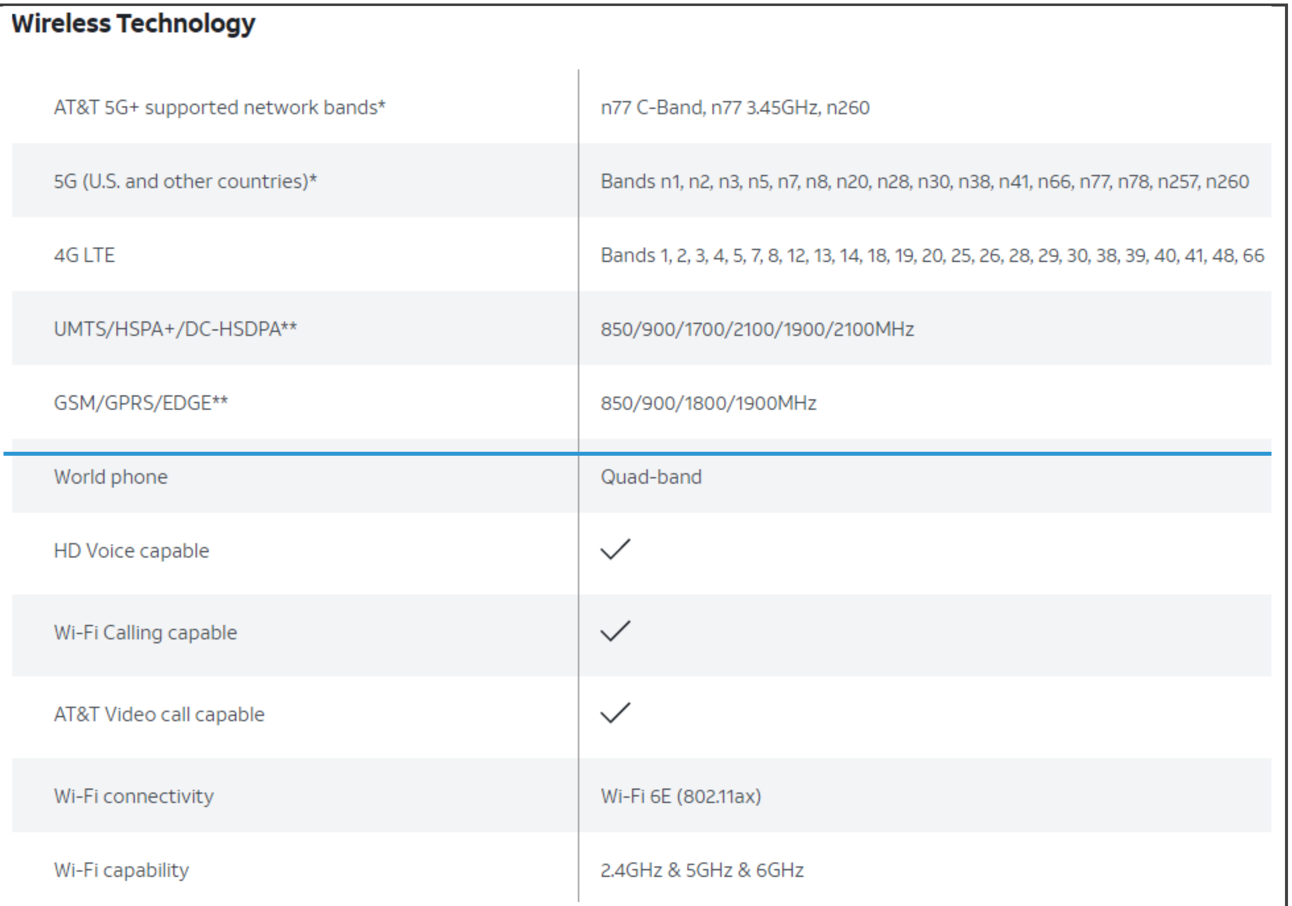


Wireless Technology

AT&T 5G+ supported network bands*	n77 C-Band, n260
5G (U.S. and other countries)*	Bands n1, n2, n3, n5, n7, n8, n12, n14, n20, n25, n26, n28, n29, n30, n38, n40, n41, n48, n53, n66, n70, n71, n77, n78 n79, n258, n260, n261
4G LTE	Bands 1, 2, 3, 4, 5, 7, 8, 12, 13, 14, 17, 18, 19, 20, 25, 26, 28, 29, 30, 32, 34, 38, 39, 40, 41, 42, 46, 48, 53, 66, 71
UMTS/HSPA+/DC-HSDPA**	850, 900, 1700/2100, 1900, 2100 MHz
GSM/GPRS/EDGE**	850, 900, 1800, 1900 MHz
HD Voice capable	✓
Wi-Fi Calling capable	✓
Video calling[9]	FaceTime video calling over cellular or Wi-Fi FaceTime HD (1080p) video calling over 5G or Wi-Fi
Audio calling[9]	FaceTime audio Voice over LTE (VoLTE)[10] Wi-Fi calling[10]
Wi-Fi connectivity	Wi-Fi 6E (802.11ax) with 2x2 MIMO[10]
Wi-Fi capability	✓

https://www.att.com/buy/phones/apple-iphone-15-pro.html



Wireless Technology

AT&T 5G+ supported network bands*	n77 C-Band, n77 3.45GHz, n260
5G (U.S. and other countries)*	Bands n1, n2, n3, n5, n7, n8, n20, n28, n30, n38, n41, n66, n77, n78, n257, n260
4G LTE	Bands 1, 2, 3, 4, 5, 7, 8, 12, 13, 14, 18, 19, 20, 25, 26, 28, 29, 30, 38, 39, 40, 41, 48, 66
UMTS/HSPA+/DC-HSDPA**	850/900/1700/2100/1900/2100MHz
GSM/GPRS/EDGE**	850/900/1800/1900MHz
World phone	Quad-band
HD Voice capable	✓
Wi-Fi Calling capable	✓
AT&T Video call capable	✓
Wi-Fi connectivity	Wi-Fi 6E (802.11ax)
Wi-Fi capability	2.4GHz & 5GHz & 6GHz

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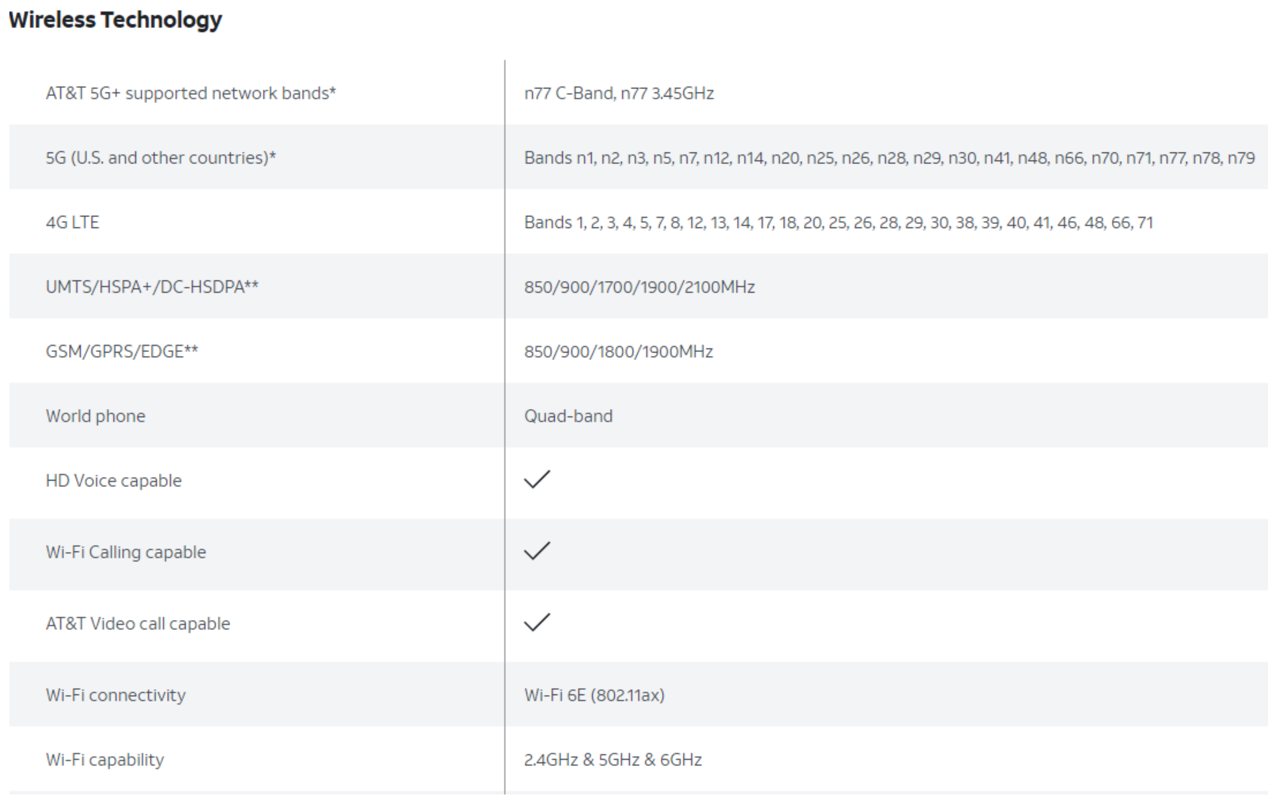

Wireless Technology

AT&T 5G+ supported network bands*	n77 C-Band, n77 3.45GHz
5G (U.S. and other countries)*	Bands n1, n2, n3, n5, n7, n12, n14, n20, n25, n26, n28, n29, n30, n41, n48, n66, n70, n71, n77, n78, n79
4G LTE	Bands 1, 2, 3, 4, 5, 7, 8, 12, 13, 14, 17, 18, 20, 25, 26, 28, 29, 30, 38, 39, 40, 41, 46, 48, 66, 71
UMTS/HSPA+/DC-HSDPA**	850/900/1700/1900/2100MHz
GSM/GPRS/EDGE**	850/900/1800/1900MHz
World phone	Quad-band
HD Voice capable	✓
Wi-Fi Calling capable	✓
AT&T Video call capable	✓
Wi-Fi connectivity	Wi-Fi 6E (802.11ax)
Wi-Fi capability	2.4GHz & 5GHz & 6GHz

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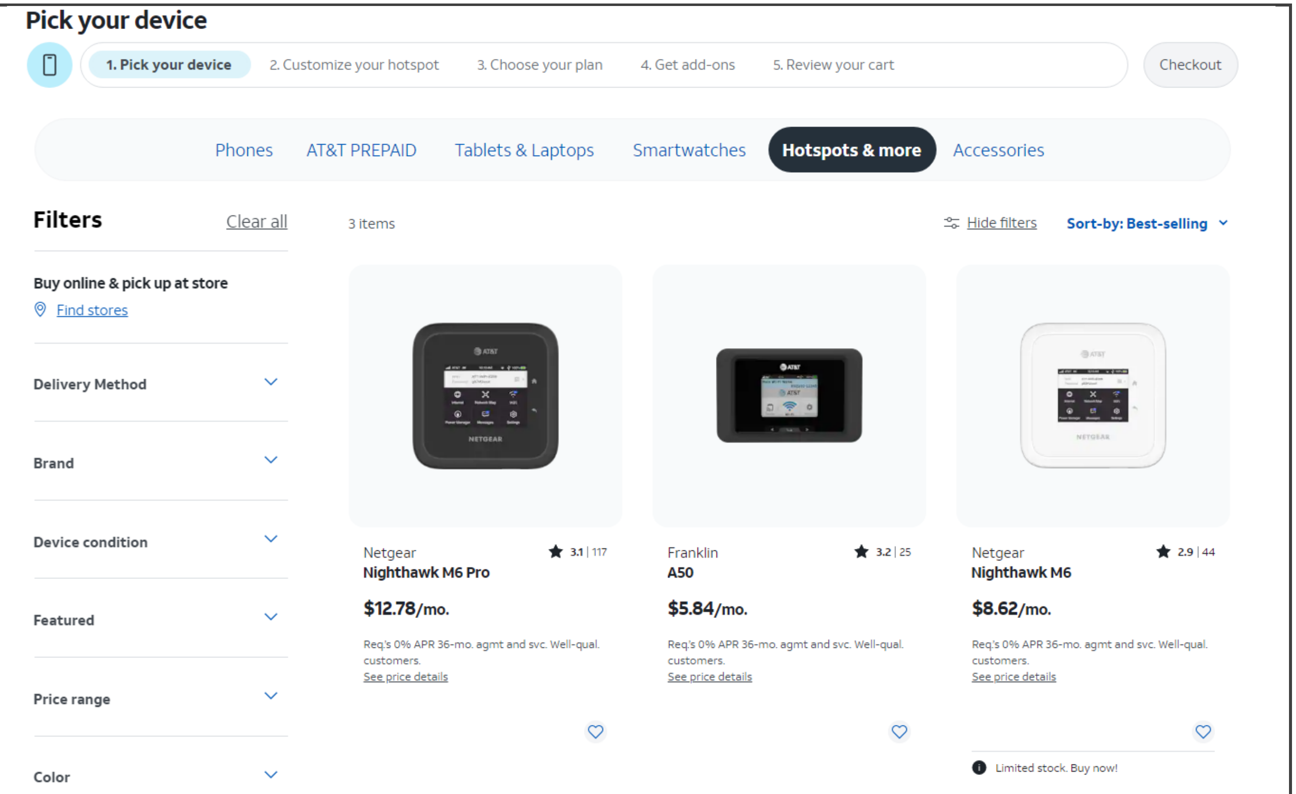

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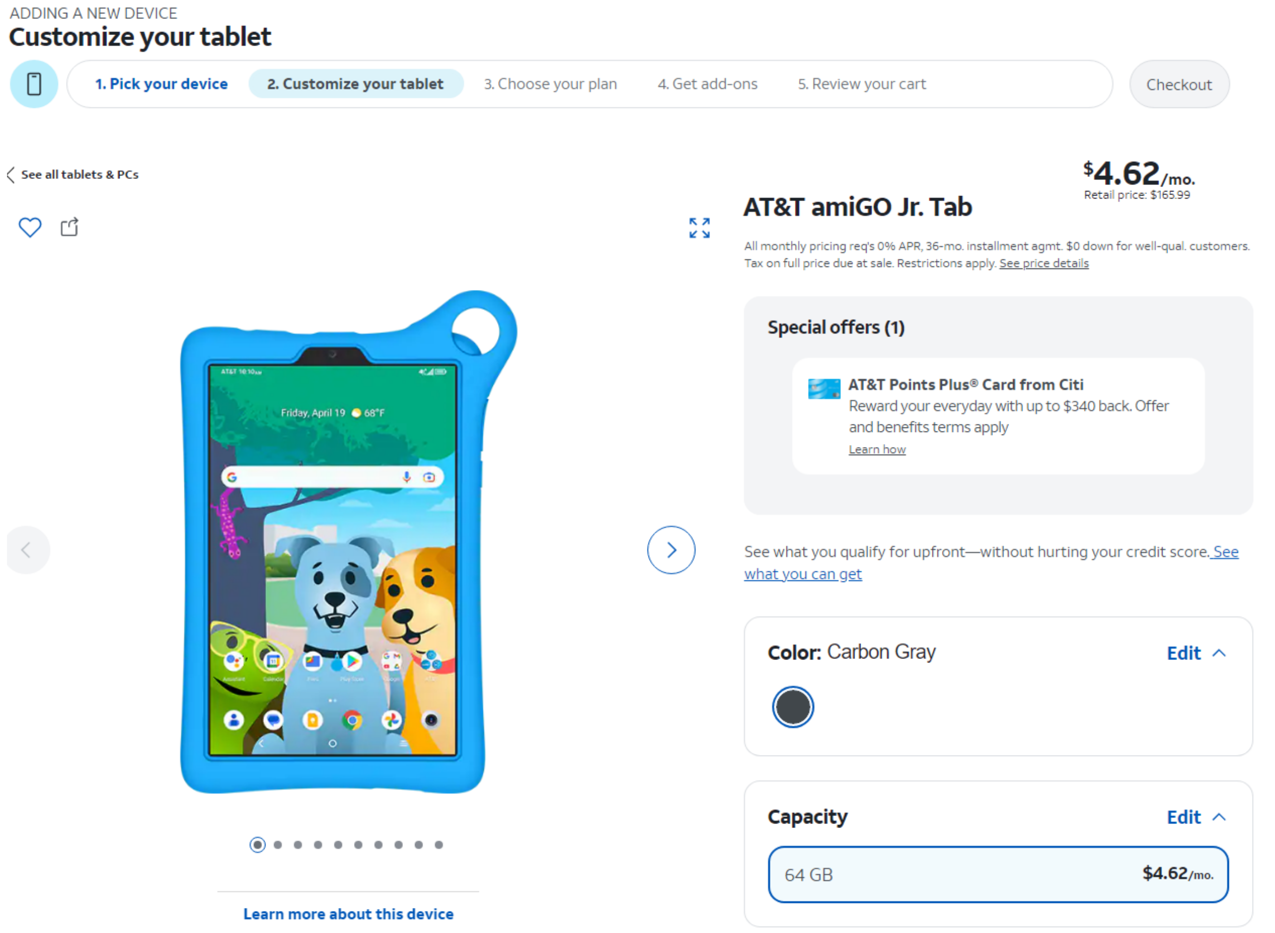

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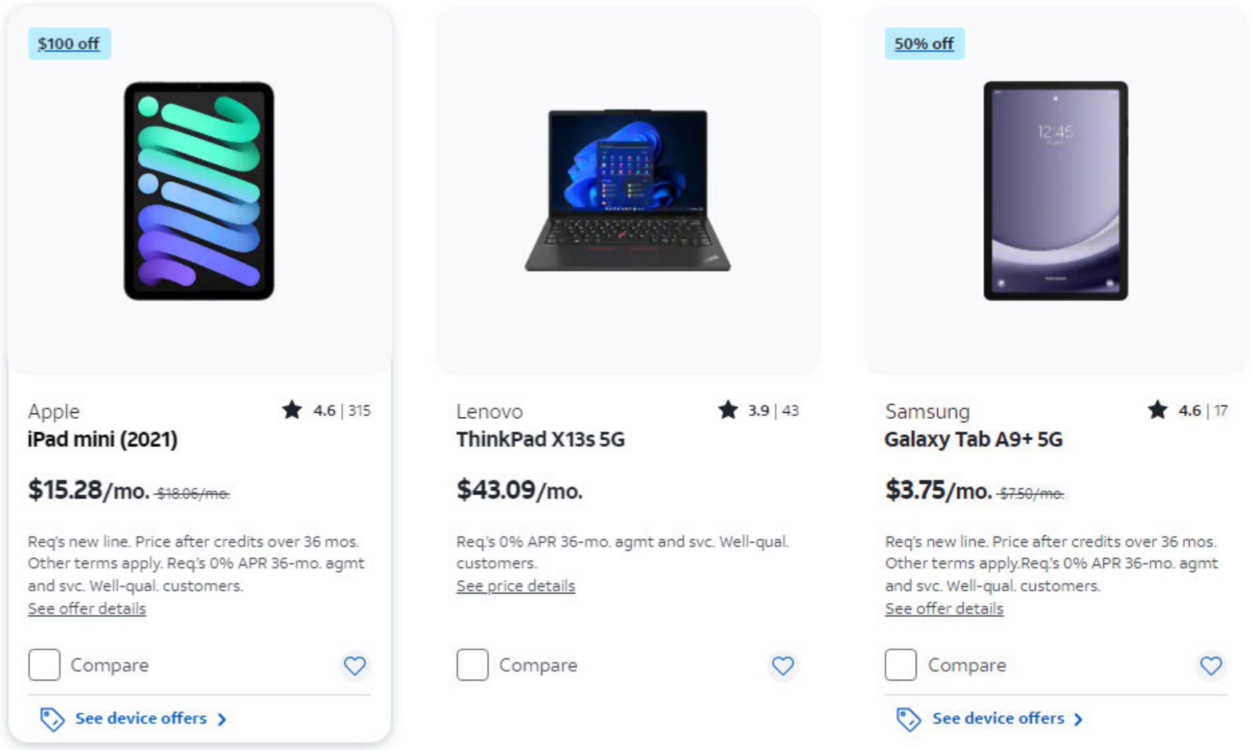

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"802.11ax radios are able to communicate will legacy 802.11a/b/g/n/ac radios. 802.11ax radios communicate with other 802.11ax radios using OFDMA and/or OFDMA. 802.11ax radios communicate with legacy radios using OFDM or HR-DSSS. When 802.11ax-only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

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[13] For the avoidance of doubt, the Samsung Galaxy Tab A9+ 5G is not an Accused Instrumentality.

"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. An RTS/CTS exchange by VHT STAs also performs fast collision inference on the secondary 20 MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel and helps the VHT STA transmitting the RTS to determine the available bandwidth at the responder.

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

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

	every Data frame transmission. Because the additional RTS and CTS frames add overhead inefficiency, the mechanism is not always justified, especially for short Data frames. The use of the RTS/CTS mechanism is under control of dot11RTSThreshold. This attribute may be set on a per-STA basis. This mechanism allows STAs to be configured to initiate RTS/CTS either always, never, or only on frames longer than a specified length. NOTE—A STA configured not to initiate the RTS/CTS mechanism updates its virtual CS mechanism with the duration information contained in a received RTS or CTS frame, and responds to an RTS frame addressed to it with a CTS frame if permitted by medium access rules. All non-DMG STAs that are members of a BSS are able to receive and transmit at all of the data rates in the BSSBasicRateSet parameter of the MLME-START.request primitive or BSSBasicRateSet parameter of the SelectedBSS parameter of the MLME-JOIN.request primitive; see 6.3.4.2.4 and 6.3.11.2.4. NOTE—A STA's operational rate set does not necessarily contain all the mandatory rates. However a STA has to be capable of receiving using a mandatory rate (as required by the rules in 10.7) even if it is not present in this set. All HT STAs that are members of a BSS are able to receive and transmit using all of the MCSs in the Basic HT-MCS Set field of the HT Operation parameter of the MLME-START.request primitive or Basic HT-MCS Set field of the HT Operation parameter of the SelectedBSS parameter of the MLME-JOIN.request primitive; see 6.3.4.2.4 and 6.3.11.2.4. All VHT STAs that are members of a BSS are able to receive and transmit using all of the <VHT-MCS, NSS> tuples in the basic VHT-MCS and NSS set (see 11.40.7) except as constrained by the rules of 10.7.12. All DMG STAs that are members of a BSS are able to receive and transmit using all of the MCSs in the OperationalRateSet parameter of the MLME-START.request primitive or OperationalRateSet parameter of the SelectedBSS parameter of the MLME-JOIN.request primitive; see 6.3.4.2.4 and 6.3.11.2.4.

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

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

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

Pages 1303-1305 of 802.11-2016

"**10.3.2.7 CTS and DMG CTS procedure**

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

A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a bandwidth signaling TA and that has the RXVECTOR parameter DYN_BANDWIDTH_IN_NON_HT equal to Static behaves as follows:

- If the NAV indicates idle and CCA has been idle for all secondary channels (secondary 20 MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel) in the channel width indicated by the RTS frame's RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT for a PIFS prior to the start of the RTS frame, then the

STA shall respond with a CTS frame carried in a non-HT or non-HT duplicate PPDU after a SIFS. The CTS frame's TXVECTOR parameters CH_BANDWIDTH and CH_BANDWIDTH_IN_NON_HT shall be set to the same value as the RTS frame's RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT.

- Otherwise, the STA shall not respond with a CTS frame.

A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a bandwidth signaling TA and that has the RXVECTOR parameter DYN_BANDWIDTH_IN_NON_HT equal to Dynamic behaves as follows:

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

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

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

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

After transmitting an RTS frame, the STA shall wait for a CTSTimeout interval with a value of aSIFSTime + aSlotTime + aRxPHYStartDelay. This interval begins when the MAC receives a PHY-TXEND.confirm primitive. If a PHY-RXSTART.indication primitive does not occur during

	the CTSTimeout interval, the STA shall conclude that the transmission of the RTS frame has failed, and this STA shall invoke its backoff procedure upon expiration of the CTSTimeout interval. If a PHY-RXSTART.indication primitive does occur during the CTSTimeout interval, the STA shall wait for the corresponding PHY-RXEND.indication primitive to determine whether the RTS frame transmission was successful. The recognition of a valid CTS frame sent by the recipient of the RTS frame, corresponding to this PHY-RXEND.indication primitive, shall be interpreted as successful response, permitting the frame exchange sequence to continue (see Annex G). The recognition of anything else, including any other valid frame, shall be interpreted as failure of the RTS frame transmission. In this instance, the STA shall invoke its backoff procedure at the PHY-RXEND.indication primitive and may process the received frame. A DMG STA follows the procedure defined in this subclause, except that it uses a DMG CTS frame instead of a CTS frame. A non-DMG STA does not transmit DMG CTS frames." 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;	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services 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, AT&T makes, uses, or sells 802.11ac-compliant stations (STA) which, when operated by AT&T's internal testers and/or AT&T's customers, require performance of a method that includes receiving at a first node (e.g. first STA) in the radio communications network an instruction [e.g. "Clear to Send" (CTS) instruction 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. **secondary 80 MHz channel**: In a 160 MHz or 80+80 MHz very high throughput (VHT) basic service set (BSS), the 80 MHz channel not including the primary 20 MHz channel, that together with the primary 80 MHz channel forms the 160 MHz or 80+80 MHz channel of the 160 MHz or 80+80 MHz VHT BSS.

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

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

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“**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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"**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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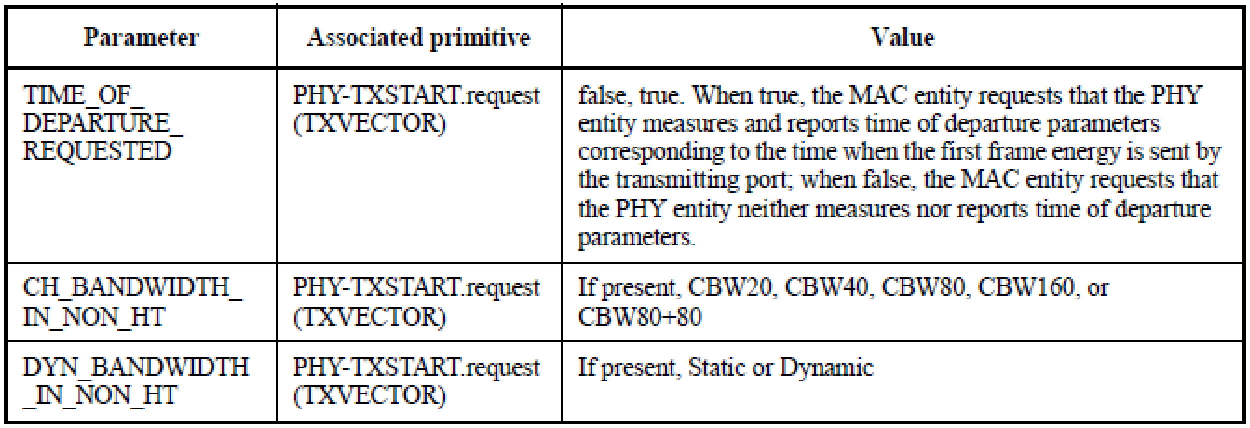
"**17.2.2.1 General**

. . .

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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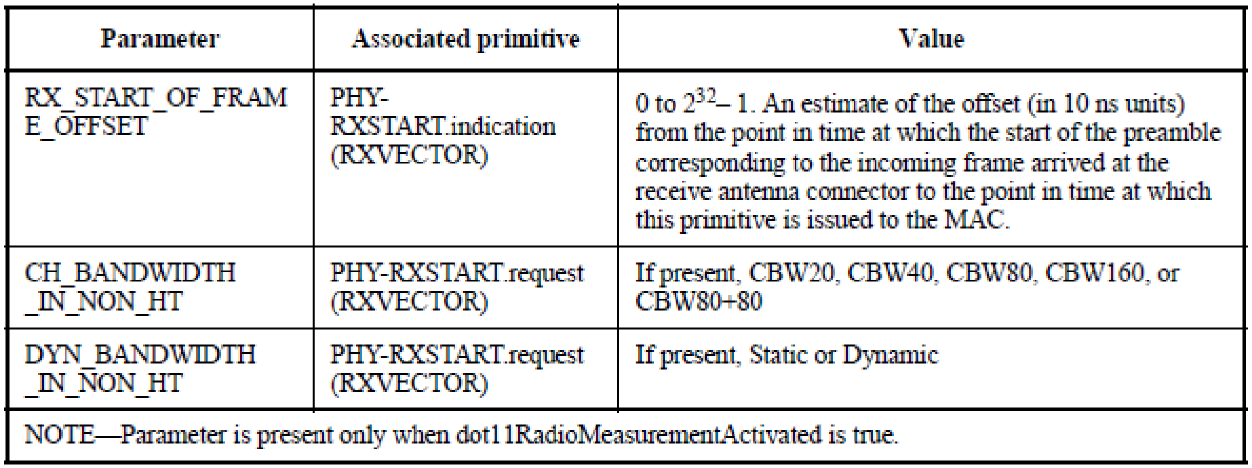
“17.2.3.1 General

. . .

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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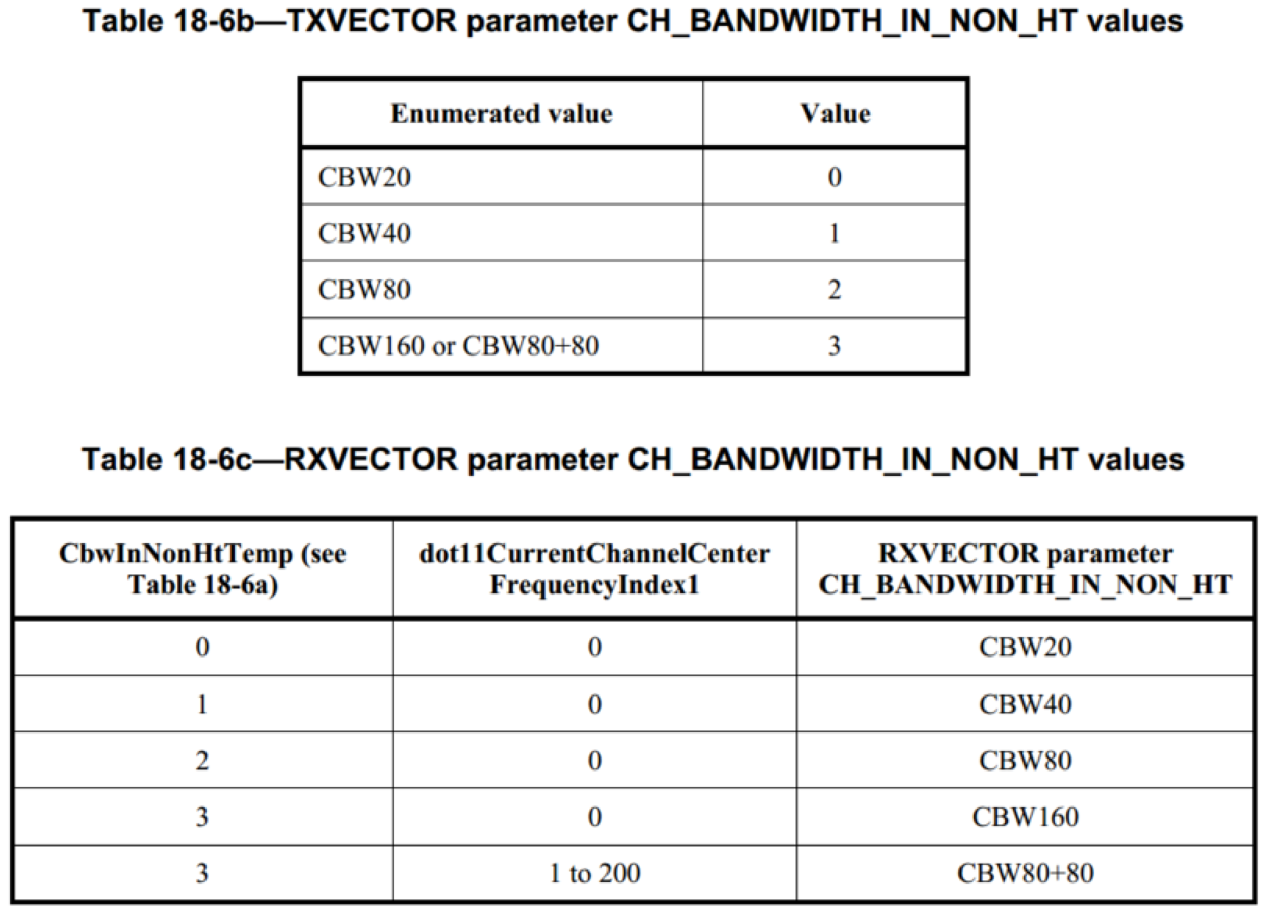

Table 18-6b—TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

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

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)	dot11CurrentChannelCenterFrequencyIndex1	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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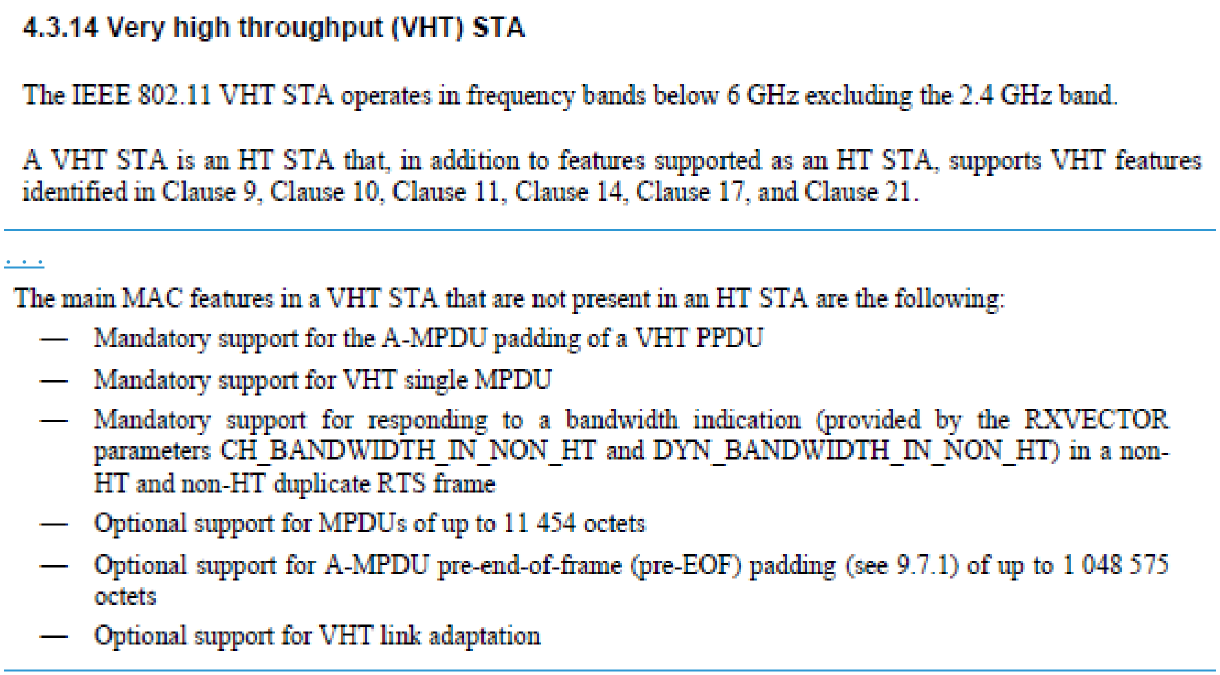
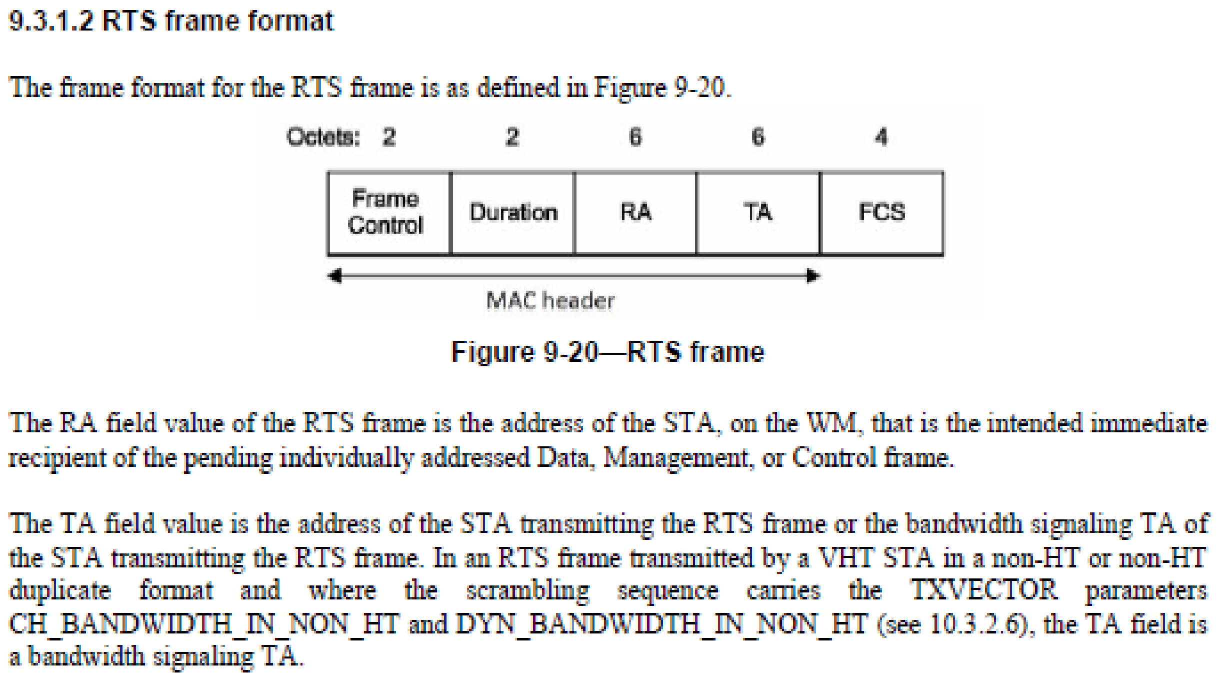
	 **4.3.14 Very high throughput (VHT) STA** The IEEE 802.11 VHT STA operates in frequency bands below 6 GHz excluding the 2.4 GHz band. A VHT STA is an HT STA that, in addition to features supported as an HT STA, supports VHT features identified in Clause 9, Clause 10, Clause 11, Clause 14, Clause 17, and Clause 21. . . . The main MAC features in a VHT STA that are not present in an HT STA are the following: — Mandatory support for the A-MPDU padding of a VHT PPDU — Mandatory support for VHT single MPDU — Mandatory support for responding to a bandwidth indication (provided by the RXVECTOR parameters CH_BANDWIDTH_IN_NON_HT and DYN_BANDWIDTH_IN_NON_HT) in a non-HT and non-HT duplicate RTS frame — Optional support for MPDUs of up to 11 454 octets — Optional support for A-MPDU pre-end-of-frame (pre-EOF) padding (see 9.7.1) of up to 1 048 575 octets — Optional support for VHT link adaptation Page 197 of 802.11-2016



9.3.1.2 RTS frame format

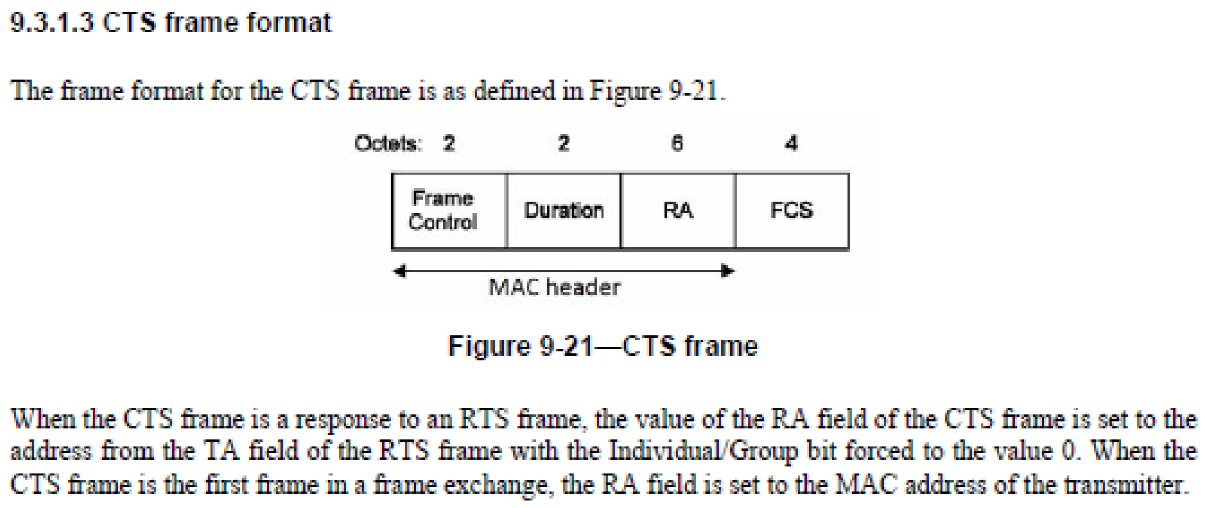
The frame format for the RTS frame is as defined in Figure 9-20.

Octets:	2	2	6	6	4
	Frame Control	Duration	RA	TA	FCS

Figure 9-20—RTS frame

The RA field value of the RTS frame is the address of the STA, on the WM, that is the intended immediate recipient of the pending individually addressed Data, Management, or Control frame.

The TA field value is the address of the STA transmitting the RTS frame or the bandwidth signaling TA of the STA transmitting the RTS frame. In an RTS frame transmitted by a VHT STA in a non-HT or non-HT duplicate format and where the scrambling sequence carries the TXVECTOR parameters CH_BANDWIDTH_IN_NON_HT and DYN_BANDWIDTH_IN_NON_HT (see 10.3.2.6), the TA field is a bandwidth signaling TA.



9.3.1.3 CTS frame format

The frame format for the CTS frame is as defined in Figure 9-21.

Figure 9-21—CTS frame

When the CTS frame is a response to an RTS frame, the value of the RA field of the CTS frame is set to the address from the TA field of the RTS frame with the Individual/Group bit forced to the value 0. When the CTS frame is the first frame in a frame exchange, the RA field is set to the MAC address of the transmitter.

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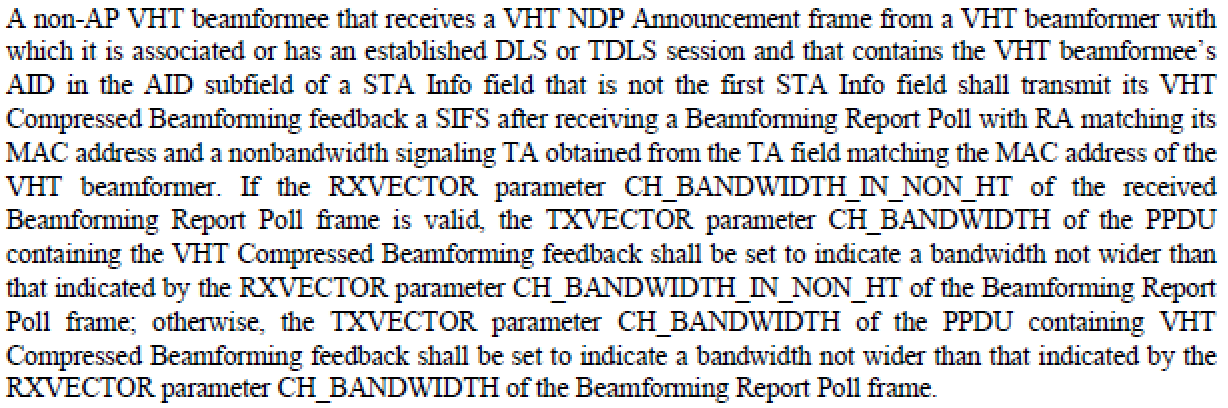
10.34.5.2 Rules for VHT sounding protocol sequences



A non-AP VHT beamformee that receives a VHT NDP Announcement frame from a VHT beamformer with which it is associated or has an established DLS or TDLS session and that contains the VHT beamformee's AID in the AID subfield of a STA Info field that is not the first STA Info field shall transmit its VHT Compressed Beamforming feedback a SIFS after receiving a Beamforming Report Poll with RA matching its MAC address and a nonbandwidth signaling TA obtained from the TA field matching the MAC address of the VHT beamformer. If the RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT of the received Beamforming Report Poll frame is valid, the TXVECTOR parameter CH_BANDWIDTH of the PPDU containing the VHT Compressed Beamforming feedback shall be set to indicate a bandwidth not wider than that indicated by the RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT of the Beamforming Report Poll frame; otherwise, the TXVECTOR parameter CH_BANDWIDTH of the PPDU containing VHT Compressed Beamforming feedback shall be set to indicate a bandwidth not wider than that indicated by the RXVECTOR parameter CH_BANDWIDTH of the Beamforming Report Poll frame.

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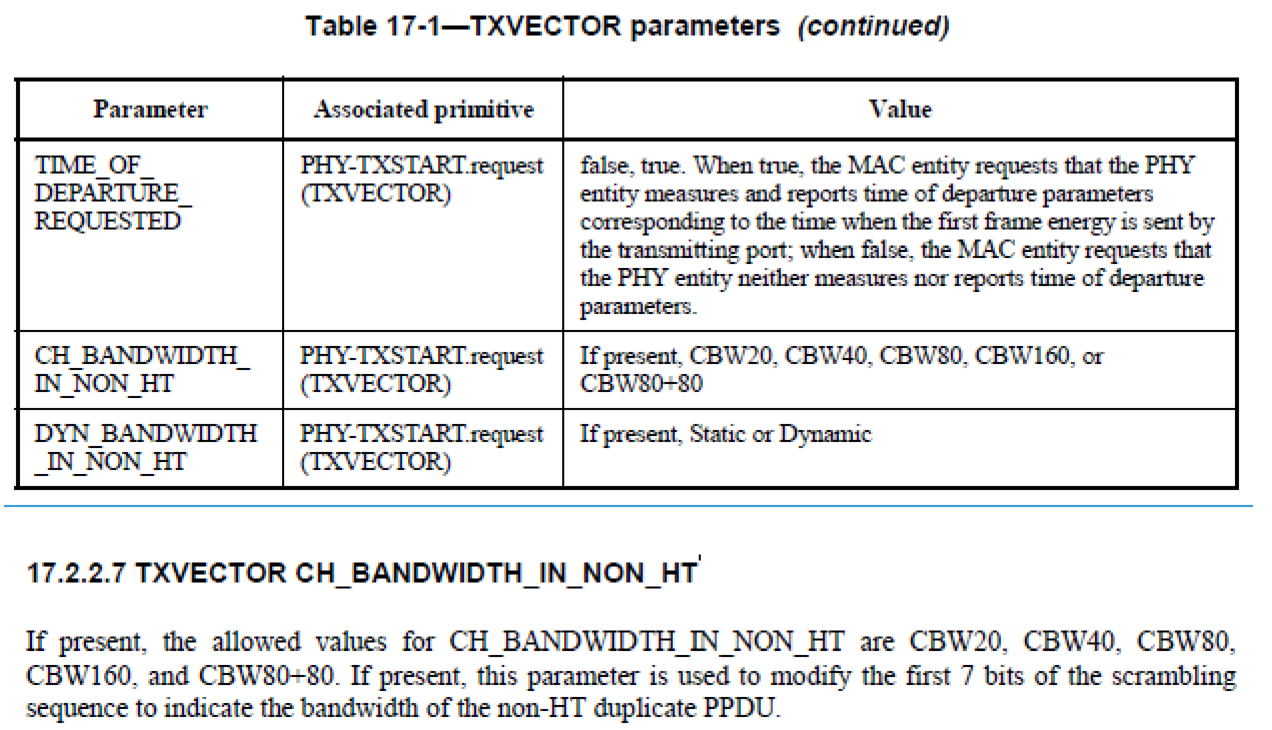

Table 17-1—TXVECTOR parameters *(continued)*

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

17.2.2.7 TXVECTOR 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, this parameter is used to modify the first 7 bits of the scrambling sequence to indicate the bandwidth of the non-HT duplicate PPDU.

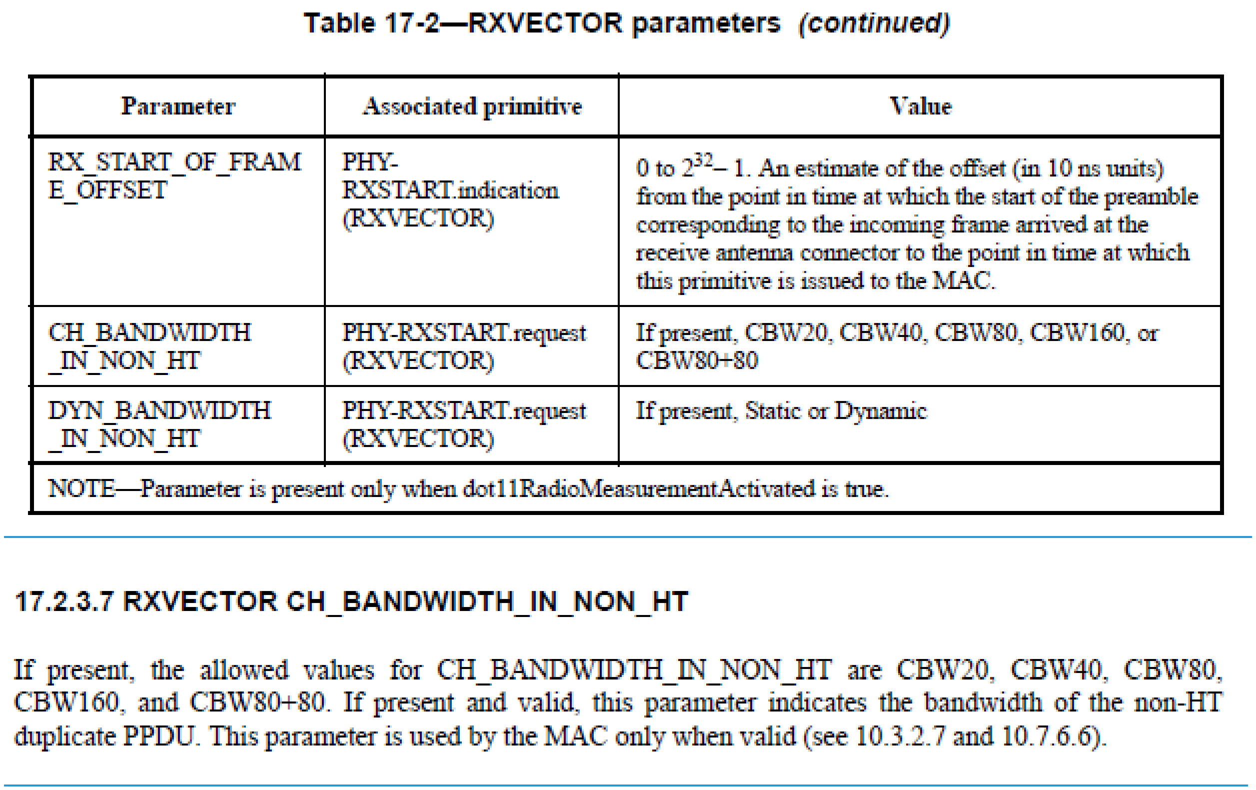

Table 17-2—RXVECTOR parameters *(continued)*

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).

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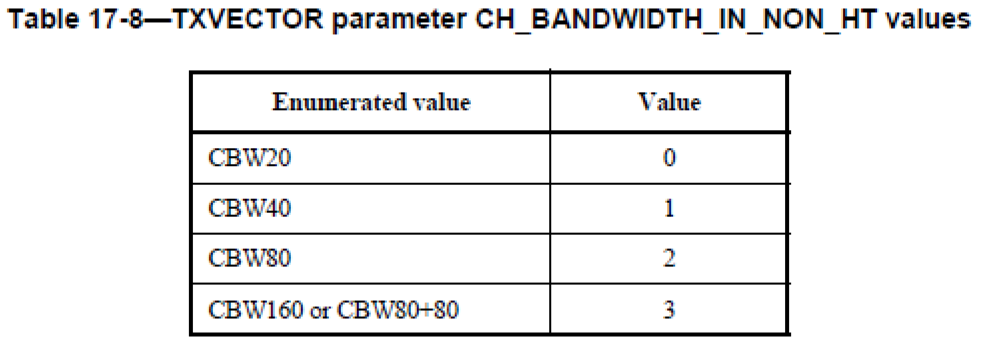

Table 17-8—TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

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

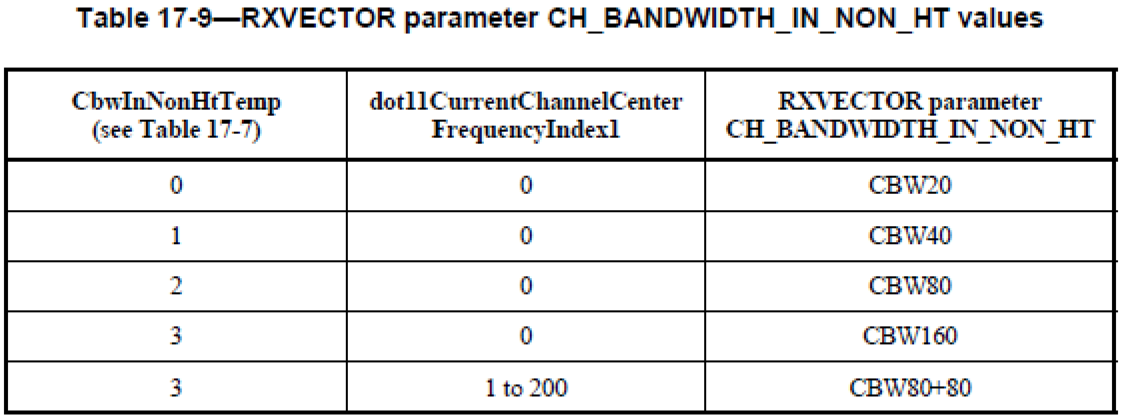

Table 17-9—RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

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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	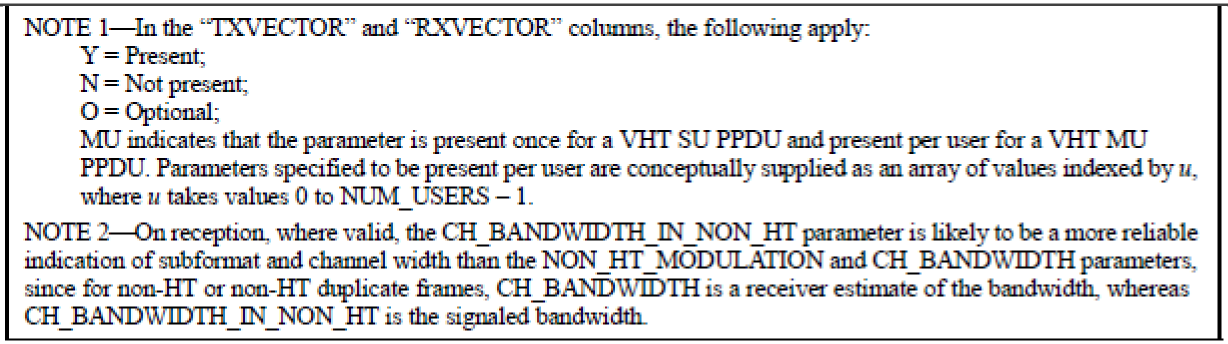 NOTE 1—In the “TXVECTOR” and “RXVECTOR” columns, the following apply: Y = Present; N = Not present; O = Optional; MU indicates that the parameter is present once for a VHT SU PPDU and present per user for a VHT MU PPDU. Parameters specified to be present per user are conceptually supplied as an array of values indexed by *u*, where *u* takes values 0 to NUM_USERS – 1. NOTE 2—On reception, where valid, the CH_BANDWIDTH_IN_NON_HT parameter is likely to be a more reliable indication of subformat and channel width than the NON_HT_MODULATION and CH_BANDWIDTH parameters, since for non-HT or non-HT duplicate frames, CH_BANDWIDTH is a receiver estimate of the bandwidth, whereas CH_BANDWIDTH_IN_NON_HT is the signaled bandwidth. Page 2633 of 802.11-2016
filtering a transmission signal to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided;	When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services 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 AT&T makes, uses, or sells 802.11ac-compliant stations (STA) which, when operated by AT&T’s internal testers and/or AT&T’s customers, require performance of a method that includes filtering a transmission signal (e.g. via a mask PPDU and resulting scrambling, and/or another filtering that results in power (that was used or could be used) being removed, etc.) to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided (e.g. based on the CTS instruction 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.

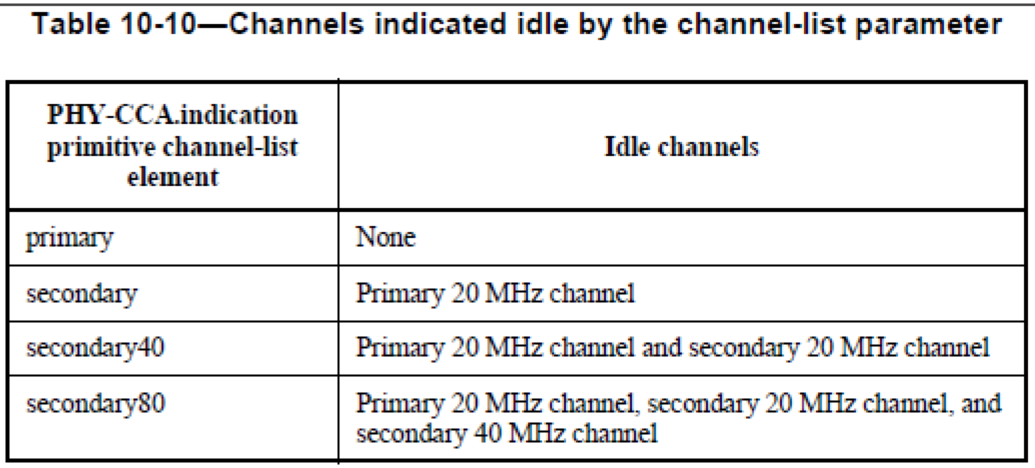

Table 10-10—Channels indicated idle by the channel-list parameter

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:

p) 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.

q) 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.
r) 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.
s) Transmit a 20 MHz mask PPDU on the primary 20 MHz channel.
t) 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

. . .

h) 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:

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

Replace Figure 18-7 with the following:

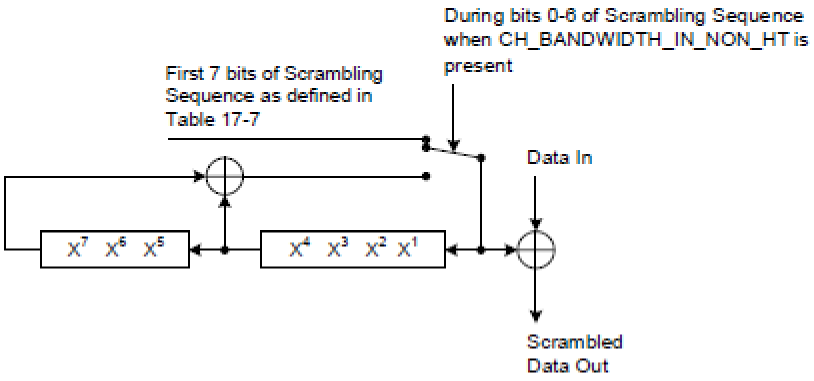

Figure 17-7—Data scrambler

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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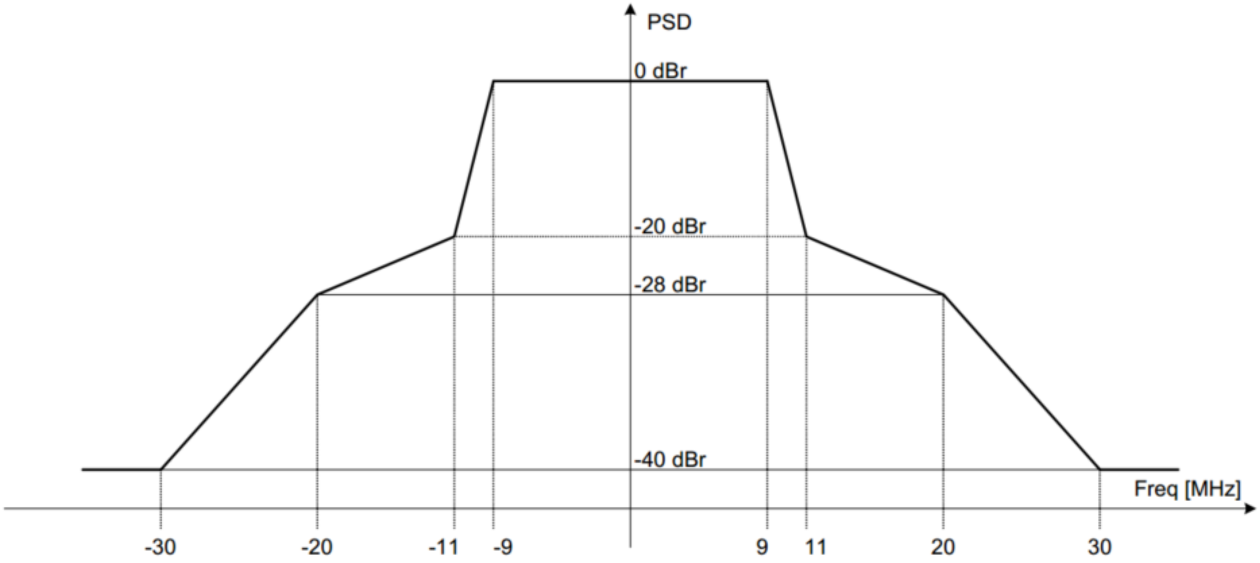
“**21.3.17 VHT transmit specification**

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 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
transmitting the filtered transmission signal to the second node;	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the step of transmitting the filtered transmission signal to the second node.

For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant stations (STA) which, when operated by AT&T's internal testers and/or AT&T's customers, 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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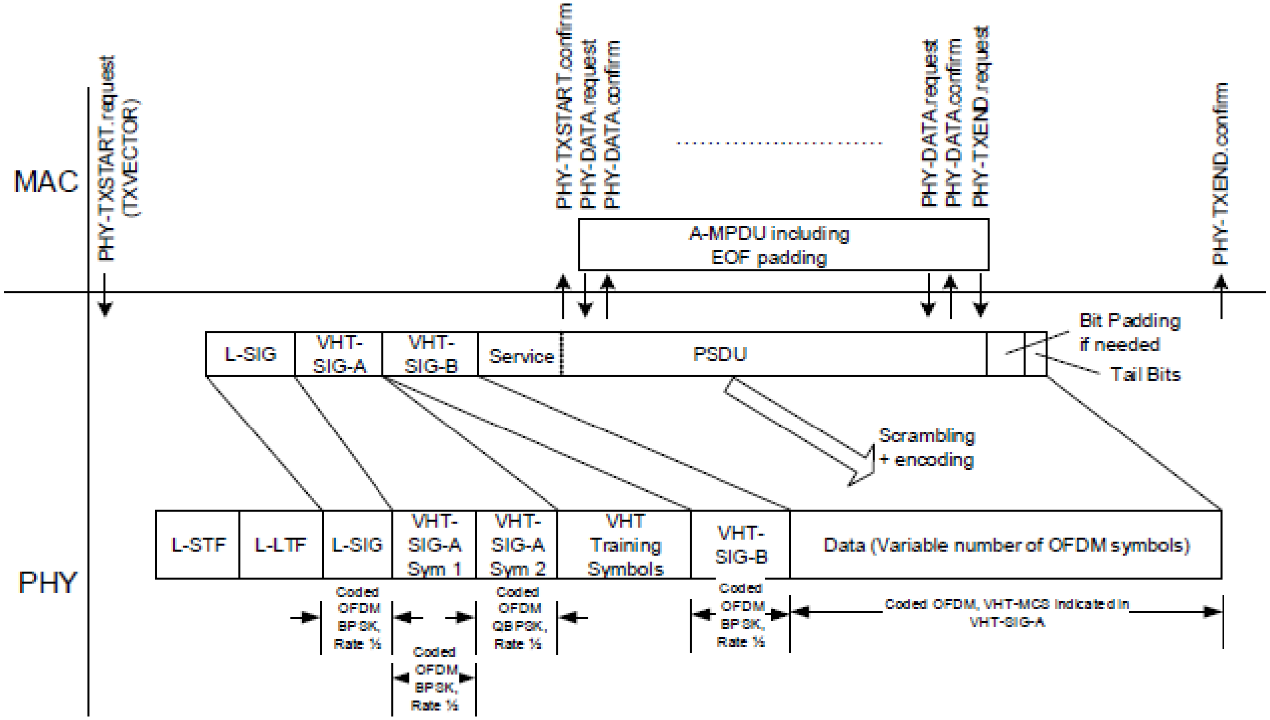

NOTE—This procedure does not describe the operation of optional features, such as MU-MIMO, LDPC or STBC.

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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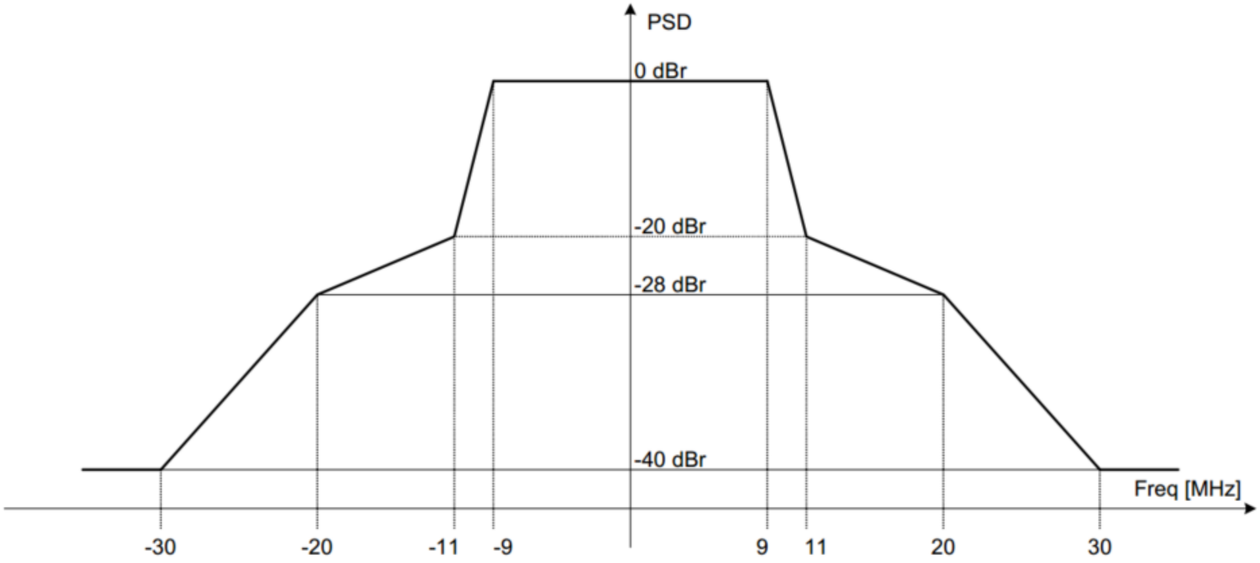
	“**21.3.17 VHT transmit specification** **21.3.17.1 Transmit spectrum mask** NOTE 1—In the presence of additional regulatory restrictions, the device has to meet both the regulatory requirements and the mask defined in this subclause. NOTE 2—Transmit spectral mask figures in this subclause are not drawn 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."

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separately from the receipt of the instruction, receiving a particular signal at the first node that is transmitted from the second node;	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services 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 Feedback Matrix *V*** "Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in Table 21-11 from the measured channel before computing a set of matrices for feedback to the beamformer. The beamforming feedback matrix, $V_{k,u}$, found by the beamformee u for subcarrier k shall be compressed in the form of angles using the method described in 19.3.12.3.6. The angles, $\varphi(k,v)$ and $\psi(k,u)$, are quantized according to Table 9-68. The number of bits for quantization is chosen by the beamformee, based on the indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DLMU- MIMO beamforming. The compressed beamforming feedback using 19.3.12.3.6 is the only Clause 21 beamforming feedback format defined. The beamformee shall generate the beamforming feedback matrices with the number of rows (Nr) equal to the N_{STS} of the NDP. After receiving the angle information, $\varphi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}-1]$ using $V_{k,u}$ and $SNR_{k,u}$ ($0 \le u \le N_{user}-1$) 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. An explicit feedback mechanism is used where the VHT beamformee directly measures the channel from the training symbols transmitted by the VHT beamformer and sends back a transformed estimate of the channel state to the VHT beamformer. The VHT beamformer then uses this estimate, perhaps combining estimates from multiple VHT beamformees, to derive the steering matrix.

If dot11VHTSUBeamformerOptionImplemented is true, a STA shall set the SU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTSUBeamformeeOptionImplemented is true, a STA shall set the SU Beamformee Capable field in the VHT Capabilities element to 1.

If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set the MU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set the MU Beamformee Capable field in the VHT Capabilities element to 1.

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

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

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

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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,

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

Nr is the number of rows in a compressed beamforming feedback matrix determined by the Nr Index field of the VHT MIMO Control field."

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	"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." 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;	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services 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 Feedback Matrix *V*** "Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in Table 21-11 from the measured channel before computing a set of matrices for feedback to the beamformer. The beamforming feedback matrix, $V_{k,u}$, found by the beamformee u for subcarrier k shall be compressed in the form of angles using the method described in 19.3.12.3.6. The angles, $\varphi(k,v)$ and $\psi(k,u)$, are quantized according to Table 9-68. The number of bits for quantization is chosen by the beamformee, based on the indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DLMU- MIMO beamforming. The compressed beamforming feedback using 19.3.12.3.6 is the only Clause 21 beamforming feedback format defined. The beamformee shall generate the beamforming feedback matrices with the number of rows (Nr) equal to the N_{STS} of the NDP. After receiving the angle information, $\varphi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may

calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,N_{user}}\text{-}1]$ using $V_{k,u}$ and $SNR_{k,u}$ $(0 \leq u \leq N_{user}\text{-}1)$ 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."

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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,

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

Nr is the number of rows in a compressed beamforming feedback matrix determined by the Nr Index field of the VHT MIMO Control field."

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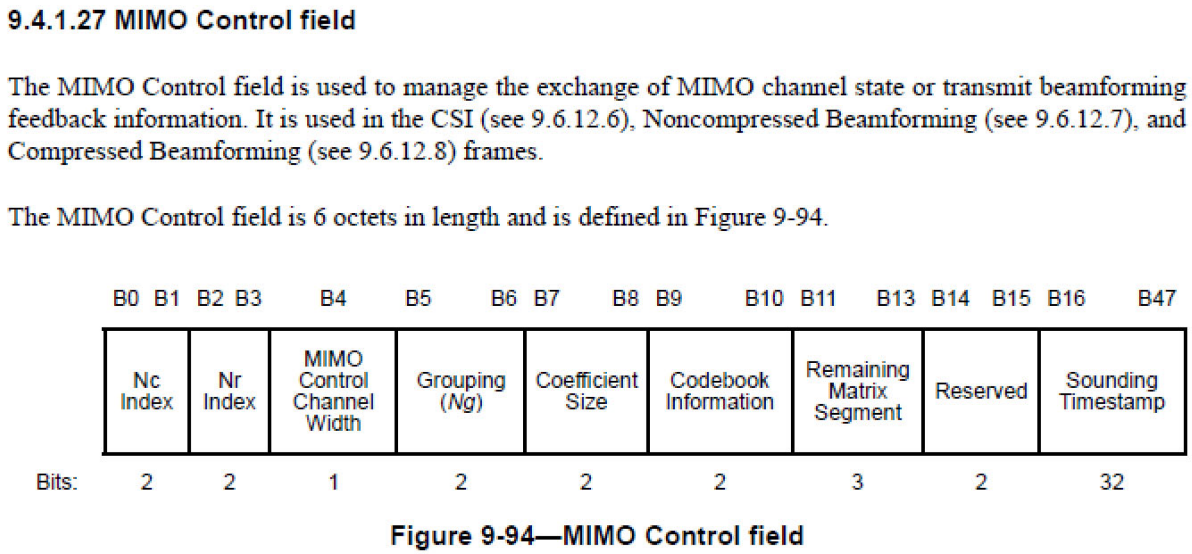
Pages 764-765 of 802.11-2016



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.

<table>
<tr><td></td><td>B0 B1</td><td>B2 B3</td><td>B4</td><td>B5 B6</td><td>B7 B8</td><td>B9 B10</td><td>B11 B13</td><td>B14 B15</td><td>B16 B47</td></tr>
<tr><td></td><td>Nc Index</td><td>Nr Index</td><td>MIMO Control Channel Width</td><td>Grouping (<i>Ng</i>)</td><td>Coefficient Size</td><td>Codebook Information</td><td>Remaining Matrix Segment</td><td>Reserved</td><td>Sounding Timestamp</td></tr>
<tr><td>Bits:</td><td>2</td><td>2</td><td>1</td><td>2</td><td>2</td><td>2</td><td>3</td><td>2</td><td>32</td></tr>
</table>

Figure 9-94—MIMO Control field

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“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.”
https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html
</td>
</tr>
<tr>
<td>compressing the feedback; and</td>
<td>
When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the step of compressing the feedback.

“19.3.12.3.6 <u>Compressed beamforming feedback matrix</u>
</td>
</tr>
</table>

	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 decompress the matrices and determine the steering matrices Q_k. The matrix per tone shall be compressed as follows: The N_r x 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 simultaneously transmitting to one or more other nodes;	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services 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. **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 Feedback Matrix *V*** "Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in Table 21-11 from the measured channel before computing a set of matrices for feedback to the beamformer. The beamforming feedback matrix, $V_{k,u}$, found by the beamformee *u* for subcarrier *k* shall be compressed in the form of angles using the method described in 19.3.12.3.6. The angles, $\varphi(k,v)$ and $\psi(k,u)$, are quantized according to Table 9-68. The number of bits for quantization is chosen by the beamformee, based on the indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DLMU- MIMO beamforming. The compressed beamforming feedback using 19.3.12.3.6 is the only Clause 21 beamforming feedback format defined.

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

After receiving the angle information, $\varphi(k,v)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,N_{user}}\text{-}1]$ using $V_{k,u}$ and $SNR_{k,u}$ ($0 \leq u \leq N_{user}\text{-}1$) 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.”

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“**10.34.5 VHT sounding protocol**

10.34.5.1 General

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

If dot11VHTSUBeamformerOptionImplemented is true, a STA shall set the SU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTSUBeamformeeOptionImplemented is true, a STA shall set the SU Beamformee Capable field in the VHT Capabilities element to 1.

If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set the MU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set the MU Beamformee Capable field in the VHT Capabilities element to 1.

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

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

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

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"**9.4.1.49 VHT Compressed Beamforming Report field**

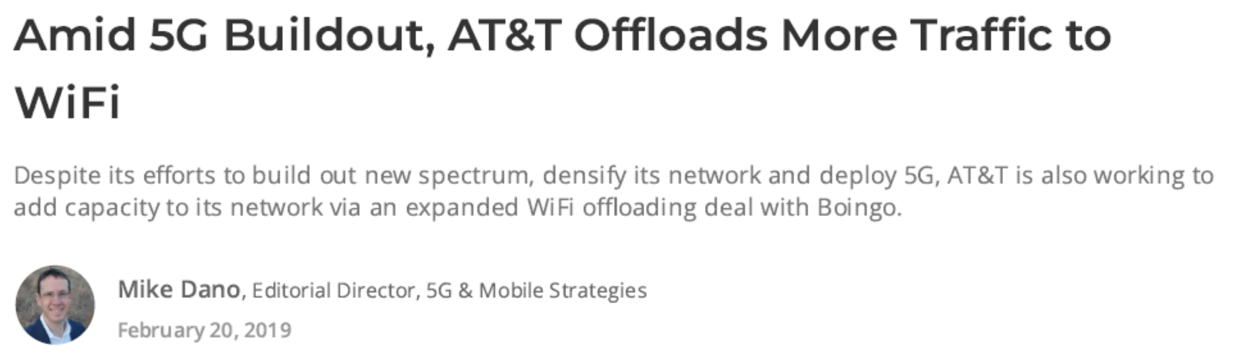
The VHT Compressed Beamforming Report field is used by the VHT Compressed Beamforming feedback (see 9.6.23.2) to carry explicit feedback information in the form of angles representing compressed beamforming feedback matrices *V* for use by a transmit beamformer to determine steering matrices *Q*, as 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, *Nc* is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field, *Nr* is the number of rows in a compressed beamforming feedback matrix determined by the Nr 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." https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html To the extent AT&T contends that the claim requires a "second node," on information and belief, AT&T directly infringes this claim by using (including internal testing, provisioning of AT&T Wi-Fi services (e.g., AT&T Nationwide Wi-Fi Hotspots, FirstNet, AT&T Hot Zones, AT&T Internet Air, All-Fi, Fixed Wireless Access, AT&T Internet, AT&T Business Internet, AT&T employees Wi-Fi services, etc.), provisioning of AT&T Wi-Fi access points, internal use of AT&T Wi-Fi services while conducting business, installation and maintenance/servicing of AT&T Internet services with Wi-Fi for business and residential customers, compatibility testing, providing services for Fixed Wireless, AT&T Internet Air, AT&T Internet Air for Business, FirstNet, Nationwide Wi-Fi Hotspot network, and other Wi-Fi service offerings by AT&T, etc.)

the Accused Instrumentalities and Services and performing the claimed methods in the United States.

For example, as evidenced below, AT&T has entered into contracts with Boingo to add capacity to its mobile network via the use of Passpoint technology, which allows AT&T to offload its mobile network traffic onto WiFi networks that utilize a second node:

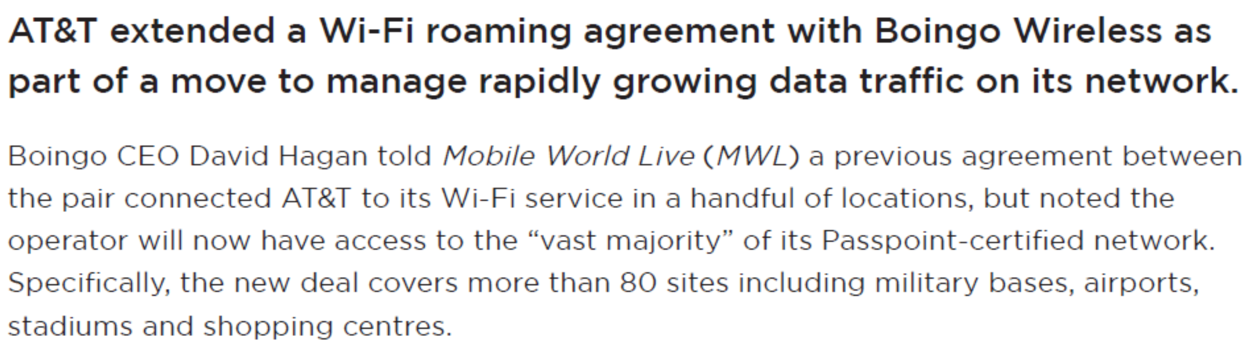


Amid 5G Buildout, AT&T Offloads More Traffic to WiFi

Despite its efforts to build out new spectrum, densify its network and deploy 5G, AT&T is also working to add capacity to its network via an expanded WiFi offloading deal with Boingo.

Mike Dano, Editorial Director, 5G & Mobile Strategies
February 20, 2019

(https://www.lightreading.com/wifi/amid-5g-buildout-at-t-offloads-more-traffic-to-wifi.)



AT&T extended a Wi-Fi roaming agreement with Boingo Wireless as part of a move to manage rapidly growing data traffic on its network.

Boingo CEO David Hagan told *Mobile World Live* (*MWL*) a previous agreement between the pair connected AT&T to its Wi-Fi service in a handful of locations, but noted the operator will now have access to the "vast majority" of its Passpoint-certified network. Specifically, the new deal covers more than 80 sites including military bases, airports, stadiums and shopping centres.

(https://www.mobileworldlive.com/att/att-boosts-wi-fi-offload-with-boingo/.)

	For example, on information and belief, AT&T operates a nationwide network of Wi-Fi hotspots for its customers and other end-users that include a second node used by AT&T.[14] AT&T encourages customers and other end-users to utilize its nationwide Wi-Fi network.[15] On information and belief, AT&T further provides managed Wi-Fi services for its customers that include site planning, deployment/installation, operation and maintenance of a second node when used by AT&T or its customers.[16] On information and belief, AT&T further conducts internal testing of instrumentalities which are a second node.[17] On information and belief, AT&T further provides numerous services related to Wi-Fi including setting up, testing, operating, maintaining, and/or upgrading its customers' Wi-Fi networks, including using a second node.[18] On information and belief, AT&T further offers Wi-Fi services at several locations, including its retail stores, to customers with qualifying data plans, and the provision of such Wi-Fi services uses a second node.[19] AT&T also makes, uses, offers to sell and sells, and induces others to use, Wi-Fi extenders with Wi-Fi gateways as a mesh network, which function as a second node.[20] Furthermore, third party actions are attributable to AT&T under the theory of joint infringement. For example, AT&T contracts with numerous third parties to provide the Accused

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[14] *See* https://www.attsavings.com/internet/wireless-internet-buyers-guide ("AT&T gives you free access to more than 30,000 Wi-Fi hotspots nationwide.").

[15] *See* https://www.business.att.com/content/dam/attbusiness/briefs/att-business-wi-fi-product-brief.pdf.

[16] *See* https://www.business.att.com/content/dam/attbusiness/briefs/att-business-wi-fi-product-brief.pdf ("If you prefer a capex model, you can purchase the equipment, and AT&T will manage it at a reduced monthly fee per access point."); https://serviceguidenew.att.com/sg_CustomPreviewer?attachmentId=00PPV00000SeyF92AJ; https://serviceguidenew.att.com/sg_CustomPreviewer?attachmentId=00PPV00000R3PC52AN; https://www.business.att.com/portfolios/networking.html.

[17] *See* https://iotdevices.att.com/devices.aspx.

[18] *See* https://www.youtube.com/watch?v=CODnk8k54Rw&list=PLxP2-8eHxebXqKMteRdxs1vEdTxt1-iEP&index=16; https://serviceguidenew.att.com/sg_CustomPreviewer?attachmentId=00PPV00000SfDFk2AN.

[19] See https://www.att.com/support/article/wireless/KM1103818/; https://www.attsavings.com/internet/wireless-internet-buyers-guide.

[20] *See, e.g.,* https://www.att.com/wi-fi/extender/.

	Instrumentalities and Services and provides detailed instructions to those third parties related to the same. For example, AT&T contracts with third parties to offer Wi-Fi services utilizing access points, including with suppliers of such access points, businesses utilizing access points, and companies testing access points and other IoT devices (for example, AT&T requires device compatibility testing and certification by AT&T for use on AT&T's networks).[21]
wherein the filtered transmission signal is transmitted to the second node using an 802.11-based orthogonal frequency-division multiplexing (OFDM) protocol;	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services 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, where k is one of the subcarriers, and Q_k is consisted of sub-matrices $Q_{k,u}$, each corresponding to one receiving STA u. • IEEE 802.11-2016: **21.3.11.2 Beamforming Feedback Matrix V** further specifies that $Q_{k,u}$ is dependent on the feedback matrix $V_{k,u}$ provided by each STA u, which is based on the actual channel measurement by each STA u. • IEEE 802.11-2016: Figure 10-53 (below) illustrates that each STA (beamformee) is getting a different polling packet, based on which the feedback matrix $V_{k,u}$ is measured and should be different from STA to STA.

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[21] *See, e.g.*, https://www.att.com/gen/general?pid=7462; https://www.boingo.com/press-releases/att-expands-wi-fi-roaming-agreement-with-boingo/; https://www.business.att.com/collateral/sd-wan-aruba.html; https://www.att.com/legal/terms.smartWiFiEULA.html; https://about.att.com/story/att_wi_fi_small_site_for_business.html; https://www.business.att.com/content/dam/businesscenter/pdf/legal/att-enterprise-additional-service-equipment-related-terms.pdf; https://www.att.com/support/article/wireless/KM1103818/; https://www.corp.att.com/cpetesting/testing-services/; http://serviceguidenew.att.com; https://web.archive.org/web/20171122213124/https://www.business.att.com/solutions/Portfolio/wifi/; https://www.business.att.com/legal/att-business-wifi-with-cisco-meraki-terms-of-service.html.

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

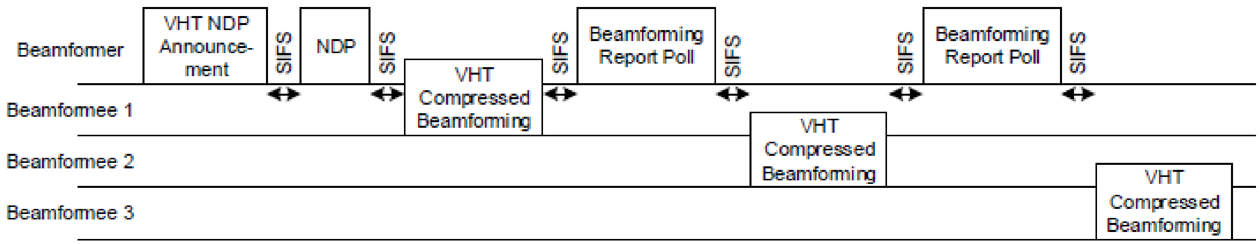

Figure 10-53—Example of the sounding protocol with more than one VHT beamformee

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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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0},\ Q_{k,l} \ldots,\ Q_{k,Nuser}\text{-}1] \text{ x } x_k + n$$

where

$H_{k,u}$	is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \text{ x } N_{TX}$
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 $Q_k = [Q_{k,0},\ Q_{k,l} \ldots,\ Q_{k,Nuser}\text{-}1]$ 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 $u = 0, 1, \ldots, N_{user}$ -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)."

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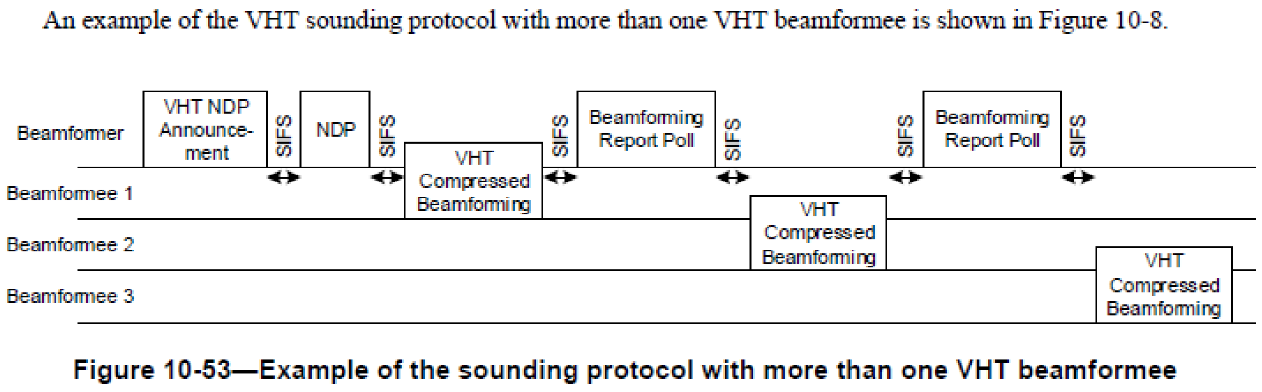
"19.3.12.3 Explicit feedback beamforming

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, $Q_{steer,k} = Q_kV_k$, with V_k found from H_kQ_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, $H_{eff,k} = H_kQ_k$, 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 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.	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services perform the prior steps listed above, wherein an update of the compressed feedback is 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. **Note**: See evidence cited earlier in this independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): i "$Q_{k,0}$ 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 $Q_k = [Q_{k,0}, Q_{k,1} \ldots, Q_{k,N_{user}}$-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 $u = 0, 1, \ldots, N_{user}$ -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 “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.” https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html
96. The method of claim 95, wherein the instruction includes a first instruction and the filtered transmission signal includes a filtered first transmission signal, and further comprising:	When used by AT&T, AT&T’s agents or customers, the Accused Instrumentalities and Services perform the claimed method as shown by the evidence below: **Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): 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. Page 1313 of 802.11-2016 • IEEE 802.11-2016: **21.3.11 SU-MIMO and DL-MU-MIMO Beamforming** and **21.3.11.1 General** specifies the steering matrix Q_k for DL-MU-MIMO, where k is one of the subcarriers, and Q_k is consisted of sub-matrices $Q_{k,u}$, each corresponding to one receiving STA u.

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



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

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

Pages 1490-2579 of 802.11-2016

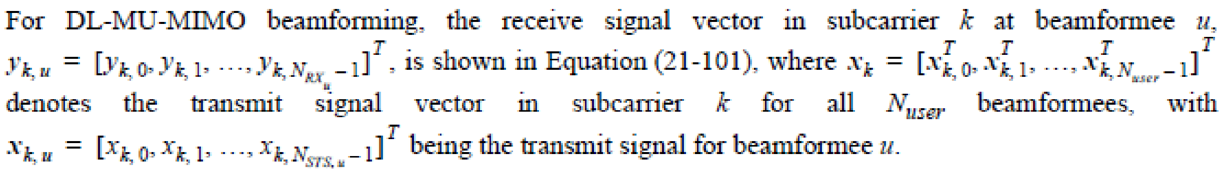
“**21.3.11 SU-MIMO and DL-MU-MIMO Beamforming**

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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1] \text{ x } x_k + n$$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions
N_{RXu} x 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 $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1]$ 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 $u = 0, 1, \ldots, N_{user}$ -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, $Q_{steer,k} = Q_kV_k$, with V_k found from H_kQ_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, $H_{eff,k} = H_kQ_k$, 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
receiving at the first node in the radio communications network a second instruction transmitted from a third node in the radio communications network to avoid using a different plurality of frequencies to transmit to the third node;	**Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): “**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.

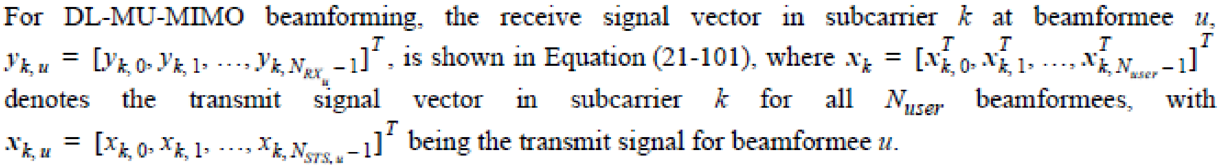
A non-VHT STA that is addressed by an RTS frame or a VHT STA that is addressed by an RTS frame carried in a non-HT or non-HT duplicate PPDU that has a nonbandwidth signaling TA or a VHT STA that is addressed by an RTS frame in a format other than non-HT or non-HT duplicate behaves as follows:

- 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." Pages 1313-1314 of 802.11-2016
filtering a second transmission signal to remove power from the second transmission signal at each frequency in the different plurality of frequencies to be avoided; and	**Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): "**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, $y_{k,u} = [y_{k,0}, y_{k,1}, \ldots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \ldots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \ldots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.

$$Y_{k,u} = H_{k,u} \text{ x } [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1] \text{ x } x_k + n$$

where

$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions
N_{RXu} x 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 $Q_k = [Q_{k,0}, Q_{k,l} \ldots, Q_{k,Nuser}\text{-}1]$ 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 $u = 0, 1, \ldots, N_{user}$ -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, $Q_{steer,k} = Q_kV_k$, with V_k found from H_kQ_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, $H_{eff,k} = H_kQ_k$, 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 the filtered second transmission signal to the third node.	**Note**: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any): **“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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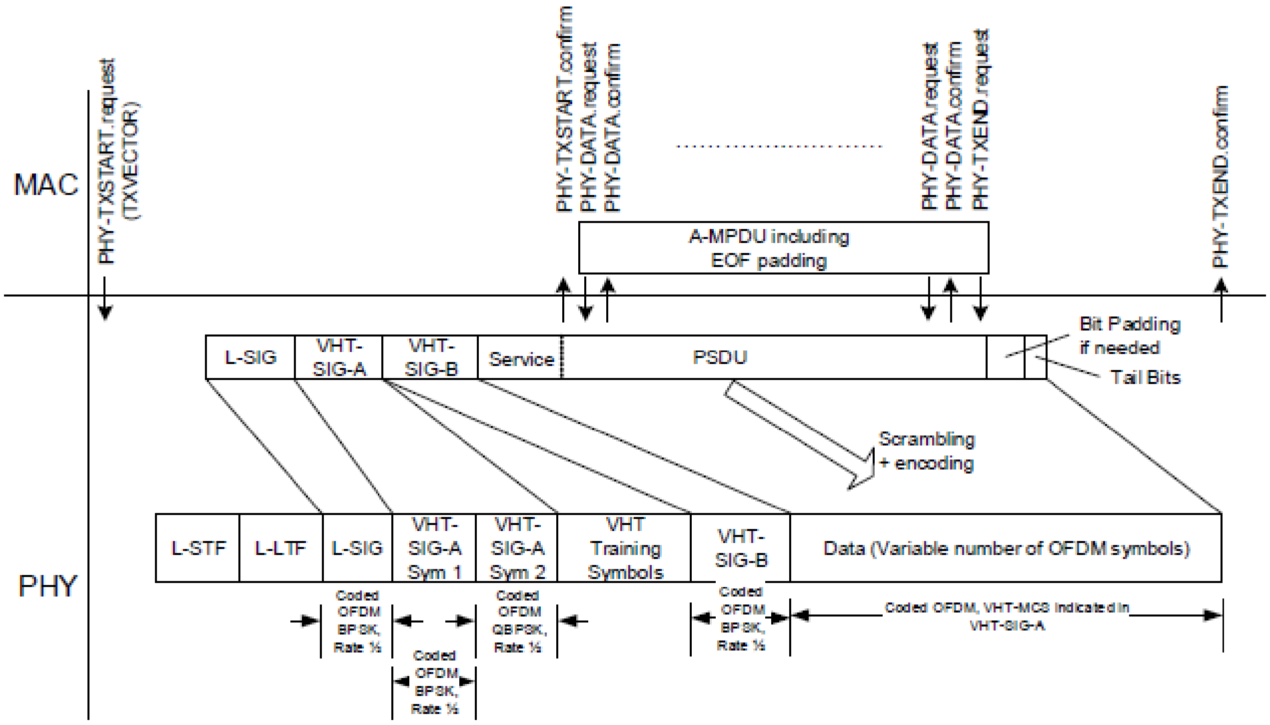

NOTE—This procedure does not describe the operation of optional features, such as MU-MIMO, LDPC or STBC.

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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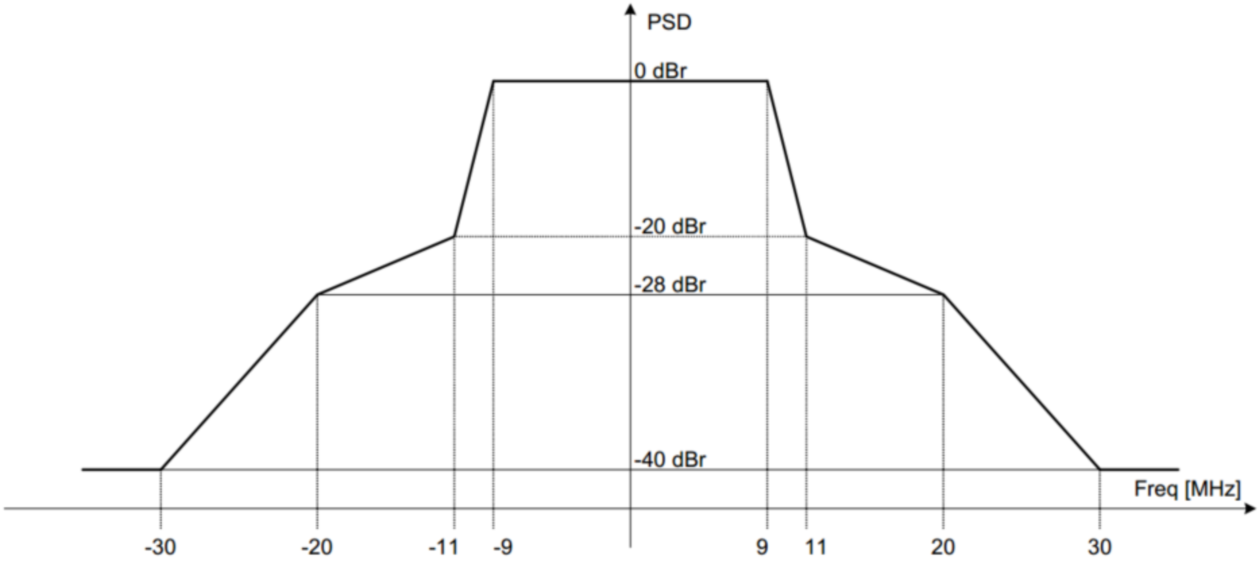
“**21.3.17 VHT transmit specification**

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."

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