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, Cradleelpoint access points (e.g., E100, E300, E320, Cradlepoint Ee3000, 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, 2Wire 3600, 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,

> Page: 1 AT&T Services, Inc. v. USTA Technology, LLC IPR2025-01166 | AT&T EX1010 | Page 1 of 426

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 BusinssBusiness 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 performs 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,

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

<u>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</u>

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

² See, e.g., https://www.att.com/gen/general?pid=7462; https://www.boingo.com/press-releases/att-expands-wi-fi-roamingagreement-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

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.

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

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.

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

<u>Note</u>: Unless annotated in the evidence, any emphasis is added.

Claim	Accused Instrumentalities and Services
19. A method for managing interference in a radio	The Accused Instrumentalities and Services perform a method for managing interference in a radio communications network
communications network,	
comprising the steps of:	For example, as evidenced below, AT&T makes, uses, or sells 802.11ac-compliant access points
	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.)
	in a radio communications network (e.g., a 802.11ac-compliant network including backwards
	compatible 802.11ax and 802.11be APs).





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.





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/



					•	_	
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
list.pdf				<u> </u>			
6690C	ATT	Turbo Hotspot 2		+	\$ 79.9	9 \$	24.99
6807B	ATT	Wireless Internet (IFW)	A-40)	+	\$ 199.9	9 \$	179.99
6778B	ATT	Unite Express 2		†	\$ 144.9	9 \$	44.99
6786B	ATT	Unite Express 2 NSV		+	\$ 144.9	9 \$	44.99
6068D	Cradlepoint	E3000		+	\$ 1,949.9	9 \$	1,499.99
6227C	Cradlepoint	IBR600		+	\$ 509.9	9 \$	302.09
6229C	Cradlepoint	AER2200		†	\$ 1,839.9	9 \$	1,229.25
6230C	Cradlepoint	IBR1700		†	\$ 1,869.9	9 \$	1,251.75
6231C	Cradlepoint	MC400 Modular LTE M	odem	+	\$ 599.9	9 \$	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/businessc enter/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: <u>www.wi-fi.org/certification/programs</u>



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 models Gateway image You may have one of the following Wi-Fi gateways: at&t BGW210 Pace 5268 POWER NVG589 NVG510 . Pace 5031 NVG599 ETHERNET BGW320 • WIRELESS 2Wire 3801 • PHONE 1 2Wire 2701 PHONE 2 2Wire 3800 2Wire 3600 Netgear 7550 BRÓADBAND Pace 5168 • 2Wire i38 • Pace 4111 • Westell 327

https://ww	w.att.com/support/art	icle/dsl-high-speed/K	<u>M1047050/</u>	
This iten WiFi Moo Router	n: AT&T Wireless Inter dem 4G LTE Home Bas	✓		
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://ww	w.amazon.com/Wirel	ess-Internet-Hotspot-A	Antenna-AT/dp/B075J	B968D?source=ps-sl-
shoppinga	<u>ls-lpcontext&ref_=fp</u>	lfs&psc=1∣=A2	40VZW9214RO6	
Moxee mo K779HSD	<u>bile hotspot https://w</u> L-UserManual-05122	ww.att.com/ecms/dam 20.pdf	n/att/devicesupport/EM	<u>IB-Moxee-</u>
<u>ZTE wirel</u> 5499/5174	ess internet MF279 h /ATT-WirelessIntern	ttps://www.att.com/ec et-MF279.pdf	cms/dam/att/devicesup	port/5000-
<u>ATT MiFi</u>	8000 https://www.att	t.com/device-support/i	index/9006088/Inseeg	o/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/autondon/ ("The AT&T Wi Ei autondon is designed to be compatible
intps://www.aut.com/wi-in/extender/ (The AT&T wi-Frextender is designed to be compatible
with the BGW320, BGW210, or 5268AC AT&T W1-F1 Gateways. These W1-F1 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,
5268 A C and NVG599 Wi-Fi gateways ")
<u>5200110 and 1000000 willing accords. J</u>
https://www.attsavings.com/internet/wireless-internet-buyers-guide ("A1&1 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® SHIFLD MegaFi 2 (Fixed Kit)
Novtivity® SHIELD MogaEi (Fixed Kit)
Nextivity® SHIELD Megal (Fixed Kit)
Nextivity® SHIELD MegaGo (integrated W1-F1 hotspot)
Nextivity® SHIELD MegaGo 2 (integrated W1-F1 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 RR1 Pro Cat 20 or
5C = MageDange HDUE (for rurel routes) = All ID54/64 and SAEU1455 MIL STD 910C)
<u>30 • Megakange nr OE (101 fural routes) • An 1r 34/04 and SAEJ1433 MIL STD 8100)</u>

"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.htm/
"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." <u>https://www.att.com/internet/what-is-all-fi/#storyoffer7</u>
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 <u>equiprementequipment</u> 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" <u>https://www.att.com/legal/terms.consumerserviceagreement.html</u>
"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)." <u>https://www.att.com/gen/general?pid=7462</u>
"Get unlimited access at more than 30,000 AT&T Wi-Fi Hot Spots nationwide." <u>https://www.att.com/plans/tethering/</u>

 "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&C contracts with owners and operators of popular establishments and businesses who purchase the Service to provide it to their employces, 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 subseribers for use in select public venues and for extain 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" "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	
 "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 preceminent provider of Wi-Fi service, 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" 	"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.
 many different factors discussed above that can affect fietwork 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 	"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
"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	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"

"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/
AT&T WI-TT Hot Spot location. <u>https://www.au.com/support/artele/wireless/Rivi1105816/</u>
"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-installNo 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." <u>https://www.business.att.com/products/business-wifi.html</u>
"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)" <u>https://serviceguidenew.att.com/sg_CustomPreviewer?attachmentId=00PPV00000Iw3JN2AZ</u>
"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



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 2019011107075120
0.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.
<u>");</u>
 https://www.youtube.com/watch?v=FmpS2xalLdU&list=PLxP2-
8eHxebXqKMteRdxs1vEdTxt1-iEP&index=3;

 https://www.youtube.com/watch?v=hSt8EH-R4&list=PLxP2- 8cHxebXqKMteRdxs1vEdTxt1-iEP&index=23; https://www.youtube.com/watch?v=hycUxRbKOw (BGW320 WiFi gateway); https://www.youtube.com/watch?v=m0n59YwPVIM&list=PLxP2- 8cHxebUNOD5oZUNe895vM_csi0Pt (Learn How to use on Guest Wifi Your Inseego MiFi 8000); https://www.youtube.com/watch?v=nIDsQJ1Le0o; 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=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 private 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-uprade.html; https://www.business.att.com/learn/articles/bainess/biefs/att-business- pasport.pdf; https://www.business.att.com/content/dam/business/biefs/att-business- pasport.pdf; https://www.business.att.com/content/dam/atbusiness/biefs/att-business- masport.pdf; https://www.business.att.com/content/dam/atbusiness/biefs/att-business-wifi-with- cisco-meraki-product-brief.pdf; https://www.business.att.com/content/dam/atbusiness/biefs/att-business-wifi-with- cisco-meraki-product-brief.pdf; https://www.business.att.com/content/dam/atbusiness/biefs/att-business-wifi-with- cisco-meraki-product-brief.pdf; https://www.business.att.com/content/dam/atbusiness/biefs/att-business- wan.pdf; https://www.business.att.com/nortfolios/networking.htm; https://www.business.att.com/lean/attbusiness/biefs/att-managed-wireless- wan.pdf; https:	
 <u>8eHxebXqkMteRdss1vEdTxt1-tDe%index=23;</u> <u>https://www.youtube.com/watch?v=hycUxRlbKOw (BGW320 WiFi gateway);</u> <u>https://www.youtube.com/watch?v=m0n59YwPVIM&list=PLxP2-</u> <u>8eHxebUNOD5oZUNe895wM_csi0Ph (Learn How to use on Guest Wifi Your Inseego MiFi 8000);</u> <u>https://www.youtube.com/watch?v=m1DsQJ1Le00;</u> <u>https://www.youtube.com/watch?v=n1DsQJ1Le00;</u> <u>https://www.youtube.com/watch?v=n1DsQJ1Le00;</u> <u>https://www.youtube.com/watch?v=1XENrj7Actg ("Learn how to set up AirTies 4971</u> <u>WiFi Extender");</u> <u>https://www.youtube.com/watch?v=Am3HmjBtYOs ("AT&T Business Wi-Fi: How to configure your private Wi-Fi");</u> <u>https://www.youtube.com/watch?v=DFjowxyv1Ac ("AT&T Business Wi-Fi: How to configure your private Wi-Fi");</u> <u>https://www.business.att.com/can/articles/bencfits-of-thc-new-standards-for-network-reliability.html ("Our network consulting experts will assess your internal evaluation and help you determine where to prioritize your network-upgradc.html;</u> <u>https://www.business.att.com/can/articles/do-i-necd-a-network-upgradc.html;</u> <u>https://www.business.att.com/ront/dam/business-wifi.html;</u> <u>https://www.business.att.com/portfolios/business-wifi.html;</u> <u>https://www.business.att.com/portfolios/business-wifi.html;</u> <u>https://www.business.att.com/portfolios/business-wifi.html;</u> <u>https://www.business.att.com/portfolios/business-wifi.html;</u> <u>https://www.business.att.com/portfolios/business-wifi.html;</u> <u>https://www.business.att.com/portfolios/business-wifi.html;</u> <u>https://www.business.att.com/portfolios/business-wifi.html;</u> <u>https://www.business.att.com/portfolios/business-wifi.html;</u> <u>https://www.business.att.com/portfolios/business-wifi.with-cisco-meraki-terms-of-service.html;</u> 	- https://www.youtube.com/watch?v=h5i8SEH-f84&list=PLxP2-
 https://www.youtube.com/watch?v=Am3HmjBtYOs (how to configure private wifi); https://www.youtube.com/watch?v=Am3HmjBtYOs (how to configure private wifi); https://www.youtube.com/watch?v=m059YwPVIM&list=PLxP2- 8eHxebUNOD5oZUNe895wM_csi0Ph (Learn How to use on Guest Wifi Your Inseego MiFi 8000); https://www.youtube.com/watch?v=nIDsQJ1Lc00; 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 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/content/dam/businesscenter/pdf/legal/att-business- passport.pdf; https://www.business.att.com/rout/striss/partner-solutions/att-alliance-channel.html; https://www.business.att.com/products/business-briefs/att-business- passport.pdf; https://www.business.att.com/products/business-briefs/att-business- wifi.with- cisco-meraki-product-brief.pdf; https://www.business.att.com/products/business-briefs/att-business- wifi.with- cisco-meraki-product-brief.pdf; https://www.business.att.com/products/business-briefs/att-managed-wireless- wan.pdf; https://www.business.att.com/products/business-wifi.html; https://www.business.att.com/products/business-wifi.stml; https://www.business.att.com/products/business-wifi.stml; https://www.business.att.com/products/business-wifi.stml; https://www.business.att.com/products/business-wifi.stml; https://www.business.att.com/pro	<u>8eHxebXqKMteRdxs1vEdTxt1-iEP&index=23;</u>
 https://www.youtube.com/watch?v=Am3HmjBtYOs (how to configure private wifi); https://www.youtube.com/watch?v=m0n59YwPVIM&Elist=PLxP2- &EltxebUNODSoZUNe895wM_csi0Ph (Learn How to use on Guest Wifi Your Inseego MiFi 8000); https://www.youtube.com/watch?v=IDSQJ1Lc0o; https://www.youtube.com/watch?v=IXENrj7Actg ("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/notustrics/partner-solutions/att-alliance-channel.html; https://www.business.att.com/products/business-wifi.html; https://www.business.att.com/content/dam/business/biefs/att-business- passport.pdf; https://www.business.att.com/content/dam/attbusiness/biefs/att-business- wifi-with- cisco-meraki-product-brief.pdf; https://www.business.att.com/content/dam/attbusiness/biefs/att-business-wifi-with- cisco-meraki-product-brief.pdf; https://www.business.att.com/portfolios/business-biefs/att-business-wifi-with- cisco-meraki-product-brief.pdf; https://www.business.att.com/portfolios/business-wifi.html; https://www.business.att.com/portfolios/business-wifi.html; https://www.business.att.com/portfolios/business-wifi.html; https://www.business.att.com/portfolios/business-wifi.html; https://www.business.att.com/potducts/business-wifi.html; https://www.business.att.com	 https://www.youtube.com/watch?v=hycUxRIbKOw (BGW320 WiFi gateway);
 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=nIDsQJ1Lc0o; 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/business-exterter/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/products/business-wifi.html; https://www.business.att.com/products/business-wifi.html; https://www.business.att.com/products/business-wifi.html; https://www.business.att.com/products/business-wifi.html#equipment-options; https://www.business.att.com/products/business-wifi.html#equipment-options; https://www.business.att.com/products/business/briefs/att-business- wan.pdf; 	- https://www.youtube.com/watch?v=Am3HmjBtYOs (how to configure private wifi);
SeffxebUNOD5oZUNe895wM_csi0Ph (Learn How to use on Guest Wifi Your Inscego 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.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-upgrade.html; - https://www.business.att.com/learn/articles/do-i-need-a-network-upgrade.html; - https://www.business.att.com/ndustries/partner-solutions/att-alliance-channel.html; - https://www.business.att.com/products/business-wifi.html; - https://www.business.att.com/products/business/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/portfolios/networking.html; - https://www.business.att.com/profilos/networking.html; - https://www.business.att.com/profilos/networking.html; - htttps://www.business.att.com/profilos/networkin	- https://www.youtube.com/watch?v=m0n59YwPVIM&list=PLxP2-
 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/content/dam/businesscenter/pdf/legal/att-business- passport.pdf; https://www.business.att.com/products/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/portfolios/business-briefs/att-business-wifi-with- cisco-meraki-product-brief.pdf; https://www.business.att.com/products/business-briefs/att-business-wifi-with- cisco-meraki-product-brief.pdf; https://www.business.att.com/portfolios/business-briefs/att-business-wifi-with- cisco-meraki-product-brief.pdf; https://www.business.att.com/portfolios/business-briefs/att-managed-wireless- wan.pdf; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; 	8eHxebUNOD5oZUNe895wM csi0Ph (Learn How to use on Guest Wifi Your Inseego
 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/products/business-wifi.html; https://www.business.att.com/products/business-wifi.stml; https://www.business.att.com/products/business-internet.html; https://www.business.att.com/products/business-wifi.stml; https://www.business.att.com/products/business-internet.html; https://www.business.att.com/products/business-wifi.stml; https://www.business.att.com/products/business-wifi.stml; https://www.business.att.com/products/business-wifi.stml; https://www.business.att.com/products/business-wifi.stml; https://www.business.att.com/products/business-wifi.stml; https://www.business.att.com/products/business-wifi.stml; https://www.business.att.com/proflois/business-wifi.stml; https://www.business.att.com/proflois/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; 	MiFi 8000);
 https://www.youtube.com/watch?v=IXENrj7Actg ("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/portfolios/business-wifi.html; https://www.business.att.com/portfolios/business-briefs/att-business-wifi- with- eisco-meraki-product-brief.pdf; https://www.business.att.com/portducts/business-wifi.html#equipment-options; https://www.business.att.com/content/dam/attbusiness/briefs/att-business- wan.pdf; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; 	- https://www.youtube.com/watch?v=nIDsQJ1Le0o;
 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/roducts/business-wifi.html; https://www.business.att.com/portfolios/business-wifi.html; https://www.business.att.com/portfolios/business-wifi.html; https://www.business.att.com/products/business-wifi.html; https://www.business.att.com/products/business-wifi.html; https://www.business.att.com/products/business-wifi.html; https://www.business.att.com/products/business-wifi.html#equipment-options; 	- https://www.youtube.com/watch?v=1XENrj7Actg ("Learn how to set up AirTies 4971
 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/roducts/business-wifi.html; https://www.business.att.com/products/business-wifi.html; https://www.business.att.com/products/business/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/products/business-wifi.html#equipment-options; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; 	Wi-Fi Extender");
 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/products/business-wifi.html; https://www.business.att.com/products/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/profolios/networking.html; https://www.business.att.com/profolios/networking.html; 	- https://www.youtube.com/watch?v=Am3HmjBtYOs ("AT&T Business Wi-Fi: How to
 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/products/business-wifi.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/products/business/briefs/att-managed-wireless-wan.pdf; https://www.business.att.com/portfolios/networking.html; 	configure your private Wi-Fi")
 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/content/dam/attbusiness/briefs/att-managed-wireless-wan.pdf; https://www.business.att.com/portfolios/networking.html; 	- https://www.youtube.com/watch?v=DFjowxyv1Ac ("AT&T Business Wi-Fi: How to
 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/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/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; 	configure your Public Wi-Fi");
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/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html;	- https://www.business.att.com/learn/articles/benefits-of-the-new-standards-for-network-
 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/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/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; 	reliability.html ("Our network consulting experts will assess your internal evaluation
 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/portfolios/networking.html; https://www.business.att.com/legal/att-business-wifi-with-cisco-meraki-terms-of- service.html; 	and help you determine where to prioritize your network needs.");
 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/portfolios/networking.html; https://www.business.att.com/legal/att-business-wifi-with-cisco-meraki-terms-of- service.html; 	- https://www.business.att.com/learn/articles/do-i-need-a-network-upgrade.html;
 <u>passport.pdf;</u> <u>https://www.business.att.com/industries/partner-solutions/att-alliance-channel.html;</u> <u>https://www.business.att.com/products/business-wifi.html;</u> <u>https://www.business.att.com/content/dam/attbusiness/briefs/att-business-wifi-with-cisco-meraki-product-brief.pdf;</u> <u>https://www.business.att.com/content/dam/attbusiness/briefs/att-managed-wireless-wan.pdf;</u> <u>https://www.business.att.com/portfolios/networking.html;</u> <u>https://www.business.att.com/portfolios/networking.html;</u> <u>https://www.business.att.com/portfolios/networking.html;</u> <u>https://www.business.att.com/portfolios/networking.html;</u> <u>https://www.business.att.com/portfolios/networking.html;</u> <u>https://www.business.att.com/legal/att-business-wifi-with-cisco-meraki-terms-of-service.html;</u> 	- https://www.business.att.com/content/dam/businesscenter/pdf/legal/att-business-
 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/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/portfolios/networking.html; https://www.business.att.com/portfolios/networking.html; 	passport.pdf;
 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/portfolios/networking.html; https://www.business.att.com/legal/att-business-wifi-with-cisco-meraki-terms-of- service.html; 	- https://www.business.att.com/industries/partner-solutions/att-alliance-channel.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/products/business-wifi.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/portfolios/business-internet.html;
 <u>cisco-meraki-product-brief.pdf;</u> <u>https://www.business.att.com/products/business-wifi.html#equipment-options;</u> <u>https://www.business.att.com/content/dam/attbusiness/briefs/att-managed-wireless-wan.pdf;</u> <u>https://www.business.att.com/portfolios/networking.html;</u> <u>https://www.business.att.com/legal/att-business-wifi-with-cisco-meraki-terms-of-service.html;</u> 	- https://www.business.att.com/content/dam/attbusiness/briefs/att-business-wifi-with-
 <u>https://www.business.att.com/products/business-wifi.html#equipment-options;</u> <u>https://www.business.att.com/content/dam/attbusiness/briefs/att-managed-wireless-wan.pdf;</u> <u>https://www.business.att.com/portfolios/networking.html;</u> <u>https://www.business.att.com/legal/att-business-wifi-with-cisco-meraki-terms-of-service.html;</u> 	cisco-meraki-product-brief.pdf;
 <u>https://www.business.att.com/content/dam/attbusiness/briefs/att-managed-wireless-wan.pdf;</u> <u>https://www.business.att.com/portfolios/networking.html;</u> <u>https://www.business.att.com/legal/att-business-wifi-with-cisco-meraki-terms-of-service.html;</u> 	- https://www.business.att.com/products/business-wifi.html#equipment-options;
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/content/dam/attbusiness/briefs/att-managed-wireless-
 <u>https://www.business.att.com/portfolios/networking.html;</u> <u>https://www.business.att.com/legal/att-business-wifi-with-cisco-meraki-terms-of-service.html;</u> 	wan.pdf;
- https://www.business.att.com/legal/att-business-wifi-with-cisco-meraki-terms-of- service.html;	- https://www.business.att.com/portfolios/networking.html;
service.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/collateral/business-wifi-with-aruba-central.html;

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

<u>MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel and helps the VHT</u> 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.
<u>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</vht-mcs,></u> .
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 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 CTST ineout interval, the
	STA shall wait for the corresponding PHY-RXEND indication primitive to determine whether the
	KIS frame transmission was successful. The recognition of a valid CIS frame sent by the
	interpreted as successful response, permitting the frame exchange sequence to continue (see
	Anney 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
	procedure at the TTTT TAXET D.indication primitive and may process the received nume.
	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	The Accused Instrumentalities and Services perform the step of receiving at a first node in the
radio communications network	radio communications network an instruction transmitted from a second node in the radio
an instruction transmitted from a	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.

1	
	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.
	e mer met, ale e fit enan not respond men a e re nume.
	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, the STA shall invoke its backoff procedure upon expiration of the CTSTimeout interval, the STA shall wait for the corresponding PHY-RXEND.indication primitive to determine whether the RTS frame transmission was successful. The recognition of a valid CTS frame sent by the recipient of the RTS frame, corresponding to this PHY-RXEND.indication primitive, shall be interpreted as successful response, permitting the frame exchange sequence to continue (see Annex G). The recognition of anything else, including any other valid frame, shall be interpreted as failure of the RTS frame transmission. In this instance, the STA shall invoke its backoff procedure at the PHY-RXEND.indication primitive and may process the received frame.
A DMG STA follows the procedure defined in this subclause, except that it uses a DMG CTS frame instead of a CTS frame. A non-DMG STA does not transmit DMG CTS frames."
Pages 1313-1314 of 802.11-2016
"10.3.1 General
The RTS/CTS exchange also performs both a type of fast collision inference and a transmission path check. If the return CTS frame is not detected by the STA originating the RTS, the originating STA may repeat the process (after observing the other medium-use rules) more quickly than if the long Data frame had been transmitted and a return Ack frame had not been detected. <u>An</u> RTS/CTS exchange by VHT STAs also performs fast collision inference on the secondary 20

MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel and helps the VHT STA transmitting the RTS to determine the available bandwidth at the responder."
Page 1304 of 802.11-2016
"10.3.2.6 VHT RTS procedure
A VHT STA transmitting an RTS frame carried in non-HT or non-HT duplicate format and addressed to a VHT STA shall set the TA field to a bandwidth signaling TA and shall set the TXVECTOR parameters CH_BANDWIDTH_IN_NON_HT and CH_BANDWIDTH to the same value. If the STA sending the RTS frame is capable of dynamic bandwidth operation (see 10.3.2.7), the STA shall set the TXVECTOR parameter DYN_BANDWIDTH_IN_NON_HT to Dynamic. Otherwise, the STA shall set the TXVECTOR parameter DYN_BANDWIDTH_IN_NON_HT to Static.
A VHT STA that initiates a TXOP by transmitting an RTS frame with the TA field set to a bandwidth signaling TA shall not send an RTS frame to a non-VHT STA for the duration of the TXOP.
NOTE—A non-VHT STA considers the bandwidth signaling TA as the address of the TXOP holder. If an RTS frame is sent to a non-VHT STA during a TXOP that is initiated by an RTS frame with a bandwidth signaling TA, the non-VHT STA does not recognize the RTS sender as the TXOP holder.
10.3.2.7 CTS and DMG CTS procedure
A STA that receives an RTS frame addressed to it considers the NAV in determining whether to respond with CTS, unless the NAV was set by a frame originating from the STA sending the RTS frame (see 10.22.2.2). In this subclause, "NAV indicates idle" means that the NAV count is 0 or that the NAV count is nonzero but the nonbandwidth signaling TA obtained from the TA field of the RTS frame matches the saved TXOP holder address.

A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a
bandwidth signaling TA and that has the RXVECTOR parameter
DYN_BANDWIDTH_IN_NON_HT equal to Static behaves as follows:
- If the NAV indicates idle and CCA has been idle for all secondary channels (secondary 20
MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel) in the channel
width indicated by the RTS frame's RXVECTOR parameter
CH BANDWIDTH IN NON HT for a PIFS prior to the start of the RTS frame, then the
STA shall respond with a CTS frame carried in a non-HT or non-HT duplicate PPDU after a
SIFS. The CTS frame's TXVECTOR parameters CH BANDWIDTH and
CH BANDWIDTH IN NON HT shall be set to the same value as the RTS frame's
RXVECTOR parameter CH BANDWIDTH IN NON HT.
- Otherwise, the STA shall not respond with a CTS frame.
A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a
bandwidth signaling TA and that has the RXVECTOR parameter
DYN BANDWIDTH IN NON HT equal to Dynamic behaves as follows:
- If the NAV indicates idle, then the STA shall respond with a CTS frame in a non-HT or non-
HT duplicate PPDU after a SIFS. The CTS frame's TXVECTOR parameters
CH BANDWIDTH and CH BANDWIDTH IN NON HT shall be set to any channel width
for which CCA on all secondary channels has been idle for a PIFS prior to the start of the
RTS frame and that is less than or equal to the channel width indicated in the RTS frame's
REALER BANDWIDTH IN NON HT
 Otherwise the STA shall not respond with a CTS frame
otherwise, the STA shah het 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 SIES
 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
The new of the RTO frame to which this CTO frame is a response. The Duration field in the CTO
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, 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
"If a TXOP is protected by an RTS or CTS frame carried in a non-HT or a non-HT duplicate PPDU, the TXOP holder shall set the TXVECTOR parameter CH_BANDWIDTH of a PPDU as follows:
 <u>Io be the same or narrower than RXVECTOR parameter</u> <u>CH_BANDWIDTH_IN_NON_HT of the last received CTS frame in the same TXOP, if the</u> <u>RTS frame with a bandwidth signaling TA and TXVECTOR parameter</u> <u>DYN_BANDWIDTH_IN_NON_HT set to Dynamic has been sent by the TXOP holder in</u> 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." Page 1386 of 802.11-2016 "17.2.2.1 General Table 17-1—TXVECTOR parameters (continued) 		
Parameter	Associated primitive	Value
TIME_OF_ DEPARTURE_ REQUESTED	PHY-TXSTART.request (TXVECTOR)	false, true. When true, the MAC entity requests that the PHY entity measures and reports time of departure parameters corresponding to the time when the first frame energy is sent by the transmitting port; when false, the MAC entity requests that the PHY entity neither measures nor reports time of departure parameters.
CH_BANDWIDTH_ IN_NON_HT	PHY-TXSTART.request (TXVECTOR)	If present, CBW20, CBW40, CBW80, CBW160, or CBW80+80
DYN_BANDWIDTH _IN_NON_HT	PHY-TXSTART.request (TXVECTOR)	If present, Static or Dynamic
IT.2.2.8 TXVECTOR If present, the allowed present, this paramete the transmitter is capa DYN_BANDWIDTH present.	R DYN_BANDWIDT l values for DYN_BAN r is used to modify the ble of Static or Dynam [IN_NON_HT is pres	H_IN_NON_HT NDWIDTH_IN_NON_HT are Static and Dynamic. If first 7 bits of the scrambling sequence to indicate if nic bandwidth operation. If ent, then CH_BANDWIDTH_IN_NON_HT is also

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." Pages 2279-2280 of 802.11-2016		
"17.2.3.1 General		
Table 17-2—RXVECTOR parameters (continued)		
Parameter	Associated primitive	Value
RX_START_OF_FRAM E_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 prese	ent only when dot11RadioMe	asurementActivated is true.

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

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

Table 17-8—TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT values

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

Page 2294 of 802.11-2016
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



9.3.1.3 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.

Page 670 of 802.11-2016

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 PPDU containing VHT Kompressed Beamforming feedback shall be set to indicate than that indicated by the RXVECTOR parameter CH_BANDWIDTH of the PPDU containing VHT Kompressed Beamforming feedback shall be set to indicate than that indicated by the RXVECTOR parameter CH_BANDWIDTH of the PPDU containing VHT Kompressed Beamforming feedback shall be set to indicate a bandwidth not wider than that indicated by the RXVECTOR parameter CH_BANDWIDTH of the PPDU containing VHT Kompressed Beamforming feedback shall be set to indicate a bandwidth not wider than that indicated by the RXVECTOR parameter CH_BANDWIDTH of the PPDU containing VHT Kompressed 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.

Page 1490 of 802.11-2016		
	Table 17-1—TXVEC	TOR parameters <i>(continued)</i>
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 If present, the allowe CBW160, and CBW86 sequence to indicate th	R CH_BANDWIDTH_IN ed values for CH_BAN 0+80. If present, this par le bandwidth of the non-H	I_NON_HT DWIDTH_IN_NON_HT are CBW20, CBW40, CBW80, rameter is used to modify the first 7 bits of the scrambling HT duplicate PPDU.

Table 17-2—RXVECTOR parameters (continued)		
Parameter	Associated primitive	Value
RX_START_OF_FRAM E_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 preser	nt only when dot11RadioMe	asurementActivated is true.
17.2.3.7 RXVECTOR CH	_BANDWIDTH_IN_NO	N_HT DTH IN NON HT are CBW20, CBW40, CBW

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)	dotllCurrentChannelCenter 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

Page 2294 of 802.11-2016

	 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.

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	1
secondary80	Primary 20 MHz channel, secondary 20 MHz channel, and secondary 40 MHz channel	
EDCA TXOP is obtain beclause means "idle pre- annel." Once an EDCA fined in 11.16.9 and 1	S, of which the STA is a member, both support multiple ined based solely on activity of the primary channel. "Id timary channel." Likewise "busy medium" means "busy A TXOP has been obtained according to this subclause, 0.22.3 might limit the width of transmission during the	lle medium" in this primary further constraints TXOP or deny the
n EDCA TXOP is obtain loclause means "idle prinannel." Once an EDCA effined in 11.16.9 and 1 nannel access, based on condary 80 MHz chan the following descript	s, of which the STA is a member, both support multiple ined based solely on activity of the primary channel. "Id rimary channel." Likewise "busy medium" means "busy A TXOP has been obtained according to this subclause, 0.22.3 might limit the width of transmission during the the state of CCA on secondary channel, secondary 40 I nel.	lle medium'' in this primary further constraints TXOP or deny the MHz channel, or nships defined in "Channel idla for
n EDCA TXOP is obtain ubclause means "idle pro- hannel." Once an EDCA lefined in 11.16.9 and 14 hannel access, based on econdary 80 MHz chan n the following descript 0.3.7. Slot boundaries a n interval of PIFS" mean primitive was IDLE, and nds at the start of transm	S, of which the STA is a member, both support multiple ined based solely on activity of the primary channel. "Id rimary channel." Likewise "busy medium" means "busy A TXOP has been obtained according to this subclause, 0.22.3 might limit the width of transmission during the the state of CCA on secondary channel, secondary 40 h nel. ion, the CCA is sampled according to the timing relation are determined solely by activity on the primary channel ins that the STATE parameter of the most recent PHY-C h no PHYCCA. Indication (BUSY) occurred during the p nission, the CCA for that channel was determined to be	Ile medium" in this primary further constraints TXOP or deny the MHz channel, or nships defined in . "Channel idle for CCA.indication period of PIFS tha idle.
n EDCA TXOP is obtain ubclause means "idle pro- hannel." Once an EDCA efined in 11.16.9 and 14 hannel access, based on econdary 80 MHz chan in the following descript 0.3.7. Slot boundaries a n interval of PIFS" mea rimitive was IDLE, and nds at the start of transmission <u>Fa STA is permitted to</u> <u>ISDU pending for transmis</u> <u>xactly one of the follow</u>	S, of which the STA is a member, both support multiple ined based solely on activity of the primary channel. "Id rimary channel." Likewise "busy medium" means "busy A TXOP has been obtained according to this subclause, 0.22.3 might limit the width of transmission during the the state of CCA on secondary channel, secondary 40 I nel. ion, the CCA is sampled according to the timing relation are determined solely by activity on the primary channel uns that the STATE parameter of the most recent PHY-C I no PHYCCA. Indication (BUSY) occurred during the p mission, the CCA for that channel was determined to be begin a TXOP (as defined in 9.19.2.3) and the STA has semission for the AC of the permitted TXOP, the STA sh <u>ving steps:</u>	lle medium" in this / primary further constraints TXOP or deny the MHz channel, or nships defined in . "Channel idle for CCA.indication period of PIFS tha idle. <u>at least one</u> <u>all perform</u>

immediately preceding the start of the TXOP.

 b) <u>Transmit an 80 MHz mask PPDU on the primary 80 MHz channel if both the secondary 40 MHz channel were idle during an interval of PIFS immediately preceding the start of the TXOP.</u> c) <u>Transmit a 40 MHz mask PPDU on the primary 40 MHz channel if the secondary</u> 	<u>ndary</u> <u>channel</u>
 <u>channel and the secondary 40 MHz channel were idle during an interval of PIFS</u> <u>immediately preceding the start of the TXOP.</u> <u>Transmit a 40 MHz mask PPDU on the primary 40 MHz channel if the secondary</u> 	<u>channel</u>
 immediately preceding the start of the TXOP. c) Transmit a 40 MHz mask PPDU on the primary 40 MHz channel if the secondary 	<u>channel</u>
c) <u>Transmit a 40 MHz mask PPDU on the primary 40 MHz channel if the secondary</u>	<u>channel</u>
was idle during an interval of PIFS immediately preceding the start of the TXOP.	
d) <u>Transmit a 20 MHz mask PPDU on the primary 20 MHz channel.</u>	•
e) <u>Restart the channel access attempt by invoking the backoff procedure as specified</u>	<u>ın</u>
10.22.2 as though the medium is busy on the primary channel as indicated by either	<u>r</u>
physical or virtual CS and the backoff timer has a value of 0."	
Page 1383 of 802.11-2016	
"17.3.2.2 Overview of the PPDU encoding process	
e) If the TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT is not present, in the scrambler with a pseudorandom nonzero seed and generate a scrambling seque the TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT is present, construc- first 7 bits of the scrambling sequence from CH_BANDWIDTH_IN_NON_HT, DYN_BANDWIDTH_IN_NON_HT (if present), and a pseudorandom integer con such that the first 7 bits of the scrambling sequence are not all 0s; then set the scram- state to these 7 bits and generate the remainder of the scrambling sequence. XOR to scrambling sequence with the extended string of data bits. Refer to 17.3.5.5 for det	itiate nce. <u>If</u> <u>et the</u> <u>strained</u> <u>nbler</u> <u>he</u> ails.
Pages 1383-2284 of 802.11-2016	
"17.3.5.5 PHY DATA scrambler and descrambler	
The DATA field, composed of SERVICE, PSDU, tail, and pad parts, shall be scrambled v	vith a
length-127 PPDU-synchronous scrambler. The octets of the PSDU are placed in the transp	nit 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:	



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."
Pages 2292-2294 of 802.11-2016
"21.3.17 VHT transmit specification
21.3.17.1 Transmit spectrum mask
NOTE 1—In the presence of additional regulatory restrictions, the device has to meet both the regulatory requirements and the mask defined in this subclause. NOTE 2—Transmit spectral mask figures in this subclause are not drawn to scale. NOTE 3—For rules regarding TX center frequency leakage levels, see 21.3.17.4.2. The spectral mask requirements in this subclause do not apply to the RF LO.
For a 20 MHz mask PPDU of non-HT, HT or VHT format, the interim transmit spectral mask shall have a 0 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 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." Page 2595 of 802.11-2016



Page: 55 Page 55 of 426

"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.



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

separately from the receipt of the	The Accused Instrumentalities and Services perform the step of, separately from the receipt of the
instruction, receiving a	instruction, receiving a compressed first feedback from the second node that is based on a received
compressed first feedback from	power and one or more frequencies of a first signal transmitted from the first node to the second
the second node that is based on	node.
a received power and one or	
more frequencies of a first signal	The Accused Instrumentalities and Services perform the step of, separately from the receipt of the
transmitted from the first node to	instruction, receiving a compressed second feedback from a third node that is based on a received
the second node;	power and one or more frequencies of a second signal transmitted from the first node to the third node.
separately from the receipt of the	
instruction, receiving a	For example, as evidenced below, AT&T makes, uses, or sells 802.11ac-compliant access points
compressed second feedback	(AP) which, when operated by AT&T (e.g., employees conducting regular business activities,
from a third node that is based	installation teams, customer support, internal testers, during AT&T's provisioning of Wi-Fi and/or
on a received power and one or	Hotspots, AT&T's provisioning of business and residential Internet, etc.) and/or AT&T's agents
more frequencies of a second	or customers, require performance of a method that includes receiving a compressed first feedback
signal transmitted from the first	(e.g. a first feedback matrix) from the second node that characterizes receipt of a first signal (e.g. a
node to the third node;	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 <u>Feedback Matrix</u> V
	"Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time
	stream CSD in Table 21-11 from the measured channel before computing a set of matrices for
	<u>feedback to the beamformer</u> . 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 $Q_k = [Q_{k,0}, Q_{k,l},, Q_{k,Nuser}-1]$ 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 <i>V</i> . A beamformer shall support all tone grouping values and Codebook Information values."
Page 2579 of 802.11-2016
"10.34.5 VHT sounding protocol
10.34.5.1 General
Transmit beamforming and DL-MU-MIMO require knowledge of the channel state to compute a steering matrix that is applied to the transmitted signal to optimize reception at one or more receivers. The STA transmitting using the steering matrix is called the VHT beamformer, and a STA for which reception is optimized is called a VHT beamformee. <u>An explicit feedback mechanism is used where the VHT beamformee directly measures the channel from the training symbols transmitted by the VHT beamformer.</u> The VHT beamformer then uses this estimate, perhaps combining estimates from multiple VHT beamformees, to derive the steering matrix.
If dot11VHTSUBeamformerOptionImplemented is true, a STA shall set the SU Beamformer Capable field in the VHT Capabilities element to 1. If

dot11VHTSUBeamformeeOptionImplemented is true, a STA shall set the SU Beamformee Capable field in the VHT Capabilities element to 1.
If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set the MU Beamformer
Capable field in the VHI Capabilities element to 1. If
Capable field in the VHT Capabilities element to 1.
If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set
dot11VHTSUBeamformerOptionImplemented to true. If
dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set
dot11VHTSUBeamformeeOptionImplemented to true.
A STA is a VHT SU-only beamformer if it sets the SU Beamformer Capable field to 1 but sets the MU Beamformer Capable field to 0 in transmitted VHT Capabilities elements. A STA is an SU-only beamformee if it sets the SU Beamformee Capable field to 1 but sets the MU Beamformee Capable field to 0 in transmitted VHT Capabilities elements.
If dot11VHTSUBeamformerOptionImplemented is false, a STA shall not act in the role of a VHT beamformer. If dot11VHTSUBeamformeeOptionImplemented is false, a STA shall not act in the role of a VHT beamformee. "
Page 1488 of 802.11-2016
"9.4.1.49 <u>VHT Compressed Beamforming Report field</u>
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."
	"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." <u>https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html</u>
decompressing the compressed first feedback resulting in a decompressed first 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.
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.
	17.5.12.5.0 Compressed beamorning reeuback 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 $N_r \ge N_c$ 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	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.
the decompressed first feedback and 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.
	<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):

21.3.11.2 Beamforming <u>Feedback Matrix</u> V
<u>"Upon receipt of a VHT NDP sounding PPDU, the</u> 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 $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,Nuser}-1]$ 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. "
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 <u>explicit feedback information in the form of angles representing compressed beamforming feedback matrices <i>V</i> for use by a transmit beamformer to determine steering matrices <i>Q</i>, as described in 10.32.3 and 19.3.12.3.</u>					
	The size of the VHT Compressed Beamforming Report field depends on the values in the VHT MIMO Control field. The VHT Compressed Beamforming Report field contains VHT Compressed Beamforming Report information or successive (possibly zero-length) portions thereof in the case of segmented VHT Compressed Beamforming feedback (see 10.34.5). VHT 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 <i>V</i> is given in 19.3.12.3.6. In Table 9-67,					
	<i>Nc</i> is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field,					
	<i>Nr</i> 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	at least one antenna of a plurality of antennas, using a first power that is based on at least one of					
via at least one antenna of a	the one or more data structures.					
plurality of antennas, using a						
first power that is based on at	For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points					
least one of the one or more data	(AP) which, when operated by AT&T (e.g., employees conducting regular business activities,					
structures; and	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: Can avidence sited continuin this independent claims (which is incomponented by reference) as					
	Note : See evidence ched earner in this independent chaim (which is incorporated by reference), as well as the following (amphasis added, if any):					
	wen as me 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 adjacent to the primary 20 MHz channel that together form the primary 40 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. 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 Qk for DL-MU-MIMO, where k is one of the subcarriers, and Qk is consisted of sub-matrices Qku, each corresponding to one receiving STA u. IEEE 802.11-2016: 21.3.11.2 Beamforming Feedback Matrix V further specifies that Qku is dependent on the feedback matrix Vku 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 (beamforme) is getting a different polling packet, based on which the feedback matrix Vku is measured and should be different from STA to STA. 	
 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 Qk for DL-MU-MIMO, where k is one of the subcarriers, and Qk is consisted of sub-matrices Qk.u, each corresponding to one receiving STA u. IEEE 802.11-2016: 21.3.11.2 Beamforming Feedback Matrix V further specifies that Qk.u is dependent on the feedback matrix Vk.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 (beamforme) is getting a different polling packet, based on which the feedback matrix Vk.u is measured and should be different from STA to STA. 	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.
 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: <u>21.3.11 SU-MIMO and DL-MU-MIMO Beamforming</u> and 21.3.11.1 General specifies the steering matrix <i>Qk</i> for DL-MU-MIMO, where k is one of the subcarriers, and <i>Qk</i> is consisted of sub-matrices <i>Qku</i>, each corresponding to one receiving STA <i>u</i>. IEEE 802.11-2016: 21.3.11.2 Beamforming Feedback Matrix <i>V</i> further specifies that <i>Qku</i> is dependent on the feedback matrix <i>Vku</i> provided by each STA <i>u</i>, which is based on the actual channel measurement by each STA <i>u</i>. 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 <i>Vku</i> is measured and should be different from STA to STA. 	secondary access category (AC) : An access category (AC) that is not associated with the enhanced distributed channel access function (EDCAF) that gains channel access.
 Pages 161-163 of 802.11-2016 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 Qk for DL-MU-MIMO, where k is one of the subcarriers, and Qk is consisted of sub-matrices Qku, each corresponding to one receiving STA u. IEEE 802.11-2016: 21.3.11.2 Beamforming Feedback Matrix V further specifies that Qku is dependent on the feedback matrix Vku 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 Vku is measured and should be different from STA to STA. 	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."
 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 Qk for DL-MU-MIMO, where k is one of the subcarriers, and Qk is consisted of sub-matrices Qku, each corresponding to one receiving STA u. IEEE 802.11-2016: 21.3.11.2 Beamforming Feedback Matrix V further specifies that Qku is dependent on the feedback matrix Vku 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 Vku is measured and should be different from STA to STA. 	Pages 161-163 of 802.11-2016
	 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 Qk for DL-MU-MIMO, where k is one of the subcarriers, and Qk is consisted of sub-matrices Qku, each corresponding to one receiving STA u. IEEE 802.11-2016: 21.3.11.2 Beamforming Feedback Matrix V further specifies that Qku is dependent on the feedback matrix Vku 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 Vku is measured and should be different from STA to STA.

_												
An exam	ple of the V	HT s	soundi	ng protocol v	ith m	iore than one	VH	T beamform	ee is	s shown in F	igur	e 10-8.
Beamformer	VHT NDP Announce- ment	SIFS	NDP	ମ ଅ ⊻	SIFS	Beamforming Report Poll	SIFS		SIFS	Beamforming Report Poll	SIFS	
Beamformee 1		↔		Compresse Beamformi	d ↔	•		VHT	↔		↔	
Beamformee 2					2			Compressed Beamforming				VHT
Beamformee 3												Compressed Beamforming
Figur	e 10-53—I	Exar	mple	of the sour	ding	protocol v	with	n more thar	ı or	ne VHT bea	amf	ormee
Pages 1490	-2579 of 8	802.	.11-2	016								
"21.3.11 SU	J -MIMO	and	d DL	-MU-MIN	O B	eamformi	ng					
21.3.11.1 G	leneral											
SU-MIMO antennas (th With SU-M reception at streams are	and DL-M ne beamfo IIMO bea a single s intended	MU- orme mfo STA for	MIM er) to rmin . Wi recep	O beamfor steer signa g all space- th DL-MU tion at diff	ming ls us time -MIN erent	g are techn sing knowle streams in MO beamfe t STAs.	iqu edg 1 the orm	es used by e of the ch e transmitt ing, disjoir	a S ann ed s nt s	STA with r nel to impr signal are s subsets of t	nul ove inte	tiple throughput. nded for space-time
For SU-MI feedback m beamformin described in	MO beam atrix V _k th ng feedbac n 9.4.1.49	iforr <u>nat i</u> ck n	ning, <u>s sen</u> natrix	<u>the steerin</u> t back to th format as	<u>g ma</u> e bea defin	atrix <i>Q_k</i> car amformer ned in 19.3	<u>n be</u> by t 5.12	e determine the beamfo .3.6. The f	<u>ed f</u> ormo eed	<u>From the be</u> ee using the back report	<u>eam</u> ne c rt fo	<u>forming</u> ompressed ormat is
For DL-MU $y_{k,u} = [y_{k,0}]$ denotes th $x_{k,u} = [x_{k,0}]$	J-MIMO , y _{k, 1} ,, y e transmi , x _{k, 1} ,, x	bean ['] k, N _{RU} it	nform _{x_u} - 1] ⁷ signal	ing, the re , is shown i vector ^T being the	ceive n Eq n s transi	e signal vo uation (21-1 subcarrier mit signal fo	ecto: .01), <i>k</i> or be	r in subca , where x _k = for all . eamformee <i>u</i>	rrie = [: N _{use} ı.	$\begin{array}{c} \mathbf{r} k \text{at be} \\ \mathbf{x}_{k, 0}^{T}, \mathbf{x}_{k, 1}^{T}, \dots \\ \mathbf{r} \text{beamfo} \end{array}$	amf ., xj rme	Formee u , $[t, N_{user} - 1]^T$ es, with

$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l} \dots, Q_{k,Nuser} - 1] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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
<i>N_{user}</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser}-1]$ 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 $u = 0, 1,, N_{user} - 1$. 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_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
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	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.
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 adjacent to the primary 20 MHz channel adjacent to the primary 20 MHz or 80+80 MHz VHT BSS, the 20 MHz channel of the 160 MHz or 80+80 MHz VHT BSS. In a 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: <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, 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 Feed	back Matrix V further specifies that
O_{ku} is dependent on the feedback matrix V_{ku} provide	led 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	s that each STA (beamformee) is getting
a different polling packet, based on which the feedb	back 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 VH	IT beamformee is shown in Figure 10-8.
VHTNDP to Beamforming to	e Beanforming to
Beamformer Announce-	Report Poll
Beamformee 1 + Compressed + +	↔ ↔
Beamtoming	VHT
Beamformee 2	Beamforming VHT
Beamformee 3	Compressed Beamforming
Figure 10-53—Example of the sounding protocol with	n more than one VHT beamformee
Pages 1490-2579 of 802.11-2016	
"21 3 11 SU-MIMO and DL-MU-MIMO Beamforming	
21.0.11 Se Millio and DE Me Millio Deamorning	
21.3.11.1 General	
SU MIMO and DL MIL MIMO beamforming are technique	use used by a STA with multiple
antennas (the beamformer) to steer signals using knowledge	e of the channel to improve throughout
With SU-MIMO beamforming all space-time streams in th	e transmitted signal are intended for
reception at a single STA. With DL-MU-MIMO beamform	ning, disjoint subsets of the space-time
streams are intended for reception at different STAs.	
1	
For SU-MIMO beamforming, the steering matrix Qk can be	e 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 , $y_{k,u} = [y_{k,0}, y_{k,1},, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T,, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1},, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u .
$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l} \dots, Q_{k,Nuser-1}] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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
<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k_kNuser}-1]$ 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 $u = 0, 1,, N_{user}-1$. 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
22. The method of claim 19, wherein the instruction includes a first instruction, and further comprising:	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.
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	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.

<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
"10.3.2.7 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, 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.
	<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 , $y_{k,u} = [y_{k,0}, y_{k,1}, \dots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \dots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \dots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u .
$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l}, Q_{k,Nuser-1}] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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
<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser}-1]$ 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 $u = 0, 1,, N_{user}-1$. 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, $Q_{steer,k} = Q_k V_k$, 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:	

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 , $y_{k,u} = [y_{k,0}, y_{k,1},, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T,, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1},, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u .
$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l}, Q_{k,Nuser-1}] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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
Nuser	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- beamformer u and SNR info The steering u new SNR info steering matr <u>MU transmiss</u> 21.3.11.4)."	MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser}-1]$ can be determined by the using the beamforming feedback matrices for subcarrier k from beamformee $u, V_{k,u}$, prmation for subcarrier k from beamformee $u, SNR_{k,u}$, where $u = 0, 1,, N_{user} - 1$. matrix that is computed (or updated) using new beamforming feedback matrices and prmation from some or all of participating beamformees might replace the existing ix Q_k for the next DL-MU-MIMO data transmission. The beamformee group for the sion is signaled using the Group ID field in VHT-SIG-A (see 21.3.8.3.3 and
Pages 2578-2	579 of 802.11-2016
"19.3.12.3 Ex	xplicit feedback beamforming
19.3.12.3.1 G	General
In explicit be measures the beamforming V_k found from the sounding product of the steering matr	amforming, in order for STA A to transmit a beamformed packet to STA B, STA B channel matrices and sends STA A either the effective channel, $H_{eff,k}$, or the feedback matrix, V_k , for STA A to determine a steering matrix, $Q_{steer,k} = Q_k V_k$, with in $H_k Q_k$, where Q_k is the orthonormal spatial mapping matrix that was used to transmit packet that elicited the V_k feedback. The effective channel, $H_{eff,k} = H_k Q_k$, is the e spatial mapping matrix used on transmit with the channel matrix. When new ix $Q_{steer,k}$ is found, $Q_{steer,k}$ may replace Q_k for the next beamformed data transmission.
NOTE— <i>Qste</i> beamformed	e_{k} is a mathematical term to update a new steering matrix for Q_k in the next 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.
	<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 , $y_{k,u} = [y_{k,0}, y_{k,1}, \dots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \dots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with
	$x_{k,u} = [x_{k,0}, x_{k,1}, \dots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u .

$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l}, Q_{k,Nuser} - 1] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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
<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser}-1]$ 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 $u = 0, 1,, N_{user} - 1$. 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.					
	beamformed data transmission."					
	Page 2396 of 802.11-2016					
25. The method of claim 19,	When used by AT&T, and/or AT&T's agents or customers, the Accused Instrumentalities and					
wherein an update of the	Services perform the claimed method as shown by the evidence below:					
compressed first feedback is						
repeatedly received at time	Note : See evidence cited earlier in independent claim (which is incorporated by reference), as well					
and the first neuron is repeatedly	as the following (emphasis added, if any):					
undated based on an undated	"Or a steering matrix for beamformed u in subcarrier k with dimensions					
decompressed first feedback at	$\mathcal{Q}_{K,0}$ is a secting matrix for beamformed u in subcarrier K with dimensions					
time periods of less than one	<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)					
second; and						
	<i>n</i> is a vector of additive noise and may include interference					
an update of the compressed						
second feedback is repeatedly	The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,Nuser-1}]$ can be determined by the					
received at time periods of less	beamformer using the beamforming feedback matrices for subcarrier k from beamformee u, Vk,u,					
than one second, and the second	and SNR information for subcarrier k from beamformee u , $SNR_{k,u}$, where $u = 0, 1,, N_{user} - 1$.					
power is repeatedly updated	The steering matrix that is computed (or updated) using new beamforming feedback matrices and					
based on an updated	new SNR information from some or all of participating beamformees might replace the existing					
decompressed second feedback	steering matrix Q_k for the next DL-MU-MIMO data transmission. The beamformee group for the					
at time periods of less than one	MU transmission is signaled using the Group ID field in VHT-SIG-A (see 21.3.8.3.3 and					
second.	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,	When used by AT&T, and/or AT&T's agents or customers, the Accused Instrumentalities and
wherein the filtered first	Services perform the claimed method as shown by the evidence below:
transmission signal and the	
filtered second transmission	Note: See evidence cited earlier in independent claim (which is incorporated by reference), as well
signal are transmitted via the	as the following (emphasis added, if any):
same transceiver.	



	5y 1-2-3 self-installat u qualify for an easy self-install kit, no technician is nee	ion ^{ded.}
	2	3
Unpack the AT&T Wi-Fi gateway	Make the connection	Sign in, register & get online
Plug the AT&T Wi-Fi gateway into an outlet.	Connect your AT&T Wi-Fi gateway to your computer using the provided cables.	Follow the easy on-screen steps—and you're good to go.
If you are unable to it	nstall the AT&T Wi-Fi Gateway, call 800.288.2020 to schedule a technician for a pro	fessional installation.
https://www.att.com/wi-fi/		



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.





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 models Gateway image You may have one of the following Wi-Fi gateways: at&t BGW210 Pace 5268 POWER NVG589 NVG510 . Pace 5031 NVG599 ETHERNET BGW320 • WIRELESS 2Wire 3801 • PHONE 1 2Wire 2701 PHONE 2 2Wire 3800 2Wire 3600 Netgear 7550 BRÓADBAND Pace 5168 • 2Wire i38 • Pace 4111 • Westell 327

Page: 94 Page 94 of 426

	https://www.att.com/support/a	rticle/dsl-high-speed/K	M1047050/	
	This item: AT&T Wireless Inte WiFi Modem 4G LTE Home Ba Router	v ernet ase		
	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 single band Class	dual band	-	dual band
	https://www.amazon.com/Wir	eless-Internet-Hotspot-	Antenna-AT/dp/B075	JB968D?source=ps-sl-
	shoppingads-lpcontext&ref_=	fplfs&psc=1∣=A2	240VZW9214RO6	
27. The method of claim 19,	The Accused Instrumentalities	and Services perform	steps of a method as a	rticulated above,
wherein the filtered first	wherein the first power and the	e second power are diff	ferent.	
transmission signal and the				
filtered second transmission	For example, as evidenced bel	ow AT&T makes, uses	s, or sells 802.11ac-con	mpliant access points
signal are transmitted via	(AP) which, when operated by	AT&T (e.g., employe	es conducting regular	business activities,
different transceivers.	installation teams, customer su	pport, internal testers,	during AT&T's provi	sioning 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.

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



	5y 1-2-3 self-installat u qualify for an easy self-install kit, no technician is nee	ion ^{ded.}
	2	3
Unpack the AT&T Wi-Fi gateway	Make the connection	Sign in, register & get online
Plug the AT&T Wi-Fi gateway into an outlet.	Connect your AT&T Wi-Fi gateway to your computer using the provided cables.	Follow the easy on-screen steps—and you're good to go.
If you are unable to it	nstall the AT&T Wi-Fi Gateway, call 800.288.2020 to schedule a technician for a pro	fessional installation.
https://www.att.com/wi-fi/		



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.





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 models Gateway image You may have one of the following Wi-Fi gateways: at&t BGW210 Pace 5268 POWER NVG589 NVG510 Pace 5031 . NVG599 ETHERNET BGW320 • WIRELESS 2Wire 3801 • PHONE 1 2Wire 2701 PHONE 2 2Wire 3800 2Wire 3600 Netgear 7550 BRÓADBAND Pace 5168 • 2Wire i38 • Pace 4111 • Westell 327

Page: 102 Page 102 of 426

	https://www	v.att.com/support/a	rticle/dsl-high-speed/K	<u>M1047050/</u>	
	This item:	AT&T Wireless Inte	ernet		
	WiFi Mode	em 4G LTE Home Ba	ise		
	Router				
	Connectivity Tech Wi	ireless, Bluetooth, Ethernet, LTE, Wi-Fi	Wi-Fi	Wi-Fi	Wi-Fi, Ethernet, USB
	Number Of Ports —		5	7	5
	Wireless Standard 80.	12 11 AC	_	2.4 ghz radio frequency	802 11 AX, 802 11 AC, 802 11 N, 802 11 G, 802 11 B
	Frequency Band sin Class	igle band	dual band	-	dual band
	https://www	.amazon.com/Wire	eless-Internet-Hotspot-	Antenna-AT/dp/B075	JB968D?source=ps-sl-
	shoppingade	s-lpcontext&ref_=f	plfs&psc=1∣=A2	240VZW9214RO6	
28. The method of claim 19, wherein the instruction is	The Accuse wherein the	d Instrumentalities instruction is recei	and Services perform ved utilizing a dedicate	steps of a method as a ed channel.	rticulated above,
channel	For example	e as evidenced hel	$\Delta T \& T $ makes uses	or sells 802 11ac-cor	nnliant access noints
	(AP) which	when operated by	$AT&T (e \sigma employed)$	es conducting regular	husiness activities
	installation	teams, customer su	port internal testers	during AT&T's provis	sioning of Wi-Fi and/or
	Hotspots, A	T&T's provisionin	g of business and resid	lential Internet, etc.) a	nd/or AT&T's agents

	or custom received u	or customers, require performance of a method as articulated above, wherein the instruction is received utilizing a dedicated channel.									
	Note: See as the foll	<u>Note</u> : 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	мімо	Contr	ol field							
	The MIN feedback Compres	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.						5			
	The MIN	IO Con	trol fiel	d is 6 octet	s in length a	nd is define	d in Figure 9	-94.			
		B0 B1	B2 B3	B4	B5 B6	B7 B8	B9 B10	B11 B13	B14 B15	B16 B47	T
		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 9-9	4—MIMO	Control fiel	d			
	Page 745	of 802	.11-20	16							
29. The method of claim 19, wherein the instruction is received via an antenna configured for omnidirectional communication.	The Accu wherein the For exam (AP) which installation Hotspots	sed Ins ne instr ple, as ch, who n team AT&T	strume ruction evider en ope s, cust	ntalities a is receiv need below rated by A comer sup visioning	nd Servic ed via an w AT&T 1 AT&T (e.g port, inter of busine	es perform antenna co nakes, use g., employ nal testers ss and resi	n steps of a onfigured fo es, or sells 8 ees conduct , during AT	method as or omnidire 302.11ac-c ting regula 5&T's prov ernet, etc.)	articulate ectional c ompliant r busines visioning and/or A	ed above, ommunicati access poin s activities, of Wi-Fi an T&T's ager	ion. .ts .id/or
	or custom received v	ers, reo via an a	quire p intenna	erforman a configu	ce of a me red for or	ethod as an inidirectio	ticulated at nal commu	nication.	ein the in	struction is	105

	 <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
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. <u>Note</u> : 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	мімо	Contr	ol field						
	The MIN feedback Compres	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 MIN	IO Con	trol fiel	d is 6 octet	s in length a	nd is define	d 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 3 2							32		
	Daga 745	- 6 9 0 7	11.20	16	Figure 9-9	4—MIMO	Control fiel	d		
	Page 745	01 802	.11-20	10						
31. The method of claim 19, wherein the compressed first feedback and the compressed second feedback are received via	The Accu wherein the antenna c	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.								
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.									
	Note: See as the foll	evider owing	nce cit (empł	ed earlier nasis adde	in indeper d, if any):	ndent clair	n (which is	incorpora	ted by ret	ference), as well

	"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	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.
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.
	<u>Note</u> : 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." <u>http://www.emperorwifi.com/2015/04/a-simplified-explanation-of-80211nac.html</u>

	Image: signal processor Radio Radio Radio	Image: Second						
	https://www.comparitech.com/net-admin/v	<u>what-is-mu-mimo/</u>						
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 Service wherein the decompressed first feedback a increase spatial separation among transmis For example, as evidenced below AT&T m (AP) which, when operated by AT&T (e.g installation teams, customer support, intern Hotspots, AT&T's provisioning of busines or customers, require performance of a me first feedback and the decompressed secon among transmissions at the same frequence	es perform steps of a method as articulated above, and the decompressed second feedback are used to assions at the same frequency. nakes, uses, or sells 802.11ac-compliant access points ., employees conducting regular business activities, nal testers, during AT&T's provisioning of Wi-Fi and/or and residential Internet, etc.) and/or AT&T's agents atthod as articulated above, wherein the decompressed ad feedback are used to increase spatial separation y.						
	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 Image: the transmission of the transmissio							
--	--	--	--	--	--	--	--	--
	Access Point © 4X4 MU-MIMO support 4 users simultaneously © 8X8 MU-MIMO support 8 users simultaneously © All data streams use same frequency simultaneously © Acts more like a switch than a hub © Much better spectral efficiency							
34. The method of claim 19, and further comprising:	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							
receiving a compressed third feedback from a fourth node that characterizes receipt of a third	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	transceivers used to transmit the filtered first transmission signal and the filtered second
the fourth node, the fourth node	transmission signal, and further using a third power that is based on the decompressed third
being a legacy node;	feedback.
decompressing the compressed	For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points
third feedback resulting in a	(AP) which, when operated by AT&T (e.g., employees conducting regular business activities,
decompressed third feedback;	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
transmitting, using a third	or customers, require performance of a method as articulated above, further comprising receiving a
frequency and another 802.11-	compressed third feedback from a fourth node that characterizes receipt of a third signal sent from
based OFDM protocol, the third	the first node to the fourth node, the fourth node being a legacy node; decompressing the
transmission signal to the fourth	compressed third feedback resulting in a decompressed third feedback; transmitting, using a third
node using a transceiver separate	frequency and another 802.11-based OFDM protocol, the third transmission signal to the fourth
from one or more other	node using a transceiver separate from one or more other transceivers used to transmit the filtered
transceivers used to transmit the	first transmission signal and the filtered second transmission signal, and further using a third
filtered first transmission signal	power that is based on the decompressed third feedback.
and the filtered second	
transmission signal, and further	Note: See evidence cited earlier in independent claim (which is incorporated by reference), as well
using a third power that is based	as the following (emphasis added, if any):
on the decompressed third	
feedback.	



Easy 1-2-3 self-installation If you qualify for an easy self-install kit, no technician is needed.							
	2	3					
Unpack the AT&T Wi-Fi gateway	Make the connection	Sign in, register & get online					
Plug the AT&T Wi-Fi gateway into an outlet.	Connect your AT&T Wi-Fi gateway to your computer using the provided cables.	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/							



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.





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 models Gateway image You may have one of the following Wi-Fi gateways: at&t BGW210 Pace 5268 POWER NVG589 NVG510 Pace 5031 . NVG599 ETHERNET BGW320 • WIRELESS 2Wire 3801 • PHONE 1 2Wire 2701 PHONE 2 2Wire 3800 2Wire 3600 Netgear 7550 BRÓADBAND Pace 5168 • 2Wire i38 • Pace 4111 • Westell 327

Page: 117 Page 117 of 426

https://www.att.com/support/a	article/dsl-high-speed/H	<u>KM1047050/</u>	
This item: AT&T Wireless Int WiFi Modem 4G LTE Home B Router	ernet ase		
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 single band Class	dual band	-	dual band
https://www.amazon.com/Win	eless-Internet-Hotspot	-Antenna-AT/dp/B075	JB968D?source=ps-sl
shoppingads-lpcontext&ref =	fplfs&psc=1∣=A	240VZW9214RO6	<u> </u>
"AT&T All-Fi is complimenta speed plan Everyone with <u>https://www.att.com/internet/v</u> <u>https://www.att.com/legal/terr</u>	ary to all AT&T Fiber All-Fi gets the AT&T what-is-all-fi/#storyoff ns.wiFiServices.html	customers, regardless o Wi-Fi Gateway" <u>er7</u> ; <i>see also</i>	of their fiber internet
"AT&T All-Fi Hub and All-Fi wireless internet service—AT cellular network." https://ww	i Booster are devices th &T Internet Air—which w.att.com/internet/what	nat are actually rela ch allows Wi-Fi servic tt-is-all-fi/#storyoffer7	ated to AT&T's e through AT&T's

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" <u>https://www.att.com/legal/terms.consumerserviceagreement.html</u>
"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" <u>https://about.att.com/sites/broadband/performance#:~:text=Nationwide%20Wi%2DFi%20Hotspot%20Service,access%20services%2C%20please%20click%20here</u> .
"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

	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." <u>https://www.business.att.com/products/business-wifi.html</u>
	" <u>802.11ax radios are able to communicate will legacy 802.11a/b/g/n/ac radios</u> . 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." <u>https://www.extremenetworks.com/wifi6/what-is-80211ax</u> .
	"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." <u>https://www.extremenetworks.com/resources/blogs/what-is-wifi-7</u> .
35. The method of claim 34, wherein the third transmission signal is transmitted simultaneously with the filtered first transmission signal and the	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.
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.
	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
	" <u>802.11ax radios are able to communicate will legacy 802.11a/b/g/n/ac radios</u> . 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." <u>https://www.extremenetworks.com/wifi6/what-is-80211ax/#:~:text=Is%20802.11ax%20backward%20compatible,g%2Fn%2Fac%20radios</u> .
36. The method of claim 19, wherein the compressed first feedback is based on a 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.
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.
	<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> 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 $Q_k = [Q_{k,0}, Q_{k,l},, Q_{k,Nuser}-1]$ 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 <i>V</i> . 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,									
<i>Nc</i> is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field,									
<i>Nr</i> 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	мімо	Contr	ol 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 MIN	IO Con	trol fiel	d is 6 octets	in length a	nd is define	d in Figure 9-	94.		
B0 B1 B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B13 B14 B15 B16 B47									
Nc IndexNr IndexMIMO Control Channel WidthGrouping (Ng)Coefficient SizeCodebook InformationRemaining Matrix SegmentReservedSounding Timestamp									
Bits:	2	2	1	2	2	2	3	2	32
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." <u>https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html</u>						
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						
		Octets: 2	2	6	6	4	
		Frame Control	- Duration MAC hea	RA	TA	FCS	
	Figure 9-20—RTS frame						



	 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 Qk for DL-MU-MIMO, where k is one of the subcarriers, and Qk is consisted of sub-matrices Qku, each corresponding to one receiving STA u. IEEE 802.11-2016: 21.3.11.2 Beamforming Feedback Matrix V further specifies that Qku is dependent on the feedback matrix Vku 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 Vku is measured and should be different from STA to STA.

An example of the VHT soundi	ng protocol with more than one V	HT beamformee is shown in l	Figure 10-8.
Beamformer	v Beamforming v HT Report Poll	Beamforming Beamforming Report Poll	S E S S S S S S S S S S S S S S S S S S
	Beamforming	VHT	
Beamformee 2		Beamforming	VHT
Beamformee 3			Compressed Beamforming
Figure 10-53—Example Pages 1490-2579 of 802.11-20 "21.3.11 SU-MIMO and DL 21.3.11.1 General SU-MIMO and DL-MU-MIM antennas (the beamformer) to With SU-MIMO beamforming reception at a single STA. Wi streams are intended for recep For SU-MIMO beamforming, feedback matrix V_k that is sem beamforming feedback matrix	of the sounding protocol with 016 - MU-MIMO Beamforming (O beamforming are techniq steer signals using knowled g all space-time streams in the th DL-MU-MIMO beamform to at different STAs. the steering matrix Q_k can be t back to the beamformer by a format as defined in 19.3.1	th more than one VHT be ues used by a STA with ge of the channel to imp he transmitted signal are ming, disjoint subsets of <u>be determined from the be</u> the beamformee using to 2.3.6. The feedback repo	multiple rove throughput. intended for the space-time <u>beamforming</u> the compressed ort format is

For DL-MU-MIMO beamforming, the receive signal vector in subcarrier k at beamformee u ,	
$y_{k,u} = [y_{k,0}, y_{k,1}, \dots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}, x_{k,1}, \dots, x_{k,N_{user}-1}]$	
denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with	
$x_{k,u} = [x_{k,0}, x_{k,1}, \dots, x_{k,N_{STS,u}-1}]^2$ being the transmit signal for beamformee <i>u</i> .	
$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l} \dots, Q_{k,Nuser-1}] \ge x + n$	
where	
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with	
dimensions	
$N_{RXu} \ge N_{TX}$	
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	
<i>N_{user}</i> is the number of VHT MU PPDU recipients (see Table 21-6)	
<i>n</i> is a vector of additive noise and may include interference	
The DL-MU-MIMO steering matrix $O_k = [O_{k,0}, O_{k,1}, \dots, O_{k,Nuser}-1]$ can be determined by the	
beamformer using the beamforming feedback matrices for subcarrier k from beamformer u, $V_{k,u}$,	
and SNR information for subcarrier k from beamformee u , $SNR_{k,u}$, where $u = 0, 1,, N_{user} - 1$.	
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	
<u>MU transmission is signaled using the Group ID field in VHT-SIG-A (see 21.3.8.3.3 and</u>	
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." <u>https://www.business.att.com/content/dam/attbusiness/briefs/att-will-5g-replace-wifi-general-business-brief.pdf</u>

39. The method of claim 19, wherein the first frequency is selected as a function of the compressed first feedback, and	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.
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, the steering matrix Q_k can be determined from the beamforming feedback matrix V_k that is sent back to the beamformer by the beamformee using the compressed beamforming feedback matrix format as defined in 19.3.12.3.6. The feedback report format is described in 9.4.1.49.

For DL-MU-MIMO beamforming, the receive signal vector in subcarrier k at beamformee u ,	
$y_{k,u} = [y_{k,0}, y_{k,1}, \dots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}, x_{k,1}, \dots, x_{k,N_{user}-1}]$	
denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with	
$x_{k,u} = [x_{k,0}, x_{k,1}, \dots, x_{k,N_{STS,u}-1}]^2$ being the transmit signal for beamformee <i>u</i> .	
$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l} \dots, Q_{k,Nuser-1}] \ge x + n$	
where	
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with	
dimensions	
$N_{RXu} \ge N_{TX}$	
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	
<i>N_{user}</i> is the number of VHT MU PPDU recipients (see Table 21-6)	
<i>n</i> is a vector of additive noise and may include interference	
The DL-MU-MIMO steering matrix $O_k = [O_{k,0}, O_{k,1}, \dots, O_{k,Nuser}-1]$ can be determined by the	
beamformer using the beamforming feedback matrices for subcarrier k from beamformer u, $V_{k,u}$,	
and SNR information for subcarrier k from beamformee u , $SNR_{k,u}$, where $u = 0, 1,, N_{user} - 1$.	
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	
<u>MU transmission is signaled using the Group ID field in VHT-SIG-A (see 21.3.8.3.3 and</u>	
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						
40. The method of claim 19, wherein the instruction includes a 802 11 clear to send (CTS)	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:						
instruction.	<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</u> 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</u> <u>STA transmitting the RTS to determine the available bandwidth at the responder."</u>						

	Page 1304 of 802.11-2016						
41. The method of claim 19, wherein the instruction includes	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:						
instruction.	<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	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:						
transmitted simultaneously with the filtered first transmission	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):						
antenna of the plurality of antennas.	• 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, 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 fun Qk,u is dependent on the feedback matrix Vk,u provided by each STA u the actual channel measurement by each STA u. IEEE 802.11-2016: Figure 10-53 (below) illustrates that each STA (b a different polling packet, based on which the feedback matrix Vk,u is be different from STA to STA. An example of the VHT sounding protocol with more than one VHT beamformee is shown. 	rther specifies that <i>u</i> , which is based on beamformee) is getting measured and should wn in Figure 10-8.
Beamformer VHT NDP Announce- ment volume G NDP volume G VHT Compressed Beamforming Beamforming G volume G Beamforming Report Poll volume G Beamforming Beamformee 1 Image: Compressed Beamforming Image: Compressed Beamforming Image: Compressed Beamforming Image: Compressed Beamforming Beamformee 3 Image: Compressed Beamforming Image: Compressed Beamforming Image: Compressed Beamforming	mforming port Poll U ↔ VHT Compressed Beamforming
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 antennas (the beamformer) to steer signals using knowledge of the channel to With SU-MIMO beamforming all space-time streams in the transmitted signareception at a single STA. With DL-MU-MIMO beamforming, disjoint subse streams are intended for reception at different STAs.	with multiple o improve throughput. al are intended for ets of the space-time
For SU-MIMO beamforming, the steering matrix Q_k can be determined from feedback matrix V_k that is sent back to the beamformer by the beamformer up	the beamforming
$\frac{1}{1}$	sing the compressed

beamforming feedback matrix format as defined in 19.3.12.3.6. The feedback report format is described in 9.4.1.49.
For DL-MU-MIMO beamforming, the receive signal vector in subcarrier k at beamformee u , $y_{k,u} = [y_{k,0}, y_{k,1}, \dots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \dots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \dots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u .
$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l} \dots, Q_{k,Nuser-1}] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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
<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k_kNuser}-1]$ 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 $u = 0, 1,, N_{user}-1$. 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." <u>https://www.business.att.com/content/dam/attbusiness/briefs/att-will-5g-replace-wifi-general-business-brief.pdf</u> "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." <u>https://www.business.att.com/products/business-wifi.html</u>
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: <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 <i>Qk</i> for DL-MU-MIMO, where k is one of the subcarriers, and <i>Qk</i> is consisted of sub-matrices <i>Qku</i>, each corresponding to one receiving STA <i>u</i>. IEEE 802.11-2016: 21.3.11.2 Beamforming Feedback Matrix <i>V</i> further specifies that <i>Qku</i> is dependent on the feedback matrix <i>Vku</i> provided by each STA <i>u</i>, which is based on the actual channel measurement by each STA <i>u</i>.
	• 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 exam	ple of the V	HT s	oundi	ing 1	protocol wit	h m	ore than one	VH	T beamform	ee is	shown in Fi	gure	e 10-8.
Beamformer	VHT NDP Announce- ment	SIFS	NDP	SIFS	VHT	SIFS	Beamforming Report Poll	SIFS		SIFS	Beamforming Report Poll	SIFS	
Beamformee 1		↔		↔	Compressed Beamforming	↔			VALT	↔		↔	
Beamformee 2					Seamoning	I			Compressed Beamforming				VHT
Beamformee 3													Compressed Beamforming
Figur	e 10-53—I	Exar	nple	of	the sound	ing	protocol	with	more thar	n or	ne VHT bea	mf	ormee
Pages 1490	-2579 of 8	802.	11-2	016	6								
"21.3.11 SU	J -MIMO	and	I DL	-M	U-MIMC) B	eamformi	ng					
21.3.11.1 G	eneral												
SU-MIMO antennas (th With SU-M reception at streams are	and DL-M ne beamfo (IMO bea a single s intended	AU- orme mfo STA for 1	MIM er) to rmin . Wi recep	10 ste g a th 1 otio	beamform eer signals ll space-ti DL-MU-N on at differ	usi usi me AIN rent	g are techn ing knowle streams ir 40 beamfo STAs.	iqu edg h the orm	es used by e of the cha e transmitta ing, disjoin	a S ann ed s nt s	TA with r el to impro signal are i ubsets of t	nul ove inte he	tiple throughput. nded for space-time
For SU-MII feedback m beamformin described in	MO beam atrix V _k th ng feedbac n 9.4.1.49	forn <u>nat is</u> ck m	ning, <u>s sen</u> natrix	, <u>th</u> <u>t ba</u> <u>x fo</u>	e steering ack to the ormat as de	<u>ma</u> bea efin	<u>ttrix <i>Q_k</i> can amformer 1</u> aed in 19.3	<u>n be</u> by 1 .12	e determine <u>the beamfo</u> .3.6. The f	ed f rme eed	rom the be ee using th back repor	eam le c rt fo	<u>forming</u> ompressed ormat is
For DL-MU $y_{k,u} = [y_{k,0}]$ denotes the $x_{k,u} = [x_{k,0}]$	J-MIMO , y _{k, 1} ,, y e transmi , x _{k, 1} ,, x	bean ^k , N _{RN} it s	nform ₍₁ – 1] ² signal	ing ^T , is l	, the rece s shown in vector in being the tra	eive Equ stansn	signal ve ation (21-1 ubcarrier nit signal fo	ecto 01) <i>k</i> or be	r in subca , where $x_k = for all kcamformee u$	rrie = [: N _{use}	$x_{k,0}^{T}, x_{k,1}^{T}, \dots$ $x_{k,0}^{T}, x_{k,1}^{T}, \dots$ y_{r} beamform	amf ., x _j	ormee u , $[T, N_{user} - 1]^T$ es, with

$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,1}, Q_{k,Nuser}-1] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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
<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser}-1]$ 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 $u = 0, 1,, N_{user} - 1$. 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_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
"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." <u>https://www.business.att.com/content/dam/attbusiness/briefs/att-will-5g-replace-wifi-general-business-brief.pdf</u>
"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." <u>https://www.business.att.com/products/business-wifi.html</u>
45. The method of claim 19, wherein the removal of power	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:
from the transmission signal at each frequency in the plurality of frequencies to be avoided is accomplished by adjusting a	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
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	 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.
instruction.	Pages 1515-1514 01 802.11-2010
46. The method of claim 19, wherein the removal of power from the transmission signal at	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:
each frequency in the plurality of frequencies to be avoided is accomplished by adjusting a	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
signal so that certain power that	

was previously used in	A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a
connection with the transmission	bandwidth signaling TA and that has the RXVECTOR parameter
signal at each frequency in the	DYN_BANDWIDTH_IN_NON_HT equal to Dynamic behaves as follows:
plurality of frequencies to be	- If the NAV indicates idle, then the STA shall respond with a CTS frame in a non-HT or non-
avoided before the instruction is	HT duplicate PPDU after a SIFS. The CTS frame's TXVECTOR parameters
received, is no longer used in	CH_BANDWIDTH and CH_BANDWIDTH_IN_NON_HT shall be set to any channel width
connection with the transmission	for which CCA on all secondary channels has been idle for a PIFS prior to the start of the
signal at each frequency in the	RTS frame and that is less than or equal to the channel width indicated in the RTS frame's
plurality of frequencies to be	RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT.
avoided in accordance with the	 Otherwise, the STA shall not respond with a CTS frame.
instruction, which specifies at	
least one frequency to use so as	Pages 1313-1314 of 802.11-2016
to avoid using the plurality of	
frequencies to be avoided in	
order to transmit to the second	
node.	
47. The method of claim 19,	When used by AT&T, and/or AT&T's agents or customers, the Accused Instrumentalities and
wherein network forwarding	Services perform the claimed method as shown by the evidence below:
decisions are guided using	
instantaneous information from a	Note: See evidence cited earlier in independent claim (which is incorporated by reference), as well
media access control (MAC)	as the following (emphasis added, if any):
layer.	
	"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
	<u>QoS mapping information</u> . 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:
	<u>Note</u> : 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 <u>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."</u>
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:
	<u>Note</u> : 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: <u>Note</u>: 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. <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." Page 1304 of 802.11-2016</u>
51. The method of claim 19, wherein RTS/CTS signaling is extended such that frequency	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:
channels are reused in order to increase spatial reuse across multiple basic service sets, to	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
accommodate legacy access points.	"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</u> <u>RTS/CTS exchange by VHT STAs also performs fast collision inference on the secondary 20</u> <u>MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel and helps the VHT</u> <u>STA transmitting the RTS to determine the available bandwidth at the responder.</u> " 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).



Eas If yo	5y 1-2-3 self-installat u qualify for an easy self-install kit, no technician is nee	ion ^{ded.}
	2	3
Unpack the AT&T Wi-Fi gateway	Make the connection	Sign in, register & get online
Plug the AT&T Wi-Fi gateway into an outlet.	Connect your AT&T Wi-Fi gateway to your computer using the provided cables.	Follow the easy on-screen steps—and you're good to go.
If you are unable to i	nstall the AT&T Wi-Fi Gateway, call 800.288.2020 to schedule a technician for a pro	fessional installation.
https://www.att.com/wi-fi/		



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.





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 models Gateway image You may have one of the following Wi-Fi gateways: at&t BGW210 Pace 5268 POWER NVG589 NVG510 Pace 5031 • NVG599 ETHERNET BGW320 • WIRELESS 2Wire 3801 • PHONE 1 2Wire 2701 PHONE 2 2Wire 3800 2Wire 3600 Netgear 7550 BRÓADBAND Pace 5168 • 2Wire i38 • Pace 4111 • Westell 327

Page: 152 Page 152 of 426

https://www.att.com/sup	port/article/dsl-high-	speed/KM1047050/	
This item: AT&T Wirele WiFi Modem 4G LTE Ho Router	ss Internet me Base		
Connectivity Tech - Wischer Diversity Ethewart 1			MC FL Februare UCD
Number Of Ports	r vvi-r1 vvi-r1	7	wi-ri, Etnernet, USB
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 single band Class	dual band	_	dual band
https://www.amazon.con	n/Wireless-Internet-I	Hotspot-Antenna-AT/dp/B	075JB968D?source=ps-sl-
shoppingads-lpcontext&	ef =fplfs&psc=1&s	mid=A24OVZW9214RO6	<u> </u>
"AT&T All-Fi is compline speed plan Everyone https://www.att.com/inte https://www.att.com/lega	nentary to all AT&T with All-Fi gets the rnet/what-is-all-fi/#s l/terms.wiFiServices	T Fiber customers, regardle AT&T Wi-Fi Gateway" atoryoffer7; see also s.html	ss of their fiber internet
"AT&T All-Fi Hub and A wireless internet service- cellular network." https://	All-Fi Booster are de —AT&T Internet Air //www.att.com/inter	evices that are actually r—which allows Wi-Fi ser net/what-is-all-fi/#storyoff	related to AT&T's vice through AT&T's er7

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. <u>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.</u>
"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." <u>https://www.business.att.com/products/att-dedicated-internet.html</u>
"AT&T provides Wi-Fi access at more than 18,000 hot spots in 42 countries globally (including company-owned and roaming locations)." <u>https://www.att.com/gen/general?pid=7462</u>
"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 ontions are available based on your
needs. Select from three flexible management ontions for equipment and services. If you prefer a
capey 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 and users and your amployees. We
and scalable connectivity, with 24/7 support for both your end users and your employees. We
take same of everything from network design to instellation. Get the high quality corrige you
take care of everything from network design to instantation. Get the high-quality service you
want, from a company you trust. A T&T
<u>https://www.business.att.com/content/dam/attbusiness/briefs/att-business-wi-fi-product-brief.pdf</u>
WILL ATOT W' T' Het Contents and the second statement of the second statement West
Use A1&1 w1-F1 Hot Spots to connect your mobile device or laptop to high-speed internet. You
can find them in public places like coffee snops, airports, and restaurants. They re available
nationwide Your device automatically connects to our W1-F1 network when you're at an
A1&T W1-F1 Hot Spot location." <u>https://www.att.com/support/article/wireless/KM1103818/</u>
"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
equinment option will best suit your needs (Cisco Meraki Aruba or Mist) Than decide whether
you would like AT&T to professionally install the agginment or you would like to salf install
you would like A Los L to professionally instant the equipment of you would like to self-illstall

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
ongoing care and maintenance. <u>https://www.ousiness.att.com/products/ousiness-win.num</u>
"AT&T Wireless I AN Service - WLAN is an extension of MLAN that includes IFFF 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 hand monitoring
and management of a Customer's Wi-Fi I AN 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. <u>An RTS/CTS exchange by VHT STAs also performs fast collision inference on the secondary 20 MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel and helps the VHT STA transmitting the RTS to determine the available bandwidth at the responder.</u>
Another advantage of the RTS/CTS mechanism occurs where multiple BSSs utilizing the same channel overlap. The medium reservation mechanism works across the BSS boundaries. The RTS/CTS mechanism might also improve operation in a typical situation in which all STAs are able to receive from the AP, but might not be able to receive from all other STAs in the BSA.
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.
<u>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</vht-mcs,></u> .
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 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, the STA shall optimize does occur during the CTSTimeout interval, the STA shall invoke its backoff procedure upon expiration of 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.
	" 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.
<u>secondary 20 MHz channel</u> : 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 adjacent to the primary 20 MHz channel adjacent to the primary 20 MHz or 80+80 MHz VHT BSS, the 20 MHz channel of the 160 MHz or 80+80 MHz VHT BSS. In a 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 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, the STA shall optimize does occur during the CTSTimeout interval, the STA shall invoke its backoff procedure upon expiration of the CTSTimeout interval, the STA shall wait for the corresponding PHY-RXEND.indication primitive to determine whether the RTS frame transmission was successful. The recognition of a valid CTS frame sent by the recipient of the RTS frame, corresponding to this PHY-RXEND.indication primitive, shall be interpreted as successful response, permitting the frame exchange sequence to continue (see Annex G). The recognition of anything else, including any other valid frame, shall be interpreted as failure of the RTS frame transmission. In this instance, the STA shall invoke its backoff procedure at the PHY-RXEND.indication primitive and may process the received frame.
A DMG STA follows the procedure defined in this subclause, except that it uses a DMG CTS frame instead of a CTS frame. A non-DMG STA does not transmit DMG CTS frames."
Pages 1313-1314 of 802.11-2016
"10.3.1 General

The RTS/CTS exchange also performs both a type of fast collision inference and a transmission path check. If the return CTS frame is not detected by the STA originating the RTS, the originating STA may repeat the process (after observing the other medium-use rules) more quickly than if the long Data frame had been transmitted and a return Ack frame had not been detected. <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
"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 shall be set to the same value as the RTS frame's RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT. Otherwise, the STA shall not respond with a CTS frame.
 A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a bandwidth signaling TA and that has the RXVECTOR parameter DYN_BANDWIDTH_IN_NON_HT equal to Dynamic behaves as follows: If the NAV indicates idle, then the STA shall respond with a CTS frame in a non-HT or non-HT duplicate PPDU after a SIFS. <u>The CTS frame's TXVECTOR parameters</u> <u>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.</u> 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
"If a TXOP is protected by an RTS or CTS frame carried in a non-HT or a non-HT duplicate PPDU, the TXOP holder shall set the TXVECTOR parameter CH_BANDWIDTH of a PPDU as follows:

 <u>To be the same</u> <u>CH_BANDWII</u> <u>RTS frame with</u> <u>DYN_BANDW</u> <u>the last RTS/C7</u> <u>Otherwise, to b</u> <u>of the RTS fram</u> <u>TXOP.</u>" Page 1386 of 802.11-2 "17.2.2.1 General 	or narrower than RXV DTH_IN_NON_HT of a bandwidth signalin /IDTH_IN_NON_HT IS exchange. e the same or narrower ne that has been sent b 2016	<u>VECTOR parameter</u> <u>Ethe last received CTS frame in the same TXOP, if the</u> <u>g TA and TXVECTOR parameter</u> <u>set to Dynamic has been sent by the TXOP holder in</u> <u>r than the TXVECTOR parameter CH_BANDWIDTH</u> <u>y the TXOP holder in the last RTS/CTS in the same</u>
····	Table 17-1—TXVEC	TOR parameters <i>(continued)</i>
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

<pre>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." Pages 2279-2280 of 802.11-2016 "17.2.3.1 General Table 17-2—RXVECTOR parameters (continued)</pre>			
Parameter	Associated primitive	Value	
RX_START_OF_FRAM E_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

	Enumerated value	Value	
	CBW20	0	
	CBW40	1	
	CBW80	2	
	CBW160 or CBW80+80	3	
Table 18-6c—F	RXVECTOR parameter CH_E	SANDWIDTH_I	N_NON_HT values
Table 18-6c—F CbwInNonHtTemp Table 18-6a)	RXVECTOR parameter CH_E (see dot11CurrentChannelC FrequencyIndex1	BANDWIDTH_II	N_NON_HT values VECTOR parameter NDWIDTH_IN_NON_H
Table 18-6c—F CbwInNonHtTemp Table 18-6a) 0	RXVECTOR parameter CH_E o (see dot11CurrentChannelC FrequencyIndex1 0	SANDWIDTH_II	N_NON_HT values VECTOR parameter NDWIDTH_IN_NON_H CBW20
Table 18-6c—F CbwInNonHtTemp Table 18-6a) 0 1	RXVECTOR parameter CH_E o (see dot11CurrentChannelC FrequencyIndex1 0 0	SANDWIDTH_II	N_NON_HT values VECTOR parameter NDWIDTH_IN_NON_H CBW20 CBW40
Table 18-6c—F CbwInNonHtTemp Table 18-6a) 0 1 2	RXVECTOR parameter CH_E o (see dot11CurrentChannelC FrequencyIndex1 0 0 0	SANDWIDTH_II	N_NON_HT values VECTOR parameter NDWIDTH_IN_NON_HT CBW20 CBW40 CBW80
Table 18-6c—F CbwInNonHtTemp Table 18-6a) 0 1 2 3	RXVECTOR parameter CH_E o (see dot11CurrentChannelC FrequencyIndex1 0 0 0 0 0	SANDWIDTH_II	N_NON_HT values VECTOR parameter NDWIDTH_IN_NON_HT CBW20 CBW40 CBW80 CBW160

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)	dotllCurrentChannelCenter FrequencyIndex1	RXVECTOR parameter CH_BANDWIDTH_IN_NON_H
0	0	CBW20
1	0	CBW40
2	0	CBW80
3	0	CBW160
3	1 to 200	CBW80+80

 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 feature 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 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 	4.3.14 Very high throughput (VHT) STA
 A VHT STA is an HT STA that, in addition to features supported as an HT STA, supports VHT feature 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 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 	The IEEE 802.11 VHT STA operates in frequency bands below 6 GHz excluding the 2.4 GHz band.
 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 Ontional support for VHT link adaptation 	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 	
 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 	The main MAC features in a VHT STA that are not present in an HT STA are the following:
 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 	Mandatory support for the A-MPDU padding of a VHI PPDU
 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 	 Mandatory support for VHT single MPDU
 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 	 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 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 	 Optional support for MPDUs of up to 11 454 octets
 Optional support for VHT link adaptation 	 Optional support for A-MPDU pre-end-of-frame (pre-EOF) padding (see 9.7.1) of up to 1 048 575 octets
opuona opport or tit ma aupaton	 Optional support for VHT link adaptation



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.

Page 670 of 802.11-2016

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 PPDU containing VHT Kompressed Beamforming feedback shall be set to indicate than that indicated by the RXVECTOR parameter CH_BANDWIDTH of the PPDU containing VHT Kompressed Beamforming feedback shall be set to indicate than that indicated by the RXVECTOR parameter CH_BANDWIDTH of the PPDU containing VHT Kompressed Beamforming feedback shall be set to indicate a bandwidth not wider than that indicated by the RXVECTOR parameter CH_BANDWIDTH of the PPDU containing VHT Kompressed Beamforming feedback shall be set to indicate a bandwidth not wider than that indicated by the RXVECTOR parameter CH_BANDWIDTH of the PPDU containing VHT Kompressed 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.

Page 1490 of 802.11-	<u>2016</u>	
	Table 17-1—TXVEC	TOR parameters <i>(continued)</i>
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 If present, the allowe CBW160, and CBW8 sequence to indicate th	R CH_BANDWIDTH_IN ed values for CH_BAN 0+80. If present, this par le bandwidth of the non-H	I_NON_HT DWIDTH_IN_NON_HT are CBW20, CBW40, CBW80, rameter is used to modify the first 7 bits of the scrambling IT duplicate PPDU.

Та	able 17-2—RXVECTOF	R parameters <i>(continued)</i>
Parameter	Associated primitive	Value
RX_START_OF_FRAM E_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 prese	nt only when dot11RadioMe	asurementActivated is true.
7.2.3.7 RXVECTOR CH	BANDWIDTH_IN_NO	N_HT DTH_IN_NON_HT are CBW20, CBW40, CBW

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)	dotllCurrentChannelCenter 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

Page 2294 of 802.11-2016

	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 802.11 ac-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. 	
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	
channel." Once an EDCA defined in 11.16.9 and 10.2 channel access, based on th	nary channel." Likewise "busy medium" means "busy TXOP has been obtained according to this subclause, 22.3 might limit the width of transmission during the he state of CCA on secondary channel, secondary 40 I	 primary further constraint TXOP or deny the MHz channel, or
channel." Once an EDCA ' defined in 11.16.9 and 10.2 channel access, based on th secondary 80 MHz channe In the following description	nary channel." Likewise "busy medium" means "busy TXOP has been obtained according to this subclause, 22.3 might limit the width of transmission during the he state of CCA on secondary channel, secondary 40 h l. n, the CCA is sampled according to the timing relatio	y primary further constraints TXOP or deny the MHz channel, or nships defined in
channel." Once an EDCA ' defined in 11.16.9 and 10.2 channel access, based on th secondary 80 MHz channe In the following description 10.3.7. Slot boundaries are an interval of PIFS" means primitive was IDLE, and n ends at the start of transmis	nary channel." Likewise "busy medium" means "busy TXOP has been obtained according to this subclause, 22.3 might limit the width of transmission during the the state of CCA on secondary channel, secondary 40 H el. n, the CCA is sampled according to the timing relation determined solely by activity on the primary channel is that the STATE parameter of the most recent PHY-C to PHYCCA. Indication (BUSY) occurred during the sision, the CCA for that channel was determined to be	y primary further constraints TXOP or deny the MHz channel, or nships defined in . "Channel idle fo CCA.indication period of PIFS tha idle.

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	<u>Transmit a 40 MHz mask PPDU on the primary 40 MHz channel if the secondary channel</u>
	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."
Page	s 1383 of 802.11-2016
"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.
Page	s 1383-2284 of 802.11-2016
"17.3	.5.5 PHY DATA scrambler and descrambler
The I	DATA field, composed of SERVICE, PSDU, tail, and pad parts, shall be scrambled with a
lengt	n-127 PPDU-synchronous scrambler. The octets of the PSDU are placed in the transmit serial
hit st	ream, bit 0 first and bit 7 last. The PPDU synchronous scrambler uses the generator
nolvr	f_{constant} of the final set of the first set of t
00191	



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."
Pages 2292-2294 of 802.11-2016
"21.3.17 VHT transmit specification
21.3.17.1 Transmit spectrum mask
NOTE 1—In the presence of additional regulatory restrictions, the device has to meet both the regulatory requirements and the mask defined in this subclause. NOTE 2—Transmit spectral mask figures in this subclause are not drawn to scale. NOTE 3—For rules regarding TX center frequency leakage levels, see 21.3.17.4.2. The spectral mask requirements in this subclause do not apply to the RF LO.
For a 20 MHz mask PPDU of non-HT, HT or VHT format, the interim transmit spectral mask shall have a 0 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 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." Page 2595 of 802.11-2016



Page: 187 Page 187 of 426

"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.

	↑ PSD
	0 dBr
	-20 dBr
	-28 dBr -40 dBr
	Freq [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."
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

<u>disjoint subsets of space-time streams, or any other signal, intended for reception at a first one of</u> <u>different STAs, etc.)</u> 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

Page: 190 Page 190 of 426

SU-MIMO ar antennas (the With SU-MIN reception at a streams are in	nd DL-MU-MIMO beamforming are techniques used by a STA with multiple beamformer) to steer signals using knowledge of the channel to improve throughput. MO beamforming all space-time streams in the transmitted signal are intended for single STA. With DL-MU-MIMO beamforming, disjoint subsets of the space-time ntended for reception at different STAs.
For SU-MIM feedback mat beamforming described in 9	O beamforming, the steering matrix Q_k can be determined from the beamforming rix V_k that is sent back to the beamformer by the beamformee using the compressed feedback matrix format as defined in 19.3.12.3.6. The feedback report format is 0.4.1.49.
For DL-MU-I $y_{k,u} = [y_{k,0}, y]$ denotes the $x_{k,u} = [x_{k,0}, x]$	MIMO beamforming, the receive signal vector in subcarrier k at beamformee u, $y_{k,1},, y_{k,N_{RX_u}-1}$ ^T , is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T,, x_{k,N_{user}-1}^T]^T$ transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,1},, x_{k,N_{STS,u}-1}$ ^T being the transmit signal for beamformee u.
$Y_{k,u} = H_{k,u} \mathbf{x}$	$x [Q_{k,0}, Q_{k,l}, Q_{k,Nuser-1}] x x_k + n$
where	
H _{k,u} dimensions N _{RXu}	is the channel matrix from the beamformer to beamformee u in subcarrier k with a x N_{TX}
NRXu	is the number of receive antennas at beamformee u
$Q_{k,0}$	is a steering matrix for beamformee u in subcarrier k with dimensions
Nuser	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 $Q_k = [Q_{k,0}, Q_{k,l},, Q_{k,Nuser}-1]$ can be determined by th beamformer using the beamforming feedback matrices for subcarrier k from beamformer k and SNR information for subcarrier k from beamformee u, $SNR_{k,u}$, where $u = 0, 1,, N_{user}$. The steering matrix that is computed (or updated) using new beamforming feedback matri new SNR information from some or all of participating beamformees might replace the ex steering matrix Q_k for the next DL-MU-MIMO data transmission. The beamformee group MUL transmission is signaled using the Group ID field in VHT SIG. A (2022) 1.2.8.3.2 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_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	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	Note: See evidence cited earlier in this independent claim (which is incorporated by reference), as
of trequencies to transmit to the	well as the following (emphasis added, if any):
third node;	"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 nonhondwidth signaling TA obtained from the TA field of
	the RTS frame matches the saved TXOP holder address
	the KTS frame matches the saved 17Kor 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
	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, the STA shall invoke its backoff procedure upon expiration of 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	 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. <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):
	"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, $y_{k,u} = [y_{k,0}, y_{k,1},, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T,, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1},, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.
	$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l}, Q_{k,Nuser-1}] \ge x_k + n$
	where

<i>H_{k,u}</i> dimensions	is the channel matrix from the beamformer to beamformee u in subcarrier k with
N _{RX}	$u \ge N_{TX}$
NrXu	is the number of receive antennas at beamformee u
$Q_{k,0}$	is a steering matrix for beamformee u in subcarrier k with dimensions
Nuser	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- beamformer v and SNR info The steering new SNR info steering matr MU transmis 21.3.11.4)."	-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser}-1]$ can be determined by the using the beamforming feedback matrices for subcarrier k from beamformee u, $V_{k,u}$, ormation for subcarrier k from beamformee u, $SNR_{k,u}$, where $u = 0, 1,, N_{user}-1$. matrix that is computed (or updated) using new beamforming feedback matrices and formation from some or all of participating beamformees might replace the existing ix Q_k for the next DL-MU-MIMO data transmission. The beamformee group for the sion is signaled using the Group ID field in VHT-SIG-A (see 21.3.8.3.3 and
Pages 25/8-2	2579 61 802.11-2016
"19.3.12.3 Explicit feedback beamforming	
19.3.12.3.1 (General
In explicit be measures the beamforming V_k found from the sounding	channel matrices and sends STA A to transmit a beamformed packet to STA B, STA B channel matrices and sends STA A either the effective channel, $H_{eff,k}$, or the g feedback matrix, V_k , for STA A to determine a steering matrix, $Q_{steer,k} = Q_k V_k$, with m $H_k Q_k$, where Q_k is the orthonormal spatial mapping matrix that was used to transmit 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 Qk for DL-MU-MIMO, where k is one of the subcarriers, and Qk is consisted of sub-matrices Qku, each corresponding to one receiving STA u. IEEE 802.11-2016: 21.3.11.2 Beamforming Feedback Matrix V further specifies that Qku is dependent on the feedback matrix Vku 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 Vku is measured and should be different from STA to STA.

An exam	ple of the V	HT s	oundi	ing 1	protocol wit	h m	ore than one	VH	T beamform	ee is	shown in Fi	gure	e 10-8.
Beamformer	VHT NDP Announce- ment	SIFS	NDP	SIFS	VHT	SIFS	Beamforming Report Poll	SIFS		SIFS	Beamforming Report Poll	SIFS	
Beamformee 1		↔		↔	Compressed Beamforming	↔			VALT	↔		↔	
Beamformee 2					Seamoning	I			Compressed Beamforming				VHT
Beamformee 3													Compressed Beamforming
Figur	e 10-53—I	Exar	nple	of	the sound	ing	protocol	with	more thar	n or	ne VHT bea	mf	ormee
Pages 1490	-2579 of 8	802.	11-2	016	6								
"21.3.11 SU	J -MIMO	and	I DL	-M	U-MIMC) B	eamformi	ng					
21.3.11.1 G	eneral												
SU-MIMO antennas (th With SU-M reception at streams are	and DL-M ne beamfo (IMO bea a single s intended	AU- orme mfo STA for 1	MIM er) to rmin . Wi recep	10 ste g a th 1 otio	beamform eer signals ll space-ti DL-MU-N on at differ	usi usi me AIN rent	g are techn ing knowle streams ir 40 beamfo STAs.	iqu edg 1 th orm	es used by e of the cha e transmitta ing, disjoin	a S ann ed s nt s	TA with r el to impro signal are i ubsets of t	nul ove inte he	tiple throughput. nded for space-time
For SU-MII feedback m beamformin described in	MO beam atrix V _k th ng feedbac n 9.4.1.49	forn <u>nat is</u> ck m	ning, <u>s sen</u> natrix	, <u>th</u> <u>t ba</u> <u>x fo</u>	e steering ack to the ormat as de	<u>ma</u> bea efin	<u>ttrix <i>Q_k</i> can amformer 1</u> aed in 19.3	<u>n be</u> by 1 .12	e determine <u>the beamfo</u> .3.6. The f	ed f rme eed	rom the be ee using th back repor	eam le c rt fo	<u>forming</u> ompressed ormat is
For DL-MU $y_{k,u} = [y_{k,0}]$ denotes the $x_{k,u} = [x_{k,0}]$	J-MIMO , y _{k, 1} ,, y e transmi , x _{k, 1} ,, x	bean ^k , N _{RN} it s	nform ₍₁ – 1] ² signal	ing ^T , is l	, the rece s shown in vector in being the tra	eive Equ stansn	signal ve ation (21-1 ubcarrier nit signal fo	ecto 01) <i>k</i> or be	r in subca , where $x_k = for all kcamformee u$	rrie = [: N _{use}	$x_{k,0}^{T}, x_{k,1}^{T}, \dots$ $x_{k,0}^{T}, x_{k,1}^{T}, \dots$ y_{r} beamform	amf ., x _j	ormee u , $[T, N_{user} - 1]^T$ es, with

$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l} \dots, Q_{k,Nuser} - 1] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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
<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser}-1]$ 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 $u = 0, 1,, N_{user} - 1$. 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_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, $H_{eff,k} = H_k Q_k$, 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— $O_{\text{steer }k}$ is a mathematical term to update a new steering matrix for O_k in the next
beamformed data transmission."
Page 2396 of 802.11-2016
MIL-MIMO technology further changed the rules of wireless engagement, enabling an ΔP 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." <u>https://www.business.att.com/products/business-wifi.html</u>
53. A method for managing interference in a radio communications network,	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.
comprising the steps of:	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).



	5y 1-2-3 self-installat u qualify for an easy self-install kit, no technician is nee	ion _{ded.}
	2	3
Unpack the AT&T Wi-Fi gateway	Make the connection	Sign in, register & get online
Plug the AT&T Wi-Fi gateway into an outlet.	Connect your AT&T Wi-Fi gateway to your computer using the provided cables.	Follow the easy on-screen steps—and you're good to go.
If you are unable to it	nstall the AT&T Wi-Fi Gateway, call 800.288.2020 to schedule a technician for a pro	fessional installation.
https://www.att.com/wi-fi/		



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.





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 models Gateway image You may have one of the following Wi-Fi gateways: at&t BGW210 Pace 5268 POWER NVG589 NVG510 Pace 5031 • NVG599 ETHERNET BGW320 • WIRELESS 2Wire 3801 • PHONE 1 2Wire 2701 PHONE 2 2Wire 3800 2Wire 3600 Netgear 7550 BRÓADBAND Pace 5168 • 2Wire i38 • Pace 4111 • Westell 327

Page: 208 Page 208 of 426

https://www.att.com/sup	port/article/dsl-high-	speed/KM1047050/	
This item: AT&T Wirele WiFi Modem 4G LTE Ho Router	ss Internet me Base		
Connectivity Tech - Wischer Diversity Ethoren 1			MC FL Februare UCD
Number Of Ports	r vvi-r1 vvi-r1	7	wi-ri, Etnernet, USB
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 single band Class	dual band	_	dual band
https://www.amazon.con	n/Wireless-Internet-I	Hotspot-Antenna-AT/dp/B	075JB968D?source=ps-sl-
shoppingads-lpcontext&	ef =fplfs&psc=1&s	mid=A24OVZW9214RO6	<u> </u>
"AT&T All-Fi is compline speed plan Everyone https://www.att.com/inte https://www.att.com/lega	nentary to all AT&T with All-Fi gets the rnet/what-is-all-fi/#s l/terms.wiFiServices	T Fiber customers, regardle AT&T Wi-Fi Gateway" atoryoffer7; see also s.html	ss of their fiber internet
"AT&T All-Fi Hub and A wireless internet service- cellular network." https://	All-Fi Booster are de —AT&T Internet Air //www.att.com/inter	evices that are actually r—which allows Wi-Fi ser net/what-is-all-fi/#storyoff	related to AT&T's vice through AT&T's er7

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. <u>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.</u>
"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." <u>https://www.business.att.com/products/att-dedicated-internet.html</u>
"AT&T provides Wi-Fi access at more than 18,000 hot spots in 42 countries globally (including company-owned and roaming locations)." <u>https://www.att.com/gen/general?pid=7462</u>
"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
<u>nups.//www.uu.com/regu/renns.wn/roctvices.num</u>
"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 solf installation antions are available based on your
business and consumers Froressional and sent-installation options are available, based on your
approx model you can available the equipment and AT &T will menage it at a reduced monthly fee
capex model, you can purchase the equipment, and AT&T will manage it at a reduced monthly lee
per access point A l & l is a preeminent provider of wi-Fi services, derivering nighty 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." <u>https://www.att.com/support/article/wireless/KM1103818/</u>
"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
ongoing cure and maintenance. <u>maps.//www.ousmess.att.com/products/ousmess/wm.num</u>
"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. <u>An RTS/CTS exchange by VHT STAs also performs fast collision inference on the secondary 20 MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel and helps the VHT STA transmitting the RTS to determine the available bandwidth at the responder.</u>
Another advantage of the RTS/CTS mechanism occurs where multiple BSSs utilizing the same channel overlap. The medium reservation mechanism works across the BSS boundaries. The RTS/CTS mechanism might also improve operation in a typical situation in which all STAs are able to receive from the AP, but might not be able to receive from all other STAs in the BSA.

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.
<u>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</vht-mcs,></u> .

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, the STA shall or primitive does occur during the CTSTimeout interval, the STA shall invoke its backoff procedure upon expiration of 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	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.
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 adjacent to the primary 20 MHz channel adjacent to the primary 20 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. 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

CUL DANDWIDTH, IN NON UT for a DIES prior to the start of the DTS frame, then the
CH_BANDWIDTH_IN_NON_HT for a PIFS prior to the start of the KTS 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
handwidth signaling TA and that has the RXVECTOR parameter
DVN BANDWIDTH IN NON HT equal to Dynamic behaves as follows:
If the NAV indicates it is then the STA shall reasond with a CTS frame in a new UT ennew
- If the NAV indicates fulle, then the STA shall respond with a CTS frame in a non-rif or non-
HI duplicate PPDU after a SIFS. The CIS 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
habeves as fallows:
$\frac{1}{1} = \frac{1}{1} = \frac{1}$
- 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
a SIESTime + a Slot Time + a $PxPHVStart Delay$ This interval begins when the MAC receives a
ash stime + asion me + arxi it i standeray. This interval begins when the MAC receives a

1	
	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, the STA shall wait for the corresponding PHY-RXEND.indication primitive to determine whether the RTS frame transmission was successful. The recognition of a valid CTS frame sent by the recipient of the RTS frame, corresponding to this PHY-RXEND.indication primitive, shall be interpreted as successful response, permitting the frame exchange sequence to continue (see Annex G). The recognition of anything else, including any other valid frame, shall be interpreted as failure of the RTS frame transmission. In this instance, the STA shall invoke its backoff procedure at the PHY-RXEND.indication primitive and may process the received frame. A DMG STA follows the procedure defined in this subclause, except that it uses a DMG CTS frame instead of a CTS frame. A non-DMG STA does not transmit DMG CTS frames."
	Pages 1313-1314 of 802.11-2016
	"10.3.1 General
	The RTS/CTS exchange also performs both a type of fast collision inference and a transmission path check. If the return CTS frame is not detected by the STA originating the RTS, the originating STA may repeat the process (after observing the other medium-use rules) more quickly than if the long Data frame had been transmitted and a return Ack frame had not been detected. <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
	"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 <u>RTS frame</u> and that is less than or equal to the channel width indicated in the RTS frame's RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT. Otherwise, the STA shall not respond with a CTS frame. A non-VHT STA that is addressed by an RTS frame or a VHT STA that is addressed by an RTS frame carried in a non-HT or non-HT duplicate PPDU that has a nonbandwidth signaling TA or a VHT STA that is addressed by an RTS frame in a format other than non-HT or non-HT duplicate behaves as follows: If the NAV indicates idle, the STA shall respond with a CTS frame after a SIFS. Otherwise, the STA shall not respond with a CTS frame after a SIFS. Otherwise, the STA shall not respond with a CTS frame after a SIFS. Otherwise, the STA shall not respond with a CTS frame after a SIFS. Otherwise, the STA shall not respond with a CTS frame after a SIFS. Otherwise, the STA shall not respond with a CTS frame after a SIFS. Otherwise, the STA shall not respond with a CTS frame after a SIFS. Otherwise, the STA shall not respond with a CTS frame after a SIFS. Otherwise, the STA shall not respond with a CTS frame after a SIFS. 	
 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_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_IN_NON_HT. Otherwise, the STA shall not respond up 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 and other is addressed by an RTS frame. A non-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 after a SIFS. Otherwise, the STA shall not respond with a CTS frame after a SIFS. Otherwise, the STA shall not respond with a CTS frame after a data rate determined by the rules in 10.7. 	SIFS. The CTS frame's TXVECTOR parameters CH_BANDWIDTH and
 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. The RA field of the CTS frame shall be the transmitting an RTS frame adjusted by subtraction of aSIFSTime and the number of microseconds required 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. 	CH_BANDWIDTH_IN_NON_HT shall be set to the same value as the RTS frame's
 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 or a 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. 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, 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 the transmitting an RTS frame, the STA s	RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT.
 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. 	 Otherwise, the STA shall not respond with a CTS frame.
 A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a bandwidth signaling TA and that has the RXVECTOR parameter DYN_BANDWIDTH_IN_NON_HT equal to Dynamic behaves as follows: If the NAV indicates idle, then the STA shall respond with a CTS frame in a non-HT or non-HT duplicate PPDU after a SIFS. <u>The CTS frame's TXVECTOR parameters</u> <u>CH BANDWIDTH and CH BANDWIDTH IN NON HT shall be set to any channel width</u> for which CCA on all secondary channels has been idle for a PIFS prior to the start of the <u>RTS frame</u> and that is less than or equal to the channel width indicated in the RTS frame's <u>RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT</u>. 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 a SIFSTime and the number of microseconds required to transmit the CTS frame at data rate determined by the rules in 10.7. 	
 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 <u>RTS frame</u> and that is less than or equal to the channel width indicated in the RTS frame's RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT. Otherwise, the STA shall not respond with a CTS frame. A non-VHT STA that is addressed by an RTS frame or a VHT STA that is addressed by an RTS frame carried in a non-HT or non-HT duplicate PPDU that has a nonbandwidth signaling TA or a VHT STA that is addressed by an RTS frame in a format other than non-HT or non-HT duplicate behaves as follows: If the NAV indicates idle, the STA shall respond with a CTS frame after a SIFS. Otherwise, the STA shall not respond with a CTS frame after a SIFS. 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. 	A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a
 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 after a SIFS. Otherwise, the STA shall not respond with a CTS frame after a SIFS. A field of the CTS 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. 	bandwidth signaling TA and that has the RXVECTOR parameter
 If the NAV indicates idle, then the STA shall respond with a CTS frame in a non-HT or non-HT duplicate PPDU after a SIFS. <u>The CTS frame's TXVECTOR parameters</u> <u>CH BANDWIDTH and CH BANDWIDTH IN NON HT shall be set to any channel width</u> for which CCA on all secondary channels has been idle for a PIFS prior to the start of the <u>RTS frame</u> and that is less than or equal to the channel width indicated in the RTS frame's RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT. Otherwise, the STA shall not respond with a CTS frame. A non-VHT STA that is addressed by an RTS frame or a VHT STA that is addressed by an RTS frame carried in a non-HT or non-HT duplicate PPDU that has a nonbandwidth signaling TA or a VHT STA that is addressed by an RTS frame in a format other than non-HT or non-HT duplicate behaves as follows: If the NAV indicates idle, the STA shall respond with a CTS frame after a SIFS. Otherwise, the STA shall not respond with a CTS frame after a SIFS. 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. 	DYN BANDWIDTH IN NON HT equal to Dynamic behaves as follows:
 HT duplicate PPDU after a SIFS. <u>The CTS frame's TXVECTOR parameters</u> <u>CH_BANDWIDTH and CH_BANDWIDTH_IN_NON_HT shall be set to any channel width</u> for which CCA on all secondary channels has been idle for a PIFS prior to the start of the <u>RTS frame</u> and that is less than or equal to the channel width indicated in the RTS frame's <u>RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT</u>. 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.	- If the NAV indicates idle, then the STA shall respond with a CTS frame in a non-HT or non-
 <u>CH_BANDWIDTH and CH_BANDWIDTH_IN_NON_HT shall be set to any channel width</u> for which CCA on all secondary channels has been idle for a PIFS prior to the start of the <u>RTS frame</u> and that is less than or equal to the channel width indicated in the RTS frame's RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT. Otherwise, the STA shall not respond with a CTS frame. A non-VHT STA that is addressed by an RTS frame or a VHT STA that is addressed by an RTS frame carried in a non-HT or non-HT duplicate PPDU that has a nonbandwidth signaling TA or a VHT STA that is addressed by an RTS frame in a format other than non-HT or non-HT duplicate behaves as follows: If the NAV indicates idle, the STA shall respond with a CTS frame after a SIFS. Otherwise, the STA shall not respond with a CTS frame after a SIFS. Otherwise, the STA shall not respond with a CTS frame after a SIFS. A field of the CTS 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. 	HT duplicate PPDU after a SIFS. The CTS frame's TXVECTOR parameters
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	CH BANDWIDTH and CH BANDWIDTH IN NON HT shall be set to any channel width
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 after a SIFS. — Otherwise, the STA shall not respond with a CTS frame after a SIFS. — Otherwise, the STA shall not respond with a CTS frame after a SIFS. — Otherwise, the STA shall not respond with a CTS frame after a SIFS. — Otherwise, the STA frame to which this 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 a SIFSTime 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	for which CCA on all secondary channels has been idle for a PIFS prior to the start of the
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 after a SIFS. — Otherwise, the STA shall not respond with a CTS frame after of the CTS frame shall be set to the nonbandwidth signaling TA obtained from the TA field of the CTS 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 a SIFSTime 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	RTS frame and that is less than or equal to the channel width indicated in the RTS frame's
 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 a SIFSTime and the number of microseconds required to transmit the CTS frame at a data rate determined by the rules in 10.7. 	RXVECTOR parameter CH BANDWIDTH IN NON HT.
 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 a SIFSTime 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 	- 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. 	
 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. 	A non-VHT STA that is addressed by an RTS frame or a VHT STA that is addressed by an RTS
 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 a SIFSTime 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 	frame carried in a non-HT or non-HT duplicate PPDU that has a nonbandwidth signaling TA or a
 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 	VHT STA that is addressed by an RTS frame in a format other than non-HT or non-HT duplicate
 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 	behaves as follows:
 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 	— If the NAV indicates idle, the STA shall respond with a CTS frame after a SIFS.
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	— 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 a SIFSTime 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 	
 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 	The RA field of the CTS frame shall be set to the nonbandwidth signaling TA obtained from the
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	TA field of the RTS frame to which this CTS frame is a response. The Duration field in the CTS
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	frame shall be the duration field from the received RTS frame, adjusted by subtraction of
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 and the number of microseconds required to transmit the CTS frame at a data rate
After transmitting an RTS frame, the STA shall wait for a CTSTimeout interval with a value of	determined by the rules in 10.7.
After transmitting an RTS frame, the STA shall wait for a CTSTimeout interval with a value of	
	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	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	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	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
as failure of the RTS frame transmission. In this instance, the STA shall invoke its backoff
procedure at the PHY-RXEND.indication primitive and may process the received frame.
A DMG STA follows the procedure defined in this subclause, except that it uses a DMG CTS
frame instead of a CTS frame. A non-DMG STA does not transmit DMG CTS frames."
Pages 1313-1314 of 802.11-2016
"If a TXOP is protected by an RTS or CTS frame carried in a non-HT or a non-HT duplicate
<u>PPDU, the TXOP holder shall set the TXVECTOR parameter CH_BANDWIDTH of a PPDU as</u>
<u>IOHOWS:</u> — To be the same or parrower 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 nerrower than the TXVECTOP nerometer CH, PANDWIDTH
of the RTS frame that has been sent by the TXOP holder in the last RTS/CTS in the same
<u>TXOP.</u> "
Page 1386 of 802.11-2016
"17.2.2.1 General

	Table 17-1—TXVEC	TOR parameters <i>(continued)</i>
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
f present, the allowed resent, this paramete ne transmitter is capa DYN_BANDWIDTH resent.	d values for DYN_BAN r is used to modify the ble of Static or Dynam [_IN_NON_HT is pres	NDWIDTH_IN_NON_HT are Static and Dynamic. If first 7 bits of the scrambling sequence to indicate if nic bandwidth operation. If ent, then CH_BANDWIDTH_IN_NON_HT is also
NOTE—The DYN_B ransmitted by a non-' present when the fram	ANDWIDTH_IN_NO VHT STA. The DYN_ ne is transmitted by a V	N_HT parameter is not present when the frame is BANDWIDTH_IN_NON_HT parameter is not WHT STA to a non-VHT STA. See 10.7.11."
Pages 2279-2280 of 8	02.11-2016	
17.2.3.1 General		

T	able 17-2—RXVECTOR	a parameters <i>(continued)</i>
Parameter	Associated primitive	Value
RX_START_OF_FRAM E_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 prese	nt only when dot11RadioMea	asurementActivated is true.
17.2.3.7 RXVECTOR C If present, the allowed va CBW80, CBW160, and C of the non-HT duplicate T and 10.7.6.6).	CH_BANDWIDTH_IN llues for CH_BANDWI CBW80+80. If present a PPDU. This parameter i	_NON_HT DTH_IN_NON_HT are CBW20, CBW40, nd valid, this parameter indicates the bandwidth s used by the MAC only when valid (see 10.3.2.7
NOTE—The CH_BAND received by a non-VHT S	WIDTH_IN_NON_HT STA (see 10.7.11)."	parameter is not present when the frame is
Pages 2281-2282 of 802.	11-2016	

	Enumerated value	Value	
С	CBW20	0	
С	CBW40	1	
С	CBW80	2	
С	CBW160 or CBW80+80	3	
Table 18-6c—RXV	VECTOR parameter CH_B	ANDWIDTH_I	N_NON_HT values
Table 18-6c—RXV CbwInNonHtTemp (see Table 18-6a)	VECTOR parameter CH_B ee dot11CurrentChannelCo FrequencyIndex1	ANDWIDTH_I enter RX CH_BA	N_NON_HT values (VECTOR parameter NDWIDTH_IN_NON_H
Table 18-6c—RXV CbwInNonHtTemp (see Table 18-6a) 0	VECTOR parameter CH_B dot11CurrentChannelCo FrequencyIndex1	ANDWIDTH_I	N_NON_HT values XVECTOR parameter NDWIDTH_IN_NON_H CBW20
Table 18-6c—RXV CbwInNonHtTemp (see Table 18-6a) 0 1	VECTOR parameter CH_B dot11CurrentChannelCo FrequencyIndex1 0 0	ANDWIDTH_I	N_NON_HT values XVECTOR parameter NDWIDTH_IN_NON_H CBW20 CBW40
Table 18-6c—RXV CbwInNonHtTemp (see Table 18-6a) 0 1 2	VECTOR parameter CH_B dot11CurrentChannelCo FrequencyIndex1 0 0 0 0	ANDWIDTH_I	N_NON_HT values XVECTOR parameter NDWIDTH_IN_NON_HT CBW20 CBW40 CBW80
Table 18-6c—RXV CbwInNonHtTemp (see Table 18-6a) 0 1 2 3	VECTOR parameter CH_B dot11CurrentChannelCo FrequencyIndex1 0 0 0 0 0 0	ANDWIDTH_I	N_NON_HT values XVECTOR parameter NDWIDTH_IN_NON_H CBW20 CBW40 CBW80 CBW160

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)	dotllCurrentChannelCenter 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

1
 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



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.

Page 670 of 802.11-2016

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 PPDU containing VHT Kertor 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 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 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 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.

Page 1490 of 802.11-	2016	
	Table 17-1—TXVEC	TOR parameters <i>(continued)</i>
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 If present, the allowe CBW160, and CBW86 sequence to indicate th	R CH_BANDWIDTH_IN ed values for CH_BAN 0+80. If present, this par le bandwidth of the non-H	I_NON_HT DWIDTH_IN_NON_HT are CBW20, CBW40, CBW80, rameter is used to modify the first 7 bits of the scrambling IT duplicate PPDU.

Table 17-2—RXVECTOR parameters (continued)		
Parameter	Associated primitive	Value
RX_START_OF_FRAM E_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 preser	nt only when dot11RadioMe	asurementActivated is true.
17.2.3.7 RXVECTOR CH	_BANDWIDTH_IN_NO	N_HT DTH IN NON HT are CBW20, CBW40, CBW

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)	dotllCurrentChannelCenter 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

Page 2294 of 802.11-2016

	 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.

PHY-CCA.in primitive cha eleme	ndication nnnel-list nt	Idle channels	
primary	1	None	
secondary	F	Primary 20 MHz channel	
secondary40	F	Primary 20 MHz channel and secondary 20 MHz channel	
secondary80	Fs	Primary 20 MHz channel, secondary 20 MHz channel, and secondary 40 MHz channel	
hannel." Once efined in 11.10 hannel access,	an EDCA TX 5.9 and 10.22 based on the	Try channel." Likewise "busy medium" means "busy XOP has been obtained according to this subclause, .3 might limit the width of transmission during the state of CCA on secondary channel, secondary 40 h	r primary further constrair ΓΧΟΡ or deny th MHz channel, or
channel." Once defined in 11.10 channel access, secondary 80 M	an EDCA TX 5.9 and 10.22 based on the IHz channel.	the CCA is sempled according to the timing relation	r primary further constrain ΓΧΟΡ or deny th MHz channel, or
hannel." Once lefined in 11.10 hannel access, econdary 80 M n the following 0.3.7. Slot bou n interval of P primitive was II ends at the start	an EDCA TX an EDCA TX 5.9 and 10.22 based on the Hz channel. description, andaries are de IFS" means the DLE, and no 1 of transmissi	The CCA is sampled according to the timing relation the STATE parameter of the most recent PHY-C PHYCCA. Indication (BUSY) occurred during the ion, the CCA for that channel was determined to be	r primary further constrain FXOP or deny the MHz channel, or nships defined in . "Channel idle the CA.indication period of PIFS the idle.
hannel." Once lefined in 11.10 hannel access, econdary 80 M n the following 0.3.7. Slot bou n interval of P rimitive was II nds at the start <u>f a STA is perr</u> <u>ISDU pending</u>	an EDCA TX an EDCA TX 5.9 and 10.22 based on the Hz channel. description, indaries are do IFS" means the DLE, and no 1 of transmission	The CCA is sampled according to the timing relation the STATE parameter of the most recent PHY-C PHYCCA. Indication (BUSY) occurred during the p ion, the CCA for that channel was determined to be in a TXOP (as defined in 9.19.2.3) and the STA has sion for the AC of the permitted TXOP, the STA sh	y primary further constrain FXOP or deny the MHz channel, or nships defined in . "Channel idle for CA.indication period of PIFS the idle. <u>at least one</u> <u>all perform</u>
channel." Once lefined in 11.10 channel access, accondary 80 M n the following 0.3.7. Slot bou in interval of P primitive was II ends at the start <u>f a STA is perr</u> <u>MSDU pending</u> <u>xactly one of t</u>	an EDCA TX an EDCA TX 5.9 and 10.22 based on the Hz channel. g description, indaries are do IFS" means the DLE, and no 1 of transmission itted to begin for transmission he following	ACP has been obtained according to this subclause, ACP has been obtained according to this subclause, and a state of CCA on secondary channel, secondary 40 for the CCA is sampled according to the timing relation etermined solely by activity on the primary channel hat the STATE parameter of the most recent PHY-C PHYCCA. Indication (BUSY) occurred during the pion, the CCA for that channel was determined to be an a TXOP (as defined in 9.19.2.3) and the STA has sion for the AC of the permitted TXOP, the STA sh steps:	r primary further constrain TXOP or deny the Alter channel, or nships defined in . "Channel idle for CA.indication period of PIFS the idle. <u>at least one</u> <u>all perform</u>
hannel." Once lefined in 11.10 hannel access, econdary 80 M n the following 0.3.7. Slot bou n interval of P rimitive was II nds at the start <u>f a STA is perr</u> <u>ASDU pending</u> <u>xactly one of t</u> k) <u>Transmi</u> <u>40 MHz</u>	an EDCA TX an EDCA TX 5.9 and 10.22 based on the IHz channel. g description, indaries are do IFS" means the DLE, and no 1 of transmission itted to begin for transmission t a 160 MHz channel and	ry channel." Likewise "busy medium" means "busy XOP has been obtained according to this subclause, 3 might limit the width of transmission during the state of CCA on secondary channel, secondary 40 I the CCA is sampled according to the timing relatio etermined solely by activity on the primary channel hat the STATE parameter of the most recent PHY-C PHYCCA. Indication (BUSY) occurred during the ion, the CCA for that channel was determined to be in a TXOP (as defined in 9.19.2.3) and the STA has sion for the AC of the permitted TXOP, the STA sh steps: or 80+80 MHz mask PPDU if the secondary channel the secondary 80 MHz channel were idle during ar	r primary further constrai TXOP or deny t vIHz channel, o nships defined i . "Channel idle CA.indication period of PIFS t idle. <u>at least one</u> <u>all perform</u> <u>el, the secondar</u>

1)	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.
n	n) <u>Transmit a 40 MHz mask PPDU on the primary 40 MHz channel if the secondary channel</u>
	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.
0) <u>Restart the channel access attempt by invoking the backoff procedure as specified in</u>
	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."
Page	s 1383 of 802.11-2016
"17.3	.2.2 Overview of the PPDU encoding process
g) <u>If the TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT is not present</u> , initiate the scrambler with a pseudorandom nonzero seed and generate a scrambling sequence. <u>If</u> 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.
Page	s 1383-2284 of 802.11-2016
"17.3	5.5 PHY DATA scrambler and descrambler
The I	DATA field, composed of SERVICE, PSDU, tail, and pad parts, shall be scrambled with a
lengt	h-127 PPDU-synchronous scrambler. The octets of the PSDU are placed in the transmit serial
bit st	ream, bit 0 first and bit 7 last. The PPDU synchronous scrambler uses the generator
polyr	nomial S(x) as follows and is illustrated in Figure 17-7:



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."
Pages 2292-2294 of 802.11-2016
"21.3.17 VHT transmit specification
21.3.17.1 Transmit spectrum mask
NOTE 1—In the presence of additional regulatory restrictions, the device has to meet both the regulatory requirements and the mask defined in this subclause. NOTE 2—Transmit spectral mask figures in this subclause are not drawn to scale. NOTE 3—For rules regarding TX center frequency leakage levels, see 21.3.17.4.2. The spectral mask requirements in this subclause do not apply to the RF LO.
For a 20 MHz mask PPDU of non-HT, HT or VHT format, the interim transmit spectral mask shall have a 0 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 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." Page 2595 of 802.11-2016



Page: 243 Page 243 of 426

"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.

	↑ PSD
	0 dBr
	-20 dBr
	-40 dBr -40 dBr
	-30 -20 -11 -9 9 11 20 30
	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;	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Service							
	perform the step of receiving a compressed second feedback from a third node that character							
receiving a compressed second	receipt of a second signal sent from the first node to the third node.							
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 time node,	the second node that characterizes receipt of a first signal (e.g. a first VHT NDP sounding PPDI)							
the second node that characterizes receipt of a first signal (e.g. a first VH1 NDP sound) sent from the first node to the second node; and receiving a compressed second feedbac								
	second feedback matrix) from a third node that characterizes receipt of a second signal (e.g. a							
	second VHT NDP sounding PPDU) sent from the first node to the third node.							
	21.3.11.2 Beamforming <u>Feedback Matrix</u> V							
	"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 beamform							
	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 num								
bits for quantization is chosen by the beamformee, based on the indication from the beamf								
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 <i>N</i> _{STS} of the NDP.							
	After receiving the engle information $a(t,y)$ and $w(t,y)$ the beamformer recordensets V_{ij} using							
	After receiving the angle information, $\psi(k, v)$ and $\psi(k, u)$, the beamformer constructs $V_{k,u}$ using Equation (10.70). For SU MIMO beamforming, the beamformer consumption the $V_{k,u}$ and $V_{k,u}$ is the second							
	<u>Equation (17-79)</u> . For SO-WINVO beamforming, the beamforming the beamformer may determine the steering matrix $O_{\rm L}$ For DL MIL MIMO beamforming the beamformer may							
	calculate a steering matrix $Q_k = [Q_{k,k}, Q_{k,k}] = [Q_{k,k}, Q_{k,k}]$ and SNR_k ($0 \le u \le N = 1$) in							
	calculate a second matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,Nuser-1}]$ using $V_{k,u}$ and $S_{VK,k,u}$ $(0 \le u \le N_{user-1})$ 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 <i>V</i> . A beamformer shall support all tone grouping values and Codebook Information values."
Page 2579 of 802.11-2016
"10.34.5 VHT sounding protocol
10.34.5.1 General
Transmit beamforming and DL-MU-MIMO require knowledge of the channel state to compute a steering matrix that is applied to the transmitted signal to optimize reception at one or more receivers. The STA transmitting using the steering matrix is called the VHT beamformer, and a STA for which reception is optimized is called a VHT beamformee. <u>An explicit feedback mechanism is used where the VHT beamformee directly measures the channel from the training symbols transmitted by the VHT beamformer and sends back a transformed estimate of the channel state to the VHT beamformer. The VHT beamformer then uses this estimate, perhaps combining estimates from multiple VHT beamformees, to derive the steering matrix.</u>
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 <u>VHT Compressed Beamforming Report field</u>
The VHT Compressed Beamforming Report field is used by the VHT Compressed Beamforming feedback (see 9.6.23.2) to carry explicit feedback information in the form of angles representing compressed beamforming feedback matrices <i>V</i> for use by a transmit beamformer to determine steering matrices <i>Q</i> , 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	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.
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 decompress the matrices and determine the steering matrices Q_k .
	The matrix per tone shall be compressed as follows: The $N_r \ge N_c$ 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	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services							
signal is a filtered first	perform the prior steps listed above, wherein the filtered transmission signal is a filtered first							
transmission signal that is	transmission signal (e.g. a first one of multiple disjoint subsets of space-time streams, or any oth							
transmitted to the second node	signal, intended for reception at a first one of different STAs, etc.) that is transmitted to the second							
using an 802.11-based	node using an 802.11-based orthogonal frequency-division multiplexing (OFDM) protocol via at							
orthogonal frequency-division	least one antenna of a plurality of antennas, using a first power that is based on the decompressed							
multiplexing (OFDM) protocol	first feedback.							
via at least one antenna of a								
plurality of antennas, using a	For example, as evidenced below AT&T makes, uses, or sells 802.11ac-compliant access points							
first power that is based on the	(AP) which, when operated by AT&T and/or AT&T's agents or customers, require performance							
decompressed first feedback; and	of a method, wherein the filtered transmission signal is a filtered first transmission signal that is							
further comprising:	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 902.11.2016.21.2.11 SU MIMO and DL MU MIMO Deamforming and							
	• IEEE 802.11-2010: 21.3.11 SU-WINO and DL-WIU-WINO Beamforming and 21.3.11.1 Conversion amonified the stateming matrix (), for DL MIL MIMO, where h is one of							
	21.3.11.1 General specifies the steering matrix Q_k for DL-MU-MIMO, where k is one of the subcorriers and Q_k is consisted of sub matrices Q_k as a corresponding to one							
	 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 							
	• IEEE 602.11-2010: Figure 10-55 (below) mustrates that each STA (beamformee) is getting a different polling packet, based on which the feedback matrix V _k is measured and should							
	be different from STA to STA.							

 _													
An exam	ple of the V	HT s	soundi	ing 1	protocol wit	h m	ore than one	VH	T beamform	ee is	shown in Fi	igure	e 10-8.
Beamformer	VHT NDP Announce- ment	SIFS	NDP	SIFS	VHT	SIFS	Beamforming Report Poll	SIFS		SIFS	Beamforming Report Poll	SIFS	
Beamformee 1		↔		↔	Compressed Beamforming	↔		*	MUT	↔			
Beamformee 2					beamoning				Compressed Beamforming				VHT
Beamformee 3													Compressed
Figur	e 10-53—I	Exai	mple	of	the sound	ing	protocol	with	n more thar	n or	ne VHT bea	amf	ormee
Pages 1490	-2579 of 8	802.	.11-2	016	6								
"21.3.11 SU	J -MIMO	ano	d DL	-M	U-MIMC) B	eamformi	ng					
21.3.11.1 G	eneral												
SU-MIMO antennas (th With SU-M reception at streams are	and DL-M ne beamfo IMO bea a single s intended	AU- orme mfo STA for	-MIM er) to ormin A. Wi recep	10 ste g a th l otio	beamform eer signals 11 space-ti DL-MU-N on at differ	ning usi me /IIN rent	g are techn ing knowle streams ir 40 beamfo STAs.	iqu edg 1 th orm	es used by e of the ch e transmitt ing, disjoir	a S ann ed s nt s	TA with r el to impro signal are i ubsets of t	nul ove inte he	tiple throughput. nded for space-time
For SU-MI feedback m beamformin described in	MO beam atrix V _k th ng feedba n 9.4.1.49	forr <u>nat i</u> ck n	nin <u>g</u> s sen natrix	, <u>th</u> <u>t ba</u> x fo	e steering ack to the ormat as de	<u>ma</u> bea efin	<u>ttrix <i>Q_k</i> can amformer 1</u> aed in 19.3	<u>n be</u> by 1 .12	e determine the beamfo .3.6. The f	ed f rme eed	rom the be ee using th back repor	eam <u>ie c</u> rt fo	<u>forming</u> ompressed ormat is
For DL-MU $y_{k,u} = [y_{k,0}]$ denotes th $x_{k,u} = [x_{k,0}]$	J-MIMO , y _{k, 1} ,, y e transmi , x _{k 1} ,, x	bean <i>k</i> , <i>N_R</i> it	nform _{x_} -1] ² signal	ing ^T , is l	, the rece s shown in vector in being the tra	eive Equ si	signal ve ation (21-1 ubcarrier nit signal fo	ecto 01) <i>k</i> or be	r in subca , where x _k = for all . :amformee <i>u</i>	rrie = [: N _{use}	$x_{k,0}^{T}, x_{k,1}^{T}, \dots$ $x_{k,0}^{T}, x_{k,1}^{T}, \dots$ y_{r} beamform	amf ., x¦ rme	formee u , v , $N_{user} - 1$] ^T wes, with
$y_{k,u} = [y_{k,0}]$ denotes th $x_{k,u} = [x_{k,0}]$	$y_{k, 1},, y_{k}$ e transmi	k, N _R it k, N _S	$x_{u} = 1$ signal $x_{u} = 1$	^T , is l] ^T t	s shown in vector in being the tra	Equ s	uation (21-1 ubcarrier nit signal fo	01) k or be	, where x_k : for all . camformee <i>u</i>	= [: N _{use}	$x_{k,0}^T, x_{k,1}^T, \dots$ y_r beamform	., x _j	$\begin{bmatrix} T \\ T \\ N_{user} - 1 \end{bmatrix}^T$ es, with

$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l} \dots, Q_{k,Nuser} - 1] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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
<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser}-1]$ 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 $u = 0, 1,, N_{user} - 1$. 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
--
transmitting, using the 802.11- based OFDM protocol, a filtered second transmission signal, simultaneously with the filtered first transmission signal, to the third node using a second power that is based on the decompressed second feedback.

 the subcarriers, and Qk is consisted of sub-matri receiving STA u. IEEE 802.11-2016: 21.3.11.2 Beamforming Fe Qk,u is dependent on the feedback matrix Vk,u prothe actual channel measurement by each STA u IEEE 802.11-2016: Figure 10-53 (below) illustra a different polling packet, based on which the feedback matrix from STA to STA. 	tees $Q_{k,u}$, each corresponding to one eedback Matrix V further specifies that ovided by each STA u, which is based on rates that each STA (beamformee) is getting eedback matrix $V_{k,u}$ is measured and should
An example of the VHT sounding protocol with more than one Beamformer VHT NDP Announce- ment VHT NDP VHT OF Beamforming Report Poll	e VHT beamformee is shown in Figure 10-8.
Beamformee 1	\diamond \diamond \diamond
Deamonning	Compressed
	Beamforming VHT
Beamformee 3	Compressed Beamforming
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 reception at a single STA. With DL-MU-MIMO beamf streams are intended for reception at different STAs.	n the transmitted signal are intended for forming, disjoint subsets of the space-time

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 , $y_{k,u} = [y_{k,0}, y_{k,1},, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T,, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with
$x_{k,u} = [x_{k,0}, x_{k,1}, \dots, x_{k,N_{STS,u}-1}]^{*}$ being the transmit signal for beamformee u .
$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l}, Q_{k,Nuser-1}] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
<i>N_{RXu}</i> is the number of receive antennas at beamformee u
$Q_{k,0}$ is a steering matrix for beamformee u in subcarrier k with dimensions
<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,l},, Q_{k,Nuser}-1]$ 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 $u = 0, 1,, N_{user} - 1$.
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 Qk 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	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:	
comprising:	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):	
receiving at the first node in the		
radio communications network a	"10.3.2.7 CTS and DMG CTS procedure	
second instruction transmitted		
from the third node to avoid	A STA that receives an RTS frame addressed to it considers the NAV in determining whether to	
using a different plurality of	respond with C1S, unless the NAV was set by a frame originating from the STA sending the RTS	
	Irame (see 10.22.2.2). In this subclause, "NAV indicates idle" means that the NAV count is 0 or	

frequencies to transmit to the	that the NAV count is nonzero but the nonbandwidth signaling TA obtained from the TA field of
third node; and	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 WIT STA that is addressed by an DTS frame in a new UT annew UT dynlicate DDDU that has a
	A VHI SIA that is addressed by an KIS frame in a non-HI or non-HI duplicate PPDU that has a bandwidth signaling TA and that has the RXVECTOR parameter
	DVN 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, 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	Note: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
each frequency in the different	"21.3.11 SU-MIMO and DL-MU-MIMO Beamforming
plurality of frequencies to be	21 3 11 1 Conoral
second transmission signal.	

SU-MIMO and D antennas (the bear With SU-MIMO b reception at a sing streams are intend	L-MU-MIMO beamforming are techniques used by a STA with multiple nformer) to steer signals using knowledge of the channel to improve throughput. beamforming all space-time streams in the transmitted signal are intended for le STA. With DL-MU-MIMO beamforming, disjoint subsets of the space-time ed for reception at different STAs.
For SU-MIMO be feedback matrix <u>b</u> peamforming feed described in 9.4.1	amforming, the steering matrix Q_k can be determined from the beamforming V_k that is sent back to the beamformer by the beamformee using the compressed back matrix format as defined in 19.3.12.3.6. The feedback report format is 49.
For DL-MU-MIM $y_{k,u} = [y_{k,0}, y_{k,1}, \dots]$ denotes the tran $x_{k,u} = [x_{k,0}, x_{k,1}, \dots]$	D beamforming, the receive signal vector in subcarrier k at beamformee u , , $y_{k, N_{RX_u}-1}$] ^T , is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T,, x_{k,N_{user}-1}^T]^T$ smit signal vector in subcarrier k for all N_{user} beamformees, with , $x_{k, N_{STS, u}-1}$] ^T being the transmit signal for beamformee u .
$Y_{k,u} = H_{k,u} \ge [Q_k]$	0, $Q_{k,l}, Q_{k,Nuser-1} \ge x_k + n$
where	
$H_{k,u}$ is the dimensions $N_{RXu} \ge N$	te channel matrix from the beamformer to beamformee u in subcarrier k with
N _{RXu} is th	e number of receive antennas at beamformee u
$Q_{k,0}$ is a	steering matrix for beamformee u in subcarrier k with dimensions
Nuser is the	ne 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 $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser-1}]$ can be determined by the beamformer using the beamforming feedback matrices for subcarrier k from beamformer $u_{k,Nuser-1}$		
	and SNR information for subcarrier k from beamformee u , $SNR_{k,u}$, where $u = 0, 1,, N_{user}$ -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		
	$\frac{100}{21.3.11.4}$."		
	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_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,	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services		
wherein the first power and the	perform the claimed method as shown by the evidence below:		
second power are the same.	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 , $y_{k,u} = [y_{k,0}, y_{k,1},, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T,, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1},, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.
$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l}, Q_{k,Nuser} - 1] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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

<i>N_{user}</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser}-1]$ 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 $u = 0, 1,, N_{user} - 1$. 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

56. The method of claim 53,	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services
second power are different	perform the claimed method as shown by the evidence below:
second power are anterent.	<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, $y_{k,u} = [y_{k,0}, y_{k,1}, \dots, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T, \dots, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1}, \dots, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u.
	$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l}, Q_{k,Nuser-1}] \ge x_k + n$
	where
	$ \begin{array}{ c c c } H_{k,u} & \text{is the channel matrix from the beamformer to beamformee u in subcarrier k with} \\ \text{dimensions} \\ N_{RXu} \ge N_{TX} \end{array} $

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
Nuser	is the number of VHT MU PPDU recipients (see Table 21-6)
п	is a vector of additive noise and may include interference
The DL-MU- beamformer of and SNR info The steering matrix new SNR info steering matrix MU transmis 21.3.11.4)."	MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser}-1]$ can be determined by the using the beamforming feedback matrices for subcarrier k from beamformee $u, V_{k,u}$, prmation for subcarrier k from beamformee $u, SNR_{k,u}$, where $u = 0, 1,, N_{user} - 1$. matrix that is computed (or updated) using new beamforming feedback matrices and formation from some or all of participating beamformees might replace the existing ix Q_k for the next DL-MU-MIMO data transmission. The beamformee group for the sion is signaled using the Group ID field in VHT-SIG-A (see 21.3.8.3.3 and
Pages 2578-2	2579 of 802.11-2016
" 19.3.12.3 Ex	xplicit feedback beamforming
19.3.12.3.1 G	General
In explicit be measures the beamforming V_k found from the sounding product of the steering matr	amforming, in order for STA A to transmit a beamformed packet to STA B, STA B channel matrices and sends STA A either the effective channel, $H_{eff,k}$, or the g feedback matrix, V_k , for STA A to determine a steering matrix, $Q_{steer,k} = Q_k V_k$, with in $H_k Q_k$, where Q_k is the orthonormal spatial mapping matrix that was used to transmit packet that elicited the V_k feedback. The effective channel, $H_{eff,k} = H_k Q_k$, is the e spatial mapping matrix used on transmit with the channel matrix. When new ix $Q_{steer,k}$ 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:	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:
generating a first data structure based on the decompressed first feedback, where the first power	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
is based on the first data structure; and	21.3.11.2 Beamforming <u>Feedback Matrix</u> V
generating a second data structure based on the decompressed second feedback, where the second power is based on the second data structure.	<u>"Upon receipt of a VHT NDP sounding PPDU, the</u> 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 $Q_k = [Q_{k,0}, Q_{k,l},, Q_{k,Nuser}-1]$ 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. "
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 <u>explicit feedback information in the form of angles representing compressed beamforming feedback matrices V for use by a transmit beamformer to determine steering matrices Q, as described in 10.32.3 and 19.3.12.3.</u>
The size of the VHT Compressed Beamforming Report field depends on the values in the VHT MIMO Control field. The VHT Compressed Beamforming Report field contains VHT Compressed Beamforming Report information or successive (possibly zero-length) portions thereof in the case of segmented VHT Compressed Beamforming feedback (see 10.34.5). VHT 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,
<i>Nc</i> is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field,

	<i>Nr</i> 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	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:
different.	<u>Note</u> : 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 $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser-1}]$ can be determined by the beamformer using the beamforming feedback matrices for subcarrier <i>k</i> from beamformee <i>u</i> , <i>V_{k,u}</i> , and SNR information for subcarrier <i>k</i> from beamformee <i>u</i> , <i>SNR_{k,u}</i> , where $u = 0, 1,, N_{user} - 1$. 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)."
	1 age 2377 01 002.11 2010
60. The method of claim 57, wherein the first data structure is unique to the second node, 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:
the second data structure is unique to the third node.	<u>Note</u> : 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 $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser-1}]$ 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 $u = 0, 1,, N_{user}$ -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 <i>Qk</i> 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:NoteSee 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 $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k_kNuser-1}]$ 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

The beamformee decides the tone grouping value to be used in the beamforming feedback matrix <i>V</i> . 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. 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 <u>explicit feedback information in the form of angles representing compressed beamforming feedback matrices <i>V</i> for use by a transmit beamformer to determine steering matrices <i>Q</i>, as described in 10.32.3 and 19.3.12.3.</u>
The size of the VHT Compressed Beamforming Report field depends on the values in the VHT MIMO Control field. The VHT Compressed Beamforming Report field contains VHT Compressed Beamforming Report information or successive (possibly zero-length) portions thereof in the case of segmented VHT Compressed Beamforming feedback (see 10.34.5). VHT 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,
<i>Nc</i> 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	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:
a first optimal waveform profile.	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 <i>V</i> . 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. 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 <u>explicit feedback information in the form of angles representing compressed beamforming feedback matrices V for use by a transmit beamformer to determine steering matrices Q, as described in 10.32.3 and 19.3.12.3.</u>
The size of the VHT Compressed Beamforming Report field depends on the values in the VHT MIMO Control field. The VHT Compressed Beamforming Report field contains VHT Compressed Beamforming Report information or successive (possibly zero-length) portions thereof in the case of segmented VHT Compressed Beamforming feedback (see 10.34.5). VHT 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,
<i>Nc</i> 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 /64-/65 of 802.11-2016
63. The method of claim 53, 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:
generating a single data structure based on the decompressed first feedback and the decompressed	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
second feedback, where both the	"10.34.5 VHT sounding protocol
first power and the second power are based on the single data structure.	10.34.5.1 General
	Transmit beamforming and DL-MU-MIMO require knowledge of the channel state to compute a steering matrix that is applied to the transmitted signal to optimize reception at one or more receivers. The STA transmitting using the steering matrix is called the VHT beamformer, and a STA for which reception is optimized is called a VHT beamformee. <u>An explicit feedback mechanism is used where the VHT beamformee directly measures the channel from the training symbols transmitted by the VHT beamformer and sends back a transformed estimate of the channel state to the VHT beamformer. The VHT beamformer then uses this estimate, perhaps combining estimates from multiple VHT beamformees, to derive the steering matrix.</u>
	Page 1488 of 802.11-2016
	" $Q_{k,0}$ is a steering matrix for beamformee u in subcarrier k with dimensions
	<i>N_{user}</i> is the number of VHT MU PPDU recipients (see Table 21-6)
	<i>n</i> is a vector of additive noise and may include interference

	The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser}-1]$ 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 $u = 0, 1,, N_{user} - 1$. 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	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):
antennas.	 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 Qk for DL-MU-MIMO, where k is one of the subcarriers, and Qk is consisted of sub-matrices Qku, each corresponding to one receiving STA u. IEEE 802.11-2016: 21.3.11.2 Beamforming Feedback Matrix V further specifies that Qku is dependent on the feedback matrix Vku 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 Vku is measured and should be different from STA to STA.

An exam	ple of the V	HT s	oundi	ing 1	protocol wit	h m	ore than one	VH	T beamform	ee is	shown in Fi	gure	e 10-8.
Beamformer	VHT NDP Announce- ment	SIFS	NDP	SIFS	VHT	SIFS	Beamforming Report Poll	SIFS		SIFS	Beamforming Report Poll	SIFS	
Beamformee 1		↔		↔	Compressed Beamforming	↔			VALT	↔		↔	
Beamformee 2					Seamoning	I			Compressed Beamforming				VHT
Beamformee 3													Compressed Beamforming
Figur	e 10-53—I	Exar	nple	of	the sound	ing	protocol	with	more thar	n or	ne VHT bea	mf	ormee
Pages 1490	-2579 of 8	802.	11-2	016	6								
"21.3.11 SU	J -MIMO	and	I DL	-M	U-MIMC) B	eamformi	ng					
21.3.11.1 G	eneral												
SU-MIMO antennas (th With SU-M reception at streams are	and DL-M ne beamfo (IMO bea a single s intended	AU- orme mfo STA for 1	MIM er) to rmin . Wi recep	10 ste g a th 1 otio	beamform eer signals ll space-ti DL-MU-N on at differ	usi usi me AIN rent	g are techn ing knowle streams ir 40 beamfo STAs.	iqu edg h the orm	es used by e of the cha e transmitta ing, disjoin	a S ann ed s nt s	TA with r el to impro signal are i ubsets of t	nul ove inte he	tiple throughput. nded for space-time
For SU-MII feedback m beamformin described in	MO beam atrix V _k th ng feedbac n 9.4.1.49	forn <u>nat is</u> ck m	ning, <u>s sen</u> natrix	, <u>th</u> <u>t ba</u> <u>x fo</u>	e steering ack to the ormat as de	<u>ma</u> bea efin	<u>ttrix <i>Q_k</i> can amformer 1</u> aed in 19.3	<u>n be</u> by 1 .12	e determine <u>the beamfo</u> .3.6. The f	ed f rme eed	rom the be ee using th back repor	eam le c rt fo	<u>forming</u> ompressed ormat is
For DL-MU $y_{k,u} = [y_{k,0}]$ denotes the $x_{k,u} = [x_{k,0}]$	J-MIMO , y _{k, 1} ,, y e transmi , x _{k, 1} ,, x	bean ^k , N _{RN} it s	nform ₍₁ – 1] ² signal	ing ^T , is l	, the rece s shown in vector in being the tra	eive Equ stansn	signal ve ation (21-1 ubcarrier nit signal fo	ecto 01) <i>k</i> or be	r in subca , where $x_k = for all kcamformee u$	rrie = [: N _{use}	$x_{k,0}^{T}, x_{k,1}^{T}, \dots$ $x_{k,0}^{T}, x_{k,1}^{T}, \dots$ y_{r} beamform	amf ., x _j	ormee u , $[T, N_{user} - 1]^T$ es, with

$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l} \dots, Q_{k,Nuser} - 1] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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
<i>N_{user}</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser}-1]$ 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 $u = 0, 1,, N_{user} - 1$. 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_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
65. 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	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
antenna of the plurality of antennas.	 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 Qk for DL-MU-MIMO, where k is one of the subcarriers, and Qk is consisted of sub-matrices Qk,u, each corresponding to one receiving STA u.

 IEEE 802.11-2016: 21.3.11.2 Beamforming Feedbrack Qk,u is dependent on the feedback matrix Vk,u provide the actual channel measurement by each STA u. IEEE 802.11-2016: Figure 10-53 (below) illustrates a different polling packet, based on which the feedbrack be different from STA to STA. An example of the VHT sounding protocol with more than one VH 	back Matrix V further specifies that led by each STA u , which is based on is that each STA (beamformee) is getting back matrix $V_{k,u}$ is measured and should IT beamformee is shown in Figure 10-8.
Beamformer VHT NDP Announce- ment Image: Comparison of the second	WHT Compressed Beamforming 0 WHT WHT Compressed VHT Beamforming VHT Compressed Beamforming
Pages 1490-2579 of 802.11-2016	n more than one VHT beamformee
"21.3.11 SU-MIMO and DL-MU-MIMO Beamforming	
21.3.11.1 General	
SU-MIMO and DL-MU-MIMO beamforming are techniqu antennas (the beamformer) to steer signals using knowledg With SU-MIMO beamforming all space-time streams in the reception at a single STA. With DL-MU-MIMO beamform streams are intended for reception at different STAs.	tes used by a STA with multiple e of the channel to improve throughput. e transmitted signal are intended for ning, disjoint subsets of the space-time
For SU-MIMO beamforming, the steering matrix Q_k can be feedback matrix V_k that is sent back to the beamformer by t	e determined from the beamforming
<u>iccuback matrix vk</u> mat is sent back to the beamformer by t	the beannormee 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 , $y_{k,u} = [y_{k,0}, y_{k,1},, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T,, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1},, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u .
$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l} \dots, Q_{k,Nuser-1}] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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
<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser}-1]$ 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 $u = 0, 1,, N_{user}-1$. 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	Note: See evidence cited earlier in independent claim (which is incorporated by reference), as well			
the filtered first transmission	as the following (emphasis added, if any):			
signal via the at least one				
antenna of the plurality of	IEEE 802.11-2016: 21.3.11 SU-MIMO and DL-MU-MIMO Beamforming and			
antennas.	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			
	O_{ku} is dependent on the feedback matrix V_{ku} 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 $V_{k\mu}$ 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.			
	VHT NDP			
	Beamformer Announce-			
	Beamformee 1			
	Beamforming VHT			
	Beamformee 2 Beamforming VHT			
	Beamformee 3 Compressed			
	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 throughout.			

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 , $y_{k,u} = [y_{k,0}, y_{k,1},, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T,, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1},, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u .
$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l} \dots, Q_{k,Nuser-1}] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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
<i>N_{user}</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,Nuser}-1]$ 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 $u = 0, 1, \dots, N_{user} - 1$.

The steering matrix that is computed (or updated) using new beamforming feedback matrices and new SNR information from some or all of participating beamformees might replace the existing steering matrix Q_k for the next DL-MU-MIMO data transmission. The beamformee group for the MU transmission is signaled using the Group ID field in VHT-SIG-A (see 21.3.8.3.3 and 21.3.11.4)."
Pages 2578-2579 of 802.11-2016
"19.3.12.3 Explicit feedback beamforming
19.3.12.3.1 General
In explicit beamforming, in order for STA A to transmit a beamformed packet to STA B, STA B measures the channel matrices and sends STA A either the effective channel, $H_{eff,k}$, or the beamforming feedback matrix, V_k , for STA A to determine a steering matrix, $Q_{steer,k} = Q_k V_k$, with V_k found from $H_k Q_k$, where Q_k is the orthonormal spatial mapping matrix that was used to transmit the sounding packet that elicited the V_k feedback. The effective channel, $H_{eff,k} = H_k Q_k$, is the product of the spatial mapping matrix used on transmit with the channel matrix. When new steering matrix $Q_{steer,k}$ is found, $Q_{steer,k}$ may replace Q_k for the next beamformed data transmission.
NOTE— $Q_{steer,k}$ is a mathematical term to update a new steering matrix for Q_k in the next beamformed data transmission."
Page 2396 of 802.11-2016
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." <u>https://www.business.att.com/content/dam/attbusiness/briefs/att-will-5g-replace-wifi-general-business-brief.pdf</u>
	"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." <u>https://www.business.att.com/products/business-wifi.html</u>
	"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" <u>https://www.att.com/legal/terms.consumerserviceagreement.html</u>
67. The method of claim 53, wherein an update of the compressed first feedback 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:
repeatedly received, and the first power is repeatedly updated based on an updated	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
decompressed first feedback; and	" $Q_{k,0}$ is a steering matrix for beamformee u in subcarrier k with dimensions

an update of the compressed	<i>N_{user}</i> is the number of VHT MU PPDU recipients (see Table 21-6)
received, and the second power	<i>n</i> is a vector of additive noise and may include interference
is repeatedly updated based on an updated decompressed second feedback.	The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,Nuser}-1]$ 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 $u = 0, 1, \dots, N_{user}-1$. The steering matrix that is computed (or updated) using new beamforming feedback matrices and new SNR information from some or all of participating beamformees might replace the existing steering matrix Q_k for the next DL-MU-MIMO data transmission. The beamformee group for the MU transmission is signaled using the Group ID field in VHT-SIG-A (see 21.3.8.3.3 and
68. The method of claim 53, wherein an update of the	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:
compressed first feedback is repeatedly received in real-time, and the first power is repeatedly	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
updated in real-time based on an updated decompressed first feedback: and an update of the	" $Q_{k,0}$ is a steering matrix for beamformee u in subcarrier k with dimensions
compressed second feedback is repeatedly received in real-time.	<i>N_{user}</i> is the number of VHT MU PPDU recipients (see Table 21-6)
and the second power is repeatedly updated in real-time	<i>n</i> is a vector of additive noise and may include interference
based on an updated	The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,l},, Q_{k,Nuser-1}]$ can be determined by the
decompressed second feedback.	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 $u = 0, 1,, N_{user}$ -1.
	The steering matrix that is computed (or updated) using new beamforming feedback matrices and
	new SNK information from some or all of participating beamformees might replace the existing
repeatedly received in real-time, and the second power is repeatedly updated in real-time based on an updated decompressed second feedback.	<i>n</i> is a vector of additive noise and may include interference <u>The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,l},, Q_{k,Nuser}-1]$ can be determined by the beamformer using the beamforming feedback matrices for subcarrier <i>k</i> from beamformee <i>u</i>, <i>V_{k,u}</i>, and SNR information for subcarrier <i>k</i> from beamformee <i>u</i>, <i>SNR_{k,u}</i>, where $u = 0, 1,, N_{user} - 1$. <u>The steering matrix that is computed</u> (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</u>

	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
	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	When used by AT&T AT&T's agents or customers, the Accused Instrumentalities and Services
wherein an undate of the	perform the claimed method as shown by the evidence below:
compressed first feedback is	perform the elamed method as shown by the evidence below.
repeatedly received at time	Note : See evidence cited earlier in independent claim (which is incorporated by reference) as well
periods of less than one second.	as the following (emphasis added, if any):
and the first power is repeatedly	
updated based on an updated	" $O_{k,0}$ is a steering matrix for beamformee u in subcarrier k with dimensions
decompressed first feedback at	
time periods of less than one	<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)
second; and	
	<i>n</i> is a vector of additive noise and may include interference
an update of the compressed	
second feedback is repeatedly	<u>The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,l},, Q_{k,Nuser-1}]$ can be determined by the</u>
received at time periods of less	beamformer using the beamforming feedback matrices for subcarrier k from beamformee $u, V_{k,u}$,
than one second, and the second	and SNR information for subcarrier k from beamformee u , $SNR_{k,u}$, where $u = 0, 1,, N_{user} - 1$.
power is repeatedly updated	The steering matrix that is computed (or updated) using new beamforming feedback matrices and
based on an updated	new SNR information from some or all of participating beamformees might replace the existing
decompressed second feedback	steering matrix Qk for the next DL-MU-MIMO data transmission. The beamformee group for the
at time periods of less than one	MU transmission is signaled using the Group ID field in VHT-SIG-A (see 21.3.8.3.3 and
second.	21.3.11.4).
	Pages 2578 2570 of 802 11 2016
	r ages 2370-2379 01 002.11-2010
	"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." <u>https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html</u>
--	--
70. The method of claim 53, wherein the filtered first transmission signal and the	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:
filtered second transmission signal are sent via the same transceiver.	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):



Eas If yo	5y 1-2-3 self-installat u qualify for an easy self-install kit, no technician is nee	ion ^{ded.}
	2	3
Unpack the AT&T Wi-Fi gateway	Make the connection	Sign in, register & get online
Plug the AT&T Wi-Fi gateway into an outlet.	Connect your AT&T Wi-Fi gateway to your computer using the provided cables.	Follow the easy on-screen steps—and you're good to go.
If you are unable to i	nstall the AT&T Wi-Fi Gateway, call 800.288.2020 to schedule a technician for a pro	fessional installation.
https://www.att.com/wi-fi/		



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.





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 models Gateway image You may have one of the following Wi-Fi gateways: at&t BGW210 Pace 5268 POWER NVG589 NVG510 Pace 5031 • NVG599 ETHERNET BGW320 • WIRELESS 2Wire 3801 • PHONE 1 2Wire 2701 PHONE 2 2Wire 3800 2Wire 3600 Netgear 7550 BRÓADBAND Pace 5168 • 2Wire i38 • Pace 4111 • Westell 327

Page: 296 Page 296 of 426

https://ww	vw.att.com/support/art	ticle/dsl-high-speed/K	M1047050/	
This ite	m: AT&T Wireless Inter	✓		
WiFi Mo	dem 4G LTE Home Bas	se		
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://ww shoppinga	vw.amazon.com/Wire ads-lpcontext&ref_=fp	less-Internet-Hotspot- llfs&psc=1∣=A2	Antenna-AT/dp/B075J 40VZW9214RO6	B968D?source=ps-sl-
"AT&T A speed plat https://ww https://ww	All-Fi is complimentar n Everyone with A <u>vw.att.com/internet/wl</u> <u>vw.att.com/legal/terms</u>	y to all AT&T Fiber cu Ill-Fi gets the AT&T W hat-is-all-fi/#storyoffer s.wiFiServices.html	ustomers, regardless o Vi-Fi Gateway" <u>r7</u> ; <i>see also</i>	f their fiber internet

"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)." <u>https://www.att.com/gen/general?pid=7462</u>
"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"
<u>nttps://about.att.com/sites/broadband/performance#:~:text=Nationwide%20W1%2DF1%20Hotspot</u> %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"
"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." <u>https://www.att.com/support/article/wireless/KM1103818/</u>

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



	5y 1-2-3 self-installat u qualify for an easy self-install kit, no technician is nee	ion _{ded.}
	2	3
Unpack the AT&T Wi-Fi gateway	Make the connection	Sign in, register & get online
Plug the AT&T Wi-Fi gateway into an outlet.	Connect your AT&T Wi-Fi gateway to your computer using the provided cables.	Follow the easy on-screen steps—and you're good to go.
If you are unable to it	nstall the AT&T Wi-Fi Gateway, call 800.288.2020 to schedule a technician for a pro	fessional installation.
https://www.att.com/wi-fi/		



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.





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 models Gateway image You may have one of the following Wi-Fi gateways: at&t BGW210 Pace 5268 POWER NVG589 NVG510 Pace 5031 • NVG599 ETHERNET BGW320 • WIRELESS 2Wire 3801 • PHONE 1 2Wire 2701 PHONE 2 2Wire 3800 2Wire 3600 Netgear 7550 BRÓADBAND Pace 5168 • 2Wire i38 • Pace 4111 • Westell 327

	https://ww	https://www.att.com/support/article/dsl-high-speed/KM1047050/			
	This ite WiFi Mo Router	m: AT&T Wireless Interested and AG LTE Home Ba	✓		
	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 single band dual band — dual band dual band				dual band
	https://ww	ww.amazon.com/Wire	eless-Internet-Hotspot	-Antenna-AT/dp/B07	5JB968D?source=ps-sl-
	shopping	ads-lpcontext&ref_=f	plfs&psc=1∣=A	240VZW9214R06	
72. The method of claim 53, wherein the compressed first feedback and the compressed	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:				
second feedback are received utilizing a dedicated channel.	Note: See as the fol	e evidence cited earlie lowing (emphasis add	er in independent clair led, if any):	n (which is incorporat	ed by reference), as well

	9.4.1.27	мімо	Contr	ol field						
	The MIN feedback Compres The MIN	/IO Con t inform ssed Bea /IO Con	trol fiel ation. It amformi trol fiel	d is used to t is used in ing (see 9.6 d is 6 octets	o manage the the CSI (see 5.12.8) frame s in length a	e exchange 9.6.12.6), 1 es. nd is define	of MIMO ch Noncompress d in Figure 9	annel state c sed Beamfor -94.	or transmit ming (see	beamforming 9.6.12.7), and
		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 9-9	4—MIMO	Control fiel	d		
	Page 745	of 802	.11-20	16						
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.	 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 									
			2							
74. The method of claim 53, wherein the decompressed first feedback and the decompressed	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:									
second feedback are used to	Note: See as the foll	evider owing	nce cit (emph	ed earlier asis adde	in indeper d, if any):	ident clair	n (which is	incorpora	ted by ret	ference), as well

increase spatial separation among transmissions.	"In very high density environments, such as sports arenas and stadiums, high density coverage 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." <u>http://www.emperorwifi.com/2015/04/a-simplified-explanation-of-80211nac.html</u>						
	Access Point	© 4X4 MU-MIMO support 4 users simultaneously © 8X8 MU-MIMO support 8 users simultaneously © All data streams use same frequency simultaneously					
		S Acts more like a switch than a hub Much better spectral efficiency					
	https://www.comparitech.com/net-admin	n/what-is-mu-mimo/					
75. The method of claim 53, wherein the decompressed first feedback and the decompressed	When used by AT&T, AT&T's agents o perform the claimed method as shown by	r customers, the Accused Instrumentalities and Services y the evidence below:					
second feedback are used to increase spatial separation among transmissions at the same	<u>Note</u> : See evidence cited earlier in indep as the following (emphasis added, if any	endent claim (which is incorporated by reference), as well):					
trequency.							

	"In very high density environm typically achieved by using hig sectors, which may not provide <u>http://www.emperorwifi.com/2</u>	nents, such as sports why directional ante the spatial separation the spatial separation where the spatial separation the spatial separat	s arenas and stadiums, high density coverage is ennas to divide up the area into very small ion that MU-MIMO requires." d-explanation-of-80211nac.html
	\rightarrow	RADIO	
	$\stackrel{\text{Digital}}{\underset{\text{signal processor}}{\overset{\text{digital}}{\rightarrow}}}$	RADIO	
	\rightarrow	RADIO	
	Access Point	0 0 0 0	4X4 MU-MIMO support 4 users simultaneously 8X8 MU-MIMO support 8 users simultaneously All data streams use same frequency simultaneously Acts more like a switch than a hub Much better spectral efficiency
	https://www.comparitech.com/	net-admin/what-is-	mu-mimo/
76. The method of claim 53, and further comprising:	When used by AT&T, AT&T's perform the claimed method as	s agents or custome shown by the evide	rs, the Accused Instrumentalities and Services ence below:
receiving a compressed third feedback from a fourth node that	<u>Note</u> : See evidence cited earlier as the following (emphasis add	r in independent cla ed, if any):	aim (which is incorporated by reference), as well
signal sent from the first node to the fourth node, the fourth node being a legacy node;	21.3.11.2 Beamforming <u>Feed</u>	back 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 <u>computing a set of matrices for</u>
feedback to the beamformer. The beamforming feedback matrix, $V_{k,u}$, found by the beamformee u
for subcarrier k shall be compressed in the form of angles using the method described in
19.3.12.3.6. The angles, $\varphi(k, v)$ 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 Qk. For DL-MU-MIMO beamforming, the beamformer may
calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,l}, Q_{k,Nuser}-1]$ 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
<i>V</i> . 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
Transmith comforming and DL MILI MIMO require transmits for afthe share of the state to second
ransmit beamforming and DL-MO-MINO 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
SIA for which reception is optimized is called a VHI 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 MUBeamformer
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 dot11VHTMUBeamformerOntionImplemented is true a STA shall set
dot11VHTSUBeamformerOptionImplemented to true. If
dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set
dot11VHTSUBeamformeeOptionImplemented to true.
A STA is a VHT SU-only beamformer if it sets the SU Beamformer Capable field to 1 but sets the
MU Beamformer Capable field to 0 in transmitted VHT Capabilities elements. A STA is an SU-
only beamformee if it sets the SU Beamformee Capable field to 1 but sets the MU Beamformee
Capable field to 0 in transmitted VHT Capabilities elements.
If dot11VHTSUBeamformerOptionImplemented is false, a STA shall not act in the role of a VHT
beamformer. If dot11VHTSUBeamformeeOptionImplemented is false, a STA shall not act in the
role of a VHT beamformee. "
Page 1488 of 802.11-2016
"9.4.1.49 <u>VHT Compressed Beamforming Report field</u>

	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,
	<i>Nc</i> is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field,
	<i>Nr</i> 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:
decompressed unit recedence,	<u>Note</u> : 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 <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 decompress the matrices and determine the steering matrices Q_k . The matrix per tone shall be compressed as follows: The $N_r \ge N_c$ 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: <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 <i>Qk</i> for DL-MU-MIMO, <u>where k is one of the subcarriers</u>, and <i>Qk</i> is consisted of sub-matrices <i>Qku</i>, each corresponding to one receiving STA <i>u</i>. IEEE 802.11-2016: 21.3.11.2 Beamforming Feedback Matrix <i>V</i> further specifies that <i>Qku</i> is dependent on the feedback matrix <i>Vku</i> provided by each STA <i>u</i>, which is based on the actual channel measurement by each STA <i>u</i>. 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 <i>Vku</i> is measured and should be different from STA to STA.

An exam	ple of the V	HT s	oundi	ing 1	protocol wit	h m	ore than one	VH	T beamform	ee is	shown in Fi	gure	e 10-8.
Beamformer	VHT NDP Announce- ment	SIFS	NDP	SIFS	VHT	SIFS	Beamforming Report Poll	SIFS		SIFS	Beamforming Report Poll	SIFS	
Beamformee 1		↔		↔	Compressed Beamforming	↔			VALT	↔		↔	
Beamformee 2					Seamoning	I			Compressed Beamforming				VHT
Beamformee 3													Compressed Beamforming
Figur	e 10-53—I	Exar	nple	of	the sound	ing	protocol	with	more thar	n or	ne VHT bea	mf	ormee
Pages 1490	-2579 of 8	802.	11-2	016	6								
"21.3.11 SU	J -MIMO	and	I DL	-M	U-MIMC) B	eamformi	ng					
21.3.11.1 G	eneral												
SU-MIMO antennas (th With SU-M reception at streams are	and DL-M ne beamfo (IMO bea a single s intended	AU- orme mfo STA for 1	MIM er) to rmin . Wi recep	10 ste g a th 1 otio	beamform eer signals ll space-ti DL-MU-N on at differ	usi usi me AIN rent	g are techn ing knowle streams ir 40 beamfo STAs.	iqu edg 1 th orm	es used by e of the cha e transmitta ing, disjoin	a S ann ed s nt s	TA with r el to impro signal are i ubsets of t	nul ove inte he	tiple throughput. nded for space-time
For SU-MII feedback m beamformin described in	MO beam atrix V _k th ng feedbac n 9.4.1.49	forn <u>nat is</u> ck m	ning, <u>s sen</u> natrix	, <u>th</u> <u>t ba</u> <u>x fo</u>	e steering ack to the ormat as de	<u>ma</u> bea efin	<u>ttrix <i>Q_k</i> can amformer 1</u> aed in 19.3	<u>n be</u> by 1 .12	e determine <u>the beamfo</u> .3.6. The f	ed f rme eed	rom the be ee using th back repor	eam le c rt fo	<u>forming</u> ompressed ormat is
For DL-MU $y_{k,u} = [y_{k,0}]$ denotes the $x_{k,u} = [x_{k,0}]$	J-MIMO , y _{k, 1} ,, y e transmi , x _{k, 1} ,, x	bean ^k , N _{RN} it s	nform ₍₁ – 1] ² signal	ing ^T , is l	, the rece s shown in vector in being the tra	eive Equ stansn	signal ve ation (21-1 ubcarrier nit signal fo	ecto 01) <i>k</i> or be	r in subca , where $x_k = for all kcamformee u$	rrie = [: N _{use}	$x_{k,0}^{T}, x_{k,1}^{T}, \dots$ $x_{k,0}^{T}, x_{k,1}^{T}, \dots$ y_{r} beamform	amf ., x _j	ormee u , $[T, N_{user} - 1]^T$ es, with

$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,1}, Q_{k,Nuser}-1] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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
<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser}-1]$ can be determined by the beamformer using the beamforming feedback matrices for subcarrier <i>k</i> from beamformee <i>u</i> , <i>V</i> _{k,u} , and SNR information for subcarrier <i>k</i> from beamformee <i>u</i> , <i>SNR</i> _{k,u} , where $u = 0, 1,, Nuser - 1$. 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
77. The method of claim 53, wherein the compressed first feedback is based on a received power and one or more	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 (amphasis added if erg):
signal is communicated.	 21.3.11.2 Beamforming <u>Feedback Matrix</u> V
	"Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in Table 21-11 from the measured channel before <u>computing a set of matrices for</u> feedback to the beamformer. The beamforming feedback matrix, $V_{k,u}$, found by the beamformee u for subcarrier k shall be compressed in the form of angles using the method described in 19.3.12.3.6. The angles, $\varphi(k,v)$ 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.
	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 $Q_k = [Q_{k,0}, Q_{k,l},, Q_{k,Nuser}-1]$ using $V_{k,u}$ and $SNR_{k,u}$ ($0 \le u \le N_{user}-1$) in order to suppress crosstalk between participating beamformes. 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 <u>VHT Compressed Beamforming Report field</u>
The VHT Compressed Beamforming Report field is used by the VHT Compressed Beamforming feedback (see 9.6.23.2) to carry explicit feedback information in the form of angles representing compressed beamforming feedback matrices V for use by a transmit beamformer to determine steering matrices Q, as described in 10.32.3 and 19.3.12.3.
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 1 the Nc	numbe Index	r of colum field of th	nns in a co ne VHT M	mpressed IMO Con	beamformi trol field,	ng feedba	ck matrix	determined by
Nr	is the 1 Nr Ind	numbe ex fiel	r of rows i d of the V	in a comp HT MIM	ressed bea O Control	mforming field."	feedback r	natrix det	ermined by the
Pages 764	l-765 c	of 802.	11-2016						
9.4.1.27	мімо	Contr	ol field						
The MIN feedback Compres	IO Con inform sed Bea	trol fiel ation. It mform	d is used to is used in t ing (see 9.6	manage the the CSI (see .12.8) frame	e exchange 9.6.12.6), 1 es.	of MIMO ch Noncompress	annel state o ed Beamfor	or transmit ming (see	beamforming 9.6.12.7), and
The MIN	4O Con	trol fiel	d is 6 octets	in length a	nd is define	d 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
			1	Figure 9-9	4—MIMO	Control fiel	d		
Page 745	of 802	.11-20	16						
"Calculati Once the T that descr each receiphase shift https://ww	ing the NDP is ibes th iver an fts betv <u>vw.ore</u>	feedba s receiv e perfo tenna e veen ea <u>illy.co</u>	ack matrix ved, each ormance o element. T ach pair o m/library/	c can only OFDM su f the subca The conten f antennas view/8021	begin afte bcarrier is arrier betw ts of the n ." <u>lac-a-sur</u>	er receiving processed veen each tr natrix are b vival/97814	the NDP independe ransmitter ased on th	from the ently in its antenna e e received 2/ch04.hts	beamformer. s own matrix element and d power and <u>ml</u>

78. The method of claim 53,	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services
wherein the compressed first	perform the claimed method as shown by the evidence below:
feedback is based on a received	
power at a plurality of	Note: See evidence cited earlier in independent claim (which is incorporated by reference), as well
frequencies via which the first	as the following (emphasis added, if any):
signal is communicated.	
	21.3.11.2 Beamforming <u>Feedback Matrix</u> V
	" <u>Upon receipt of a VHT NDP sounding PPDU</u> , the beamformee shall remove the space-time
	stream CSD in Table 21-11 from the measured channel before <u>computing a set of matrices for</u>
	<u>feedback to the beamformer</u> . 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
	<u>19.3.12.3.6. The angles, $\varphi(k, v)$ and $\psi(k, u)$, are quantized according to Table 9-68. The number of</u>
	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 $Q_k = [Q_{k,0}, Q_{k,l},, Q_{k,Nuser}-1]$ 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 <i>V</i> . 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
viiii viii compressed Beamforming Report neid
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 <i>V</i> for use by a transmit beamformer to determine steering matrices <i>Q</i> , 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,
<i>Nc</i> is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field,
<i>Nr</i> 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	имо	Contr	ol field						
	The MIN feedback Compres	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 MIN	AO Con	trol fiel	d is 6 octets	s in length a	nd 1s define	d 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 9-9	4—MIMO	Control fiel	d		
	Page 745	of 802	.11-20	016						
	"Calculat Once the that descr each rece phase shit https://ww	ing the NDP is ibes th iver an fts betv <u>vw.ore</u>	feedb s recei e perfo tenna veen e <u>illy.co</u>	ack matrix ved, each ormance o element. 7 ach pair o m/library/	x can only OFDM su of the subca The conten f antennas view/8021	begin afte bcarrier is arrier betw ts of the r ." <u>lac-a-sur</u>	er receiving s processed veen each t natrix are b vival/9781	the NDP independe ransmitter ased on the 449357702	from the ently in its antenna e e received 2/ch04.htm	beamformer. s own matrix element and d power and <u>ml</u>
79. The method of claim 53, wherein the compressed first feedback is based on a series of power values as a function of	When use perform the set of the s	ed by A he clain e eviden	T&T, med m nce cit	AT&T's aethod as s ed earlier	agents or o shown by t in indeper	customers he eviden ident claii	, the Accus ice below: n (which is	ed Instrum incorpora	entalities ted by ref	and Services ference), as well
frequency.	as the foll 21.3.11.2	owing Beam	(empl	nasis adde	d, 11 any): ack Matri	<u>x</u> V				

" <u>Upon receipt of a VHT NDP sounding PPDU</u> , the beamformee shall remove the space-time
face to the beam former. The beam forming face has a matrix U_{i} found by the beam former u_{i}
<u>recuback to the beamformer</u> . The beamforming feedback matrix, $v_{k,u}$, found by the beamformee u for subcorrier k shall be compressed in the form of angles using the method described in
<u>10.3.12.3.6.</u> The angles $w(k, y)$ and $w(k, y)$ are quantized according to Table 0.68. The number of
<u>19.5.12.5.0.</u> The angles, $\varphi(k, v)$ and $\varphi(k, u)$, are quantized according to Table 9-08. The number of bits for quantization is shown by the beamformer based on the indication from the beamformer as
to whether the feedback is requested for SU MIMO beemforming or DI MU MIMO
to whether the recuback is requested for SO-MINO beamforming of DLMO-MINO
beamforming. The compressed beamforming feedback using 19.5.12.5.0 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
"9.4.1.49 <u>VHT Compressed Beamforming Report field</u>
The VHT Compressed Beamforming Report field is used by the VHT Compressed Beamforming feedback (see 9.6.23.2) to carry explicit feedback information in the form of angles representing compressed beamforming feedback matrices <i>V</i> for use by a transmit beamformer to determine steering matrices <i>Q</i> , 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,
<i>Nc</i> is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field,
<i>Nr</i> 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 Min	10 001	uoi nei	u is o octete	s in lengui a	iu is define	u III Figure 9-	-24.			
		B0 B1	B2 B3	B4	B5 B6	B7 B8	B9 B10	B11 B13	B14 B15	B16 B47	t
		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 9-9	4—MIMO	Control fiel	d			
	Page 745	of 802	.11-20	16							
	"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." <u>https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html</u>										
80. The method of claim 53, wherein the compressed first	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Server perform the claimed method as shown by the evidence below:				and Servic	ces					
structure that is based on a series of power values as a function of frequency	Note: See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):										
nequency.	21.3.11.2	Beam	formiı	ng <u>Feedba</u>	ack Matri	<u>x</u> V					

" <u>Upon receipt of a VHT NDP sounding PPDU</u> , the beamformee shall remove the space-time
stream CSD in Table 21-11 from the measured channel before computing a set of matrices for $\frac{1}{1000}$
<u>reedback to the beamformer</u> . The beamforming feedback matrix, $V_{k,u}$, found by the beamformee u
<u>for subcarrier k shall be compressed in the form of angles using the method described in</u> 10.2.12.2.(The shall be compressed in the form of angles using the method described in
<u>19.3.12.3.6.</u> 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 $Q_k = [Q_{k,0}, Q_{k,l},, Q_{k,Nuser}-1]$ 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
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 <i>V</i> for use by a transmit beamformer to determine steering matrices <i>Q</i> , 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,
	<i>Nc</i> is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field,
	<i>Nr</i> 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." <u>https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html</u>
81. The method of claim 53, wherein the instruction 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:
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):



	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,
	<i>Nc</i> is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field,
	<i>Nr</i> 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	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:
to the receipt of the compressed first 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):



	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,
	<i>Nc</i> is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field,
	<i>Nr</i> 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 canable	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:
of being simultaneously transmitted to at least three different devices using the same	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
multiple antennas.	"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." <u>https://www.wifisurveyors.com/wifi-mu-mimo</u>
	 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 Qk for DL-MU-MIMO, where k is one of

 the subcarriers, and Qk is consisted of sub-matrix receiving STA u. IEEE 802.11-2016: 21.3.11.2 Beamforming Fe Qku is dependent on the feedback matrix Vku proto the actual channel measurement by each STA u. IEEE 802.11-2016: Figure 10-53 (below) illustrate a different polling packet, based on which the feedback matrix from STA to STA. 	ces $Q_{k,u}$, each corresponding to one edback Matrix V further specifies that ovided by each STA u, which is based on ates that each STA (beamformee) is getting wedback matrix $V_{k,u}$ is measured and should
An example of the VHT sounding protocol with more than one Beamformer VHT NDP Announce- ment NDP O Beamforming Report Poll	VHT beamformee is shown in Figure 10-8.
Beamformee 1	\leftrightarrow \leftrightarrow \leftrightarrow
Beamforming	Compressed
	Beamforming VHT
Beamformee 3	Beamforming
Figure 10-53—Example of the sounding protocol v Pages 1490-2579 of 802.11-2016 "21.3.11 SU-MIMO and DL-MU-MIMO Beamformi	with more than one VHT beamformee
21.3.11.1 General	
SU-MIMO and DL-MU-MIMO beamforming are techn antennas (the beamformer) to steer signals using knowle With SU-MIMO beamforming all space-time streams in reception at a single STA. With DL-MU-MIMO beamfor streams are intended for reception at different STAs.	iques used by a STA with multiple edge of the channel to improve throughput. In the transmitted signal are intended for forming, disjoint subsets of the space-time

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 , $y_{k,u} = [y_{k,0}, y_{k,1},, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T,, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with
$x_{k,u} = [x_{k,0}, x_{k,1},, x_{k,N_{STS,u}-1}]^*$ being the transmit signal for beamformee u .
$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l}, Q_{k,Nuser-1}] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
<i>N_{RXu}</i> is the number of receive antennas at beamformee u
$Q_{k,0}$ is a steering matrix for beamformee u in subcarrier k with dimensions
<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,l},, Q_{k,Nuser}-1]$ 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 $u = 0, 1,, N_{user} - 1$.
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 Qk 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. <u>https://www.techtarget.com/searchnetworking/feature/5-things-to-know-about-MU-MIMO-technology-in-Wi-Fi-networks</u>

	"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" <u>https://www.att.com/legal/terms.consumerserviceagreement.html</u>
	 "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." <u>https://www.business.att.com/products/business-wifi.html</u> "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." <u>https://www.business.att.com/content/dam/attbusiness/briefs/att-will-5g-replace-</u>
	witi-general-business-brief.pdf
84. The method of claim 53, wherein at least three transmission signals are capable of being simultaneously	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
transmitted to at least three different devices, using at least	as the following (emphasis added, if any):
one different antenna.	"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." <u>https://www.wifisurveyors.com/wifi-mu-mimo</u>

 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 Qk for DL-MU-MIMO, where k is one of the subcarriers, and Qk is consisted of sub-matrices Qku, each corresponding to one receiving STA u. IEEE 802.11-2016: 21.3.11.2 Beamforming Feedback Matrix V further specifies that Qku is dependent on the feedback matrix Vku 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 Vku 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.
Beamformer VHT NDP Announce- ment Ø 50 NDP Ø 60 VHT Ø 50 Beamforming Report Poll Ø 50 Ø
Beamformee 2 Compressed Beamforming VHT
Beamformee 3 Compressed Beamforming
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-MIM	O beamforming, the steering matrix Q_k can be determined from the beamforming					
teedback 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	9.4.1.49.					
For DL-MU- $y_{k,u} = [y_{k,0}, y_{k,0}]$ denotes the $x_{k,u} = [x_{k,0}, y_{k,0}]$	MIMO beamforming, the receive signal vector in subcarrier k at beamformee u , $v_{k,1},, v_{k,N_{RX_u}-1}$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T,, x_{k,N_{user}-1}^T]^T$ transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,1},, x_{k,N_{STS,u}-1}^T$ being the transmit signal for beamformee u .					
$Y_{k,u} = H_{k,u}$	$x [Q_{k,0}, Q_{k,l}, Q_{k,Nuser-1}] x x_k + n$					
where						
where						
H _{k,u} dimensions NRXi	is the channel matrix from the beamformer to beamformee u in subcarrier k with s $u \ge N_{TX}$					
NRXu	is the number of receive antennas at beamformee u					
$Q_{k,0}$	is a steering matrix for beamformee u in subcarrier k with dimensions					
Nuser	is the number of VHT MU PPDU recipients (see Table 21-6)					
п	is a vector of additive noise and may include interference					
The DL-MU-	MIMO steering matrix $O_k = [O_{k,0}, O_{k,l}, \dots, O_{k,Nuser}-1]$ can be determined by the					
beamformer	using the beamforming feedback matrices for subcarrier k from beamformee u. V_{ku} .					
and SNR info	prmation for subcarrier k from beamformee u. SNR_{ku} , where $u = 0, 1, \dots, N_{user} - 1$.					
The steering	matrix that is computed (or updated) using new beamforming feedback matrices and					
new SNR inf	formation from some or all of participating beamformees might replace the existing					
steering matr	ix O_k for the next DL-MU-MIMO data transmission. The beamformee group for the					

<u>MU transmission is signaled using the Group ID field in VHT-SIG-A (see 21.3.8.3.3 and 21.3.11.4).</u> "
Pages 2578-2579 of 802.11-2016
"19.3.12.3 Explicit feedback beamforming
19.3.12.3.1 General
In explicit beamforming, in order for STA A to transmit a beamformed packet to STA B, STA B measures the channel matrices and sends STA A either the effective channel, $H_{eff,k}$, or the beamforming feedback matrix, V_k , for STA A to determine a steering matrix, $Q_{steer,k} = Q_k V_k$, with V_k found from H_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. <u>https://www.techtarget.com/searchnetworking/feature/5-things-to-know-about-MU-MIMO-technology-in-Wi-Fi-networks</u>

85. The method of claim 53, wherein the instruction includes	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:							
instruction.	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as was 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>							
86. The method of claim 53,	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services							
wherein the instruction includes a 802.11 clear to send (CTS)	perform the claimed method as shown by the evidence below:							
instruction.	<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." Page 1304 of 802.11-2016</u>
87. The method of claim 53, wherein the filtered first	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 using a frequency band that is selected based on the instruction and the filtered	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
second transmission signal is transmitted using the frequency	"10.3.1 General
band that is selected based on another instruction received from	
first transmission signal is transmitted using a first	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
and the filtered second transmission signal is	<u>RTS/CTS exchange by VHT STAs also performs fast collision inference on the secondary 20</u> <u>MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel and helps the VHT</u>
frequency in the frequency band.	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 adjacent to the primary 20 MHz or 80+80 MHz VHT BSS. In a 160 MHz or 80+80 MHz VHT BSS, the 20 MHz channel of the 160 MHz or 80+80 MHz VHT BSS. In a 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	 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):
transmission signal is transmitted using a second frequency.	 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 Qk for DL-MU-MIMO, where k is one of the subcarriers, and Qk is consisted of sub-matrices Qku, 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 exam	ple of the V	HT s	oundi	ing 1	protocol wit	h m	ore than one	VH	T beamform	ee is	shown in Fi	gure	e 10-8.
Beamformer	VHT NDP Announce- ment	SIFS	NDP	SIFS	VHT	SIFS	Beamforming Report Poll	SIFS		SIFS	Beamforming Report Poll	SIFS	
Beamformee 1		↔		↔	Compressed Beamforming	↔			VALT	↔		↔	
Beamformee 2					Seamoning	I			Compressed Beamforming				VHT
Beamformee 3													Compressed Beamforming
Figur	e 10-53—I	Exar	nple	of	the sound	ing	protocol	with	more thar	n or	ne VHT bea	mf	ormee
Pages 1490	-2579 of 8	802.	11-2	016	6								
"21.3.11 SU	J -MIMO	and	I DL	-M	U-MIMC) B	eamformi	ng					
21.3.11.1 G	eneral												
SU-MIMO antennas (th With SU-M reception at streams are	and DL-M ne beamfo (IMO bea a single s intended	AU- orme mfo STA for 1	MIM er) to rmin . Wi recep	10 ste g a th 1 otio	beamform eer signals ll space-ti DL-MU-N on at differ	usi usi me AIN rent	g are techn ing knowle streams ir 40 beamfo STAs.	iqu edg h the orm	es used by e of the cha e transmitta ing, disjoin	a S ann ed s nt s	TA with r el to impro signal are i ubsets of t	nul ove inte he	tiple throughput. nded for space-time
For SU-MII feedback m beamformin described in	MO beam atrix V _k th ng feedbac n 9.4.1.49	forn <u>nat is</u> ck m	ning, <u>s sen</u> natrix	, <u>th</u> <u>t ba</u> <u>x fo</u>	e steering ack to the ormat as de	<u>ma</u> bea efin	<u>ttrix <i>Q_k</i> can amformer 1</u> aed in 19.3	<u>n be</u> by 1 .12	e determine <u>the beamfo</u> .3.6. The f	ed f rme eed	rom the be ee using th back repor	eam le c rt fo	<u>forming</u> ompressed ormat is
For DL-MU $y_{k,u} = [y_{k,0}]$ denotes the $x_{k,u} = [x_{k,0}]$	J-MIMO , y _{k, 1} ,, y e transmi , x _{k, 1} ,, x	bean ^k , N _{RN} it s	nform ₍₁ – 1] ² signal	ing ^T , is l	, the rece s shown in vector in being the tra	eive Equ stansn	signal ve ation (21-1 ubcarrier nit signal fo	ecto 01) <i>k</i> or be	r in subca , where $x_k = for all kcamformee u$	rrie = [: N _{use}	$x_{k,0}^{T}, x_{k,1}^{T}, \dots$ $x_{k,0}^{T}, x_{k,1}^{T}, \dots$ y_{r} beamform	amf ., x _j	ormee u , $[T, N_{user} - 1]^T$ es, with

$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,1}, Q_{k,Nuser}-1] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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
<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser}-1]$ 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 $u = 0, 1,, N_{user} - 1$. 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
89. The method of claim 53, wherein the filtered first transmission signal and the	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:
filtered second transmission signal are transmitted using the same one or more frequencies.	<u>Note</u> : 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."



An exam	ple of the V	HT s	oundi	ing 1	protocol wit	h m	ore than one	VH	T beamform	ee is	shown in Fi	gure	e 10-8.
Beamformer	VHT NDP Announce- ment	SIFS	NDP	SIFS	VHT	SIFS	Beamforming Report Poll	SIFS		SIFS	Beamforming Report Poll	SIFS	
Beamformee 1		↔		↔	Compressed Beamforming	↔			VALT	↔		↔	
Beamformee 2					Seamoning	I			Compressed Beamforming				VHT
Beamformee 3													Compressed Beamforming
Figur	e 10-53—I	Exar	nple	of	the sound	ing	protocol	with	more thar	n or	ne VHT bea	mf	ormee
Pages 1490	-2579 of 8	802.	11-2	016	6								
"21.3.11 SU	J -MIMO	and	I DL	-M	U-MIMC) B	eamformi	ng					
21.3.11.1 G	eneral												
SU-MIMO antennas (th With SU-M reception at streams are	and DL-M ne beamfo (IMO bea a single s intended	AU- orme mfo STA for 1	MIM er) to rmin . Wi recep	10 ste g a th 1 otio	beamform eer signals ll space-ti DL-MU-N on at differ	usi usi me AIN rent	g are techn ing knowle streams ir 40 beamfo STAs.	iqu edg h the orm	es used by e of the cha e transmitta ing, disjoin	a S ann ed s nt s	TA with r el to impro signal are i ubsets of t	nul ove inte he	tiple throughput. nded for space-time
For SU-MII feedback m beamformin described in	MO beam atrix V _k th ng feedbac n 9.4.1.49	forn <u>nat is</u> ck m	ning, <u>s sen</u> natrix	, <u>th</u> <u>t ba</u> <u>x fo</u>	e steering ack to the ormat as de	<u>ma</u> bea efin	<u>ttrix <i>Q_k</i> can amformer 1</u> aed in 19.3	<u>n be</u> by 1 .12	e determine <u>the beamfo</u> .3.6. The f	ed f rme eed	rom the be ee using th back repor	eam le c rt fo	<u>forming</u> ompressed ormat is
For DL-MU $y_{k,u} = [y_{k,0}]$ denotes the $x_{k,u} = [x_{k,0}]$	J-MIMO , y _{k, 1} ,, y e transmi , x _{k, 1} ,, x	bean ^k , N _{RN} it s	nform ₍₁ – 1] ² signal	ing ^T , is l	, the rece s shown in vector in being the tra	eive Equ stansn	signal ve ation (21-1 ubcarrier nit signal fo	ecto 01) <i>k</i> or be	r in subca , where $x_k = for all kcamformee u$	rrie = [: N _{use}	$x_{k,0}^{T}, x_{k,1}^{T}, \dots$ $x_{k,0}^{T}, x_{k,1}^{T}, \dots$ y_{r} beamform	amf ., x _j	ormee u , $[T, N_{user} - 1]^T$ es, with

$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l} \dots, Q_{k,Nuser} - 1] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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
<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser}-1]$ 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 $u = 0, 1,, N_{user} - 1$. 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					
90. The method of claim 53, wherein the filtered first	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:					
filtered second transmission signal are transmitted using the	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as wel as the following (emphasis added, if any):					
same frequency band.	"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. <u>An RTS/CTS exchange by VHT STAs also performs fast collision inference on the secondary 20</u>					

<u>MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel and helps the VHT</u> <u>STA transmitting the RTS to determine the available bandwidth at the responder.</u> "
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 adjacent to the primary 20 MHz channel that together form the primary 40 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. 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	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
instruction and the filtered second transmission signal is transmitted using a second frequency that is based on another instruction received from	"10.3.1 General
the third node.	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>

<u>MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel and helps the VHT</u> <u>STA transmitting the RTS to determine the available bandwidth at the responder.</u> "
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 adjacent to the primary 20 MHz channel adjacent to the primary 20 MHz or 80+80 MHz VHT BSS, the 20 MHz channel of the 160 MHz or 80+80 MHz VHT BSS. In a 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 channel of the 160 MHz or 80+80 MHz channel of the 160 MHz or 80+80 MHz channel 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	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 using a frequency that is based on the instruction	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
and the filtered second transmission signal is	"10.3.1 General
transmitted using the frequency	
that is based on another	
instruction received from the	
tnira node.	The KIS/UIS 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

<u>MHz channel, secondary 40 MHz channel, and secondary 80 MHz channel and helps the VHT</u> <u>STA transmitting the RTS to determine the available bandwidth at the responder.</u> "
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 adjacent to the primary 20 MHz channel that together form the primary 40 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. 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 very high throughput (VHT) basic service set (BSS), the 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	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):
second transmission signal is transmitted using the frequency band that is selected based on another instruction received from the third node.	 "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</u> 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</u> <u>STA transmitting the RTS to determine the available bandwidth at the responder.</u> "
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 adjacent to the primary 20 MHz channel adjacent to the primary 20 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. 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
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).



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


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	\checkmark
Wi-Fi Calling capable	\checkmark
Video calling [®]	FaceTime video calling over cellular or Wi-Fi FaceTime HD (1080p) video calling over 5G or Wi-Fi
Audio callingº	FaceTime audio Voice over LTE (VoLTE) ¹⁰ Wi-Fi calling ¹⁰
WI-Fi connectivity	Wi-Fi 6E (802.11ax) with 2x2 MIMO $^{\rm o}$
Wi-Fi capability	\checkmark
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	\checkmark
Wi-Fi Calling capable	\checkmark
AT&T Video call capable	\checkmark
Wi-Fi connectivity	Wi-Fi 6E (802.11ax)
Wi-Fi capability	2.4GHz & 5GHz & 6GHz
https://www.att.com/buy/phones/samsung-ge	alaxy-s24.html

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	\checkmark
Wi-Fi Calling capable	\checkmark
AT&T Video call capable	\checkmark
Wi-Fi connectivity	Wi-Fi 6E (802.11ax)
Wi-Fi capability	2.4GHz & 5GHz & 6GHz
https://www.att.com/buy/phones/motor	ola-razr-2023.html

Pick your devi 1. Pick you	ice	Customize your hotspot	3. Choose your plan	4. Get add-ons	5. Review your cart		Checkout
	Phones	AT&T PREPAID	Tablets & Laptops	Smartwatches	Hotspots & more	Accessories	
Filters	<u>Clear all</u>	3 items				≌ <u>Hide filters</u>	Sort-by: Best-selling 🗡
Buy online & pick up a	at store						
Delivery Method	~		AUST		Average of the second s		
Brand	~		NETGEAR				NETGRAR
Device condition	~	Netgear Nighthawk	★ 3.1 117 M6 Pro	Franklin A50	★ 3.2 25	Netgear Nighthawk I	★ 2.9 44 M6
Featured	~	\$12.78/m d). 36-mo. agmt and svc. Well-qual.	\$5.84/mo. Reg/s 0% APR 36-	-mo. agmt and svc. Well-qual.	\$8.62/mo. Reg/s 0% APR 3	6-mo, agmt and svc. Well-qual.
Price range	~	customers. <u>See price detai</u>	<u>Is</u>	customers. <u>See price details</u>		customers. <u>See price detail</u> :	s S
Color	~					Limited sto	ock. Buy now!
https://www.a	att.com/b	ouy/connecte	ed-devices-and	<u>d-more/</u>			





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." <u>https://www.extremenetworks.com/resources/blogs/what-is-wifi-7</u> .
"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.
<u>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</vht-mcs,></u> .
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 DTS from a start of the distribution of the DTS from a start of the second start of the DTS from a start of the second start of the DTS from a start of the second start of the second start of the DTS from a start of the second start of
RIS frame and that is less than or equal to the channel width indicated in the RIS frame's RVVECTOR parameter CH RANDWIDTH IN NON HT
- Otherwise the STA shall not respond with a CTS frame
- 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 on DTS frame, the STA shall wait for a CTST impout interval with a value of
a SIFSTime + aSlot Time + aRyPHY Start Delay. 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."
receiving at a first node in the radio communications network an instruction transmitted from a second 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 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.
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 adjacent to the primary 20 MHz or 80+80 MHz VHT BSS. In a 160 MHz or 80+80 MHz VHT BSS, the 20 MHz channel of the 160 MHz or 80+80 MHz VHT BSS. In a VHT BSS. In a VHT BSS, the secondary 20 MHz channel is also the secondary channel.
<u>secondary 40 MHz channel</u> : 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."
Pages 1313-1314 of 802.11-2016
"10.3.1 General
The RTS/CTS exchange also performs both a type of fast collision inference and a transmission path check. If the return CTS frame is not detected by the STA originating the RTS, the originating STA may repeat the process (after observing the other medium-use rules) more quickly than if the long Data frame had been transmitted and a return Ack frame had not been detected. <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
"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 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
 "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."
Page 1386 of 802.11-2016
"17.2.2.1 General

Table 17-1—TXVECTOR parameters (continued)			
Parameter Associated primitive		Value	
TIME_OF_ DEPARTURE_ REQUESTED	PHY-TXSTART.request (TXVECTOR)	false, true. When true, the MAC entity requests that the PHY entity measures and reports time of departure parameters corresponding to the time when the first frame energy is sent by the transmitting port; when false, the MAC entity requests that the PHY entity neither measures nor reports time of departure parameters.	
CH_BANDWIDTH_ IN_NON_HT	PHY-TXSTART.request (TXVECTOR)	t 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."

Pages 2279-2280 of 802.11-2016

"17.2.3.1 General

т	able 17-2—RXVECTOF	R parameters <i>(continued)</i>
Parameter	Associated primitive	Value
X_START_OF_FRAM _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
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		

	Enumerated value	Value	
	CBW20	0	
	CBW40	1	
	CBW80	2	
	CBW160 or CBW80+80	3	
Table 18-6c—F	RXVECTOR parameter CH_E	SANDWIDTH_I	N_NON_HT values
Table 18-6c—F CbwInNonHtTemp Table 18-6a)	RXVECTOR parameter CH_E (see dot11CurrentChannelC FrequencyIndex1	BANDWIDTH_II	N_NON_HT values VECTOR parameter NDWIDTH_IN_NON_H
Table 18-6c—F CbwInNonHtTemp Table 18-6a) 0	RXVECTOR parameter CH_E o (see dot11CurrentChannelC FrequencyIndex1 0	SANDWIDTH_II	N_NON_HT values VECTOR parameter NDWIDTH_IN_NON_H CBW20
Table 18-6c—F CbwInNonHtTemp Table 18-6a) 0 1	RXVECTOR parameter CH_E o (see dot11CurrentChannelC FrequencyIndex1 0 0	SANDWIDTH_II	N_NON_HT values VECTOR parameter NDWIDTH_IN_NON_H CBW20 CBW40
Table 18-6c—F CbwInNonHtTemp Table 18-6a) 0 1 2	RXVECTOR parameter CH_E o (see dot11CurrentChannelC FrequencyIndex1 0 0 0	SANDWIDTH_II	N_NON_HT values VECTOR parameter NDWIDTH_IN_NON_HT CBW20 CBW40 CBW80
Table 18-6c—F CbwInNonHtTemp Table 18-6a) 0 1 2 3	RXVECTOR parameter CH_E o (see dot11CurrentChannelC FrequencyIndex1 0 0 0 0 0	SANDWIDTH_II	N_NON_HT values VECTOR parameter NDWIDTH_IN_NON_HT CBW20 CBW40 CBW80 CBW160

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)	dotllCurrentChannelCenter 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

 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



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.

Page 670 of 802.11-2016

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 PPDU containing VHT Kertor 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 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 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 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.

Page 1490 of 802.11-2016			
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_FRAM E_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 prese	nt only when dot11RadioMe	asurementActivated is true.
7.2.3.7 RXVECTOR CH	BANDWIDTH_IN_NO	N_HT DTH_IN_NON_HT are CBW20, CBW40, CBW

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)	dotllCurrentChannelCenter 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

Page 2294 of 802.11-2016

	 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.

PHY-CCA primitive ele	A.indication channel-list ment	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, an secondary 40 MHz channel
hen a STA EDCA TX bclause me annel " On	and the BSS KOP is obtain cans "idle pri	S, of which the STA is a member, both support multi ned based solely on activity of the primary channel. mary channel." Likewise "busy medium" means "b TXOP has been obtained according to this subclau
When a STA n EDCA TX ubclause me hannel." On efined in 11 nannel acce condary 80	and the BSS (OP is obtain eans "idle pri ce an EDCA .16.9 and 10 ss, based on MHz chann	S, of which the STA is a member, both support multiple based solely on activity of the primary channel. mary channel." Likewise "busy medium" means "the TXOP has been obtained according to this subclau .22.3 might limit the width of transmission during the state of CCA on secondary channel, secondary el.

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.

	1) <u>Transmit an 80 MHz mask PPDU on the primary 80 MHz channel if both the secondary</u>
	channel and the secondary 40 MHz channel were idle during an interval of PIFS
	immediately preceding the start of the TXOP.
1) <u>Iransmit a 40 MHz mask PPDU on the primary 40 MHz channel if the secondary channel</u>
	was idle during an interval of PIFS immediately preceding the start of the TXOP.
5) <u>Iransmit a 20 MHz mask PPDU on the primary 20 MHz channel.</u>
1) <u>Restart the channel access attempt by invoking the backoff procedure as specified in</u>
	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."
Page	es 1383 of 802.11-2016
"17.	3.2.2 Overview of the PPDU encoding process
	1) 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.
Page	es 1383-2284 of 802.11-2016
"17.	3.5.5 PHY DATA scrambler and descrambler
The	DATA field, composed of SERVICE, PSDU, tail, and pad parts, shall be scrambled with a
leng	th-127 PPDU-synchronous scrambler. The octets of the PSDU are placed in the transmit serial
bits	tream, bit 0 first and bit 7 last. The PPDU synchronous scrambler uses the generator
poly	nomial S(x) as follows and is illustrated in Figure 17-7:
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."
Pages 2292-2294 of 802.11-2016
"21.3.17 VHT transmit specification
21.3.17.1 Transmit spectrum mask
NOTE 1—In the presence of additional regulatory restrictions, the device has to meet both the regulatory requirements and the mask defined in this subclause. NOTE 2—Transmit spectral mask figures in this subclause are not drawn to scale. NOTE 3—For rules regarding TX center frequency leakage levels, see 21.3.17.4.2. The spectral mask requirements in this subclause do not apply to the RF LO.
For a 20 MHz mask PPDU of non-HT, HT or VHT format, the interim transmit spectral mask shall have a 0 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 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." Page 2595 of 802.11-2016


Page: 397 Page 397 of 426

"21 3 17 VHT transmit specification
21.5.17 VIII 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.



separately from the receipt of the	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services
instruction, receiving a particular	perform the step of, separately from the receipt of the instruction, receiving a particular signal at
transmitted from the second	the first node that is transmitted from the second node.
node;	Note : See evidence cited earlier in this independent claim (which is incorporated by reference), as
,	well as the following (emphasis added, if any):
	21.3.11.2 Beamforming <u>Feedback Matrix</u> V
	"Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in Table 21-11 from the measured channel before <u>computing a set of matrices for</u> <u>feedback to the beamformer</u> . The beamforming feedback matrix, $V_{k,u}$, found by the beamformee <i>u</i> <u>for subcarrier <i>k</i> 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</u>
	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 $Q_k = [Q_{k,0}, Q_{k,l} \dots, Q_{k,Nuser}-1]$ 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 <i>V</i> . A beamformer shall support all tone grouping values and Codebook Information values."
	Page 2579 of 802.11-2016

"10.34.5 VHT sounding protocol
10.34.5.1 General
Transmit beamforming and DL-MU-MIMO require knowledge of the channel state to compute a steering matrix that is applied to the transmitted signal to optimize reception at one or more receivers. The STA transmitting using the steering matrix is called the VHT beamformer, and a STA for which reception is optimized is called a VHT beamformee. <u>An explicit feedback mechanism is used where the VHT beamformee directly measures the channel from the training symbols transmitted by the VHT beamformer and sends back a transformed estimate of the channel state to the VHT beamformer. The VHT beamformer then uses this estimate, perhaps combining estimates from multiple VHT beamformees, to derive the steering matrix.</u>
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 <u>VHT Compressed Beamforming Report field</u>
The VHT Compressed Beamforming Report field is used by the VHT Compressed Beamforming feedback (see 9.6.23.2) to carry explicit feedback information in the form of angles representing compressed beamforming feedback matrices V for use by a transmit beamformer to determine steering matrices Q, as described in 10.32.3 and 19.3.12.3.
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,
<i>Nc</i> is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field,
<i>Nr</i> 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
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 <u>Feedback Matrix</u> V
	"Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in Table 21-11 from the measured channel before <u>computing a set of matrices for</u> <u>feedback to the beamformer</u> . The beamforming feedback matrix, $V_{k,u}$, found by the beamformee <i>u</i> for subcarrier <i>k</i> shall be compressed in the form of angles using the method described in <u>19.3.12.3.6. The angles, $\varphi(k,v)$ and $\psi(k,u)$, are quantized according to Table 9-68. The number of bits for quantization is chosen by the beamformee, based on the indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DLMU- MIMO beamforming. The compressed beamforming feedback using 19.3.12.3.6 is the only Clause 21 beamforming feedback format defined.</u>
	The beamformee shall generate the beamforming feedback matrices with the number of rows (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 $Q_k = [Q_{k,0}, Q_{k,l}, Q_{k,Nuser-1}]$ 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
"9.4.1.49 <u>VHT Compressed Beamforming Report field</u>
The VHT Compressed Beamforming Report field is used by the VHT Compressed Beamforming feedback (see 9.6.23.2) to carry explicit feedback information in the form of angles representing compressed beamforming feedback matrices <i>V</i> for use by a transmit beamformer to determine steering matrices <i>Q</i> , 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,
<i>Nc</i> is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field,
<i>Nr</i> 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 9.4.1.27 The MIN feedback Compres The MIN	-765 o MIMO IO Con inform sed Bea	f 802. Contr trol fiel ation. It mform trol fiel	11-2016 ol field d is used to t is used in t ing (see 9.6. d is 6 octets	manage the the CSI (see 12.8) frame in length an	e exchange 9.6.12.6), 1 s. nd is define	of MIMO ch: Noncompress d in Figure 9-	annel state o ed Beamfor -94.	or transmit ming (see 9	beamforming 9.6.12.7), and
		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
	Daga 745	-£00 0	11.20	16	Figure 9-94	4—MIMO	Control fiel	d		
	Page /45	01 802	.11-20	10						
	"Calculati Once the 1 that descr each recei phase shif https://ww	ing the NDP is ibes the ver an its betw ww.ore	feedba s receiv e perfo tenna o veen ea <u>illy.co</u>	ack matrix ved, each ormance o element. T ach pair ot m/library/	a can only OFDM su f the subca The conten f antennas view/8021	begin afte bcarrier is arrier betw ts of the n ." <u>lac-a-sur</u>	er receiving processed veen each tr natrix are ba vival/97814	the NDP independe ransmitter ased on the	from the forther from the forther for the forther forther for the forther fort	beamformer. Fown matrix Element and I power and <u>nl</u>
compressing the feedback; and	When use	d by A ne sten	T&T,	AT&T's a	agents or c	ustomers,	, the Accuse	ed Instrum	entalities	and Services
	" 19.3.12 .3	3.6 <u>Co</u>	mpres	sed beam	forming f	eedback	<u>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 decompress the matrices and determine the steering matrices Q_k . The matrix per tone shall be compressed as follows: The $N_r \ge N_c$ 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	When used by AT&T, AT&T's agents or customers, the Accused Instrumentalities and Services
feedback from the first node to	perform the step of transmitting the compressed feedback from the first node to the second node,
the second node, for use by the	for use by the second node in determining a transmit power with which the second node transmits
second node in determining a	to the first node via at least one antenna of a plurality of antennas, while simultaneously
second node transmits to the first	transmitting to one or more other nodes.
node via at least one antenna of a	Note : See evidence cited earlier in this independent claim (which is incorporated by reference) as
plurality of antennas, while	well as the following (emphasis added, if any):
simultaneously transmitting to	
one or more other nodes;	21.3.11.2 Beamforming <u>Feedback Matrix</u> V
	"Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time
	stream CSD in Table 21-11 from the measured channel before 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
	<u>19.3.12.3.6.</u> 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 $Q_k = [Q_{k,0}, Q_{k,l},, Q_{k,Nuser}-1]$ 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 <i>V</i> . A beamformer shall support all tone grouping values and Codebook Information values."
Page 2579 of 802.11-2016
"10.34.5 VHT sounding protocol
10.34.5.1 General
Transmit beamforming and DL-MU-MIMO require knowledge of the channel state to compute a steering matrix that is applied to the transmitted signal to optimize reception at one or more receivers. The STA transmitting using the steering matrix is called the VHT beamformer, and a STA for which reception is optimized is called a VHT beamformee. <u>An explicit feedback mechanism is used where the VHT beamformee directly measures the channel from the training symbols transmitted by the VHT beamformer.</u> The VHT beamformer then uses this estimate, perhaps combining estimates from multiple VHT beamformees, to derive the steering matrix.
If dot11VHTSUBeamformerOptionImplemented is true, a STA shall set the SU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTSUBeamformeeOptionImplemented is true, a STA shall set the SU Beamformee Capable field in the VHT Capabilities element to 1.

If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set the MU Beamformer Capable field in the VHT Capabilities element to 1. If dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set the MU Beamformee Capable field in the VHT Capabilities element to 1.
If dot11VHTMUBeamformerOptionImplemented is true, a STA shall set dot11VHTSUBeamformerOptionImplemented to true. If dot11VHTMUBeamformeeOptionImplemented is true, a STA shall set dot11VHTSUBeamformeeOptionImplemented to true.
A STA is a VHT SU-only beamformer if it sets the SU Beamformer Capable field to 1 but sets the MU Beamformer Capable field to 0 in transmitted VHT Capabilities elements. A STA is an SU-only beamformee if it sets the SU Beamformee Capable field to 1 but sets the MU Beamformee Capable field to 0 in transmitted VHT Capabilities elements.
If dot11VHTSUBeamformerOptionImplemented is false, a STA shall not act in the role of a VHT beamformer. If dot11VHTSUBeamformeeOptionImplemented is false, a STA shall not act in the role of a VHT beamformee. "
Page 1488 of 802.11-2016
"9.4.1.49 <u>VHT Compressed Beamforming Report field</u>
The VHT Compressed Beamforming Report field is used by the VHT Compressed Beamforming feedback (see 9.6.23.2) to carry explicit feedback information in the form of angles representing compressed beamforming feedback matrices <i>V</i> for use by a transmit beamformer to determine steering matrices <i>Q</i> , 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,
<i>Nc</i> is the number of columns in a compressed beamforming feedback matrix determined by the Nc Index field of the VHT MIMO Control field,
<i>Nr</i> 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." <u>https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html</u>
To the extent AT&T contends that the claim requires a "second node," on information and belief, <u>AT&T directly infringes this claim by using (including internal testing, provisioning of AT&T</u> <u>Wi-Fi services (e.g., AT&T Nationwide Wi-Fi Hotspots, FirstNet, AT&T Hot Zones, AT&T</u> <u>Internet Air, All-Fi, Fixed Wireless Access, AT&T Internet, AT&T Business Internet, AT&T</u>
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,
Einst Not Nationwide Wi Ei Hotsnot naturaly and other Wi Ei service offerings by AT&T at a)
Γ results in a compared with the probability of

States.	ised Instrumentalities and Services and performing the claimed methods in the United
For exar its mobil network	nple, as evidenced below, AT&T has entered into contracts with Boingo to add capacity le network via the use of Passpoint technology, which allows AT&T to offload its mobil traffic onto WiFi networks that utilize a second node:
Am	nid 5G Buildout, AT&T Offloads More Traffic to
Wi	Fi
Despit add ca	te its efforts to build out new spectrum, densify its network and deploy 5G, AT&T is also working to apacity to its network via an expanded WiFi offloading deal with Boingo.
C	Mike Dano, Editorial Director, 5G & Mobile Strategies February 20, 2019
	www.lightreading.com/wifi/amid-5g-buildout-at-t-offloads-more-traffic-to-wifi)
<u>(https://v</u>	
(<u>https://v</u> AT&T part c	extended a Wi-Fi roaming agreement with Boingo Wireless as of a move to manage rapidly growing data traffic on its network
(https://v AT&T part c Boingo	extended a Wi-Fi roaming agreement with Boingo Wireless as of a move to manage rapidly growing data traffic on its network CEO David Hagan told <i>Mobile World Live</i> (<i>MWL</i>) a previous agreement betwee
AT&T part c Boingo the pair	extended a Wi-Fi roaming agreement with Boingo Wireless as of a move to manage rapidly growing data traffic on its network CEO David Hagan told <i>Mobile World Live</i> (<i>MWL</i>) a previous agreement betwee r connected AT&T to its Wi-Fi service in a handful of locations, but noted the
(https://v AT&T part c Boingo the pair operato	extended a Wi-Fi roaming agreement with Boingo Wireless as of a move to manage rapidly growing data traffic on its network CEO David Hagan told <i>Mobile World Live</i> (<i>MWL</i>) a previous agreement betwee r connected AT&T to its Wi-Fi service in a handful of locations, but noted the pr will now have access to the "vast majority" of its Passpoint-certified network.

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

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.").

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/.

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

	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. <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 Qk for DL-MU-MIMO, where k is one of the subcarriers, and Qk is consisted of sub-matrices Qk,u, each corresponding to one receiving STA u. IEEE 802.11-2016: 21.3.11.2 Beamforming Feedback Matrix V further specifies that Qk,u is dependent on the feedback matrix Vk,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 Vk,u is measured and should be different from STA to STA.

²¹ See, e.g., https://www.att.com/gen/general?pid=7462; https://www.boingo.com/press-releases/att-expands-wi-fi-roamingagreement-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 exam	ple of the V	HT sound	ing protocol wi	th more than o	one VH	IT beamform	ee is shown i	n Figu	re 10-8.
Beamformer	VHT NDP Announce- ment	SE NDP	S VHT	Beamform Report P	ning oll us		ග Beamfom Report F	ning Sell S	
Beamformee 1		↔	 Compressed Beamforming 	↔	~	VHT	↔ 	•	•
Beamformee 2						Compressed Beamforming			VHT
Beamformee 3						• –			Compressed Beamforming
Figur	e 10-53—I	Example	of the sound	ding protoce	ol with	n more thar	n one VHT	beam	formee
Pages 1490	-2579 of	802.11-2	2016						
"21.3.11 S	J -MIMO	and DI	-MU-MIM	O Beamfor	ming				
21.3.11.1 (eneral								
SU-MIMO antennas (tl With SU-M reception at streams are	and DL-M ne beamfo IIMO bea a single intended	MU-MIN ormer) to mformin STA. W for rece	AO beamforn o steer signal ng all space-t ith DL-MU- ption at diffe	ning are tec s using knov ime streams MIMO bear rent STAs.	chniqu wledg s in th nform	tes used by te of the ch e transmitt ning, disjoir	a STA wi annel to in ed signal a nt subsets	th mut aprove re inte of the	ltiple e throughput. ended for space-time
For SU-MI feedback m beamformin described in	MO beam <u>atrix V_k tl</u> 1 <u>g feedba</u> 1 9.4.1.49	forming <u>nat is ser</u> c <u>k matri</u>	the steering the steering the back to the the steering the steering the steering the steering the steering the steering the steering	g matrix <i>Q_k</i> beamforme lefined in 19	<u>can bo</u> er by 1 9.3.12	e determine the beamfo 2.3.6. The f	ed from the ormee using eedback re	<u>e bean</u> g the c port f	nforming compressed format is
For DL-MU $y_{k,u} = [y_{k,0}]$ denotes th $x_{k,u} = [x_{k,0}]$	J-MIMO , y _{k, 1} ,, y e transm , x _{k, 1} ,, y	beamforr ⁷ k, N _{RX_u} - 1] it signa	ning, the rec ^T , is shown in 1 vector in 1 ^T being the t	eive signal Equation (2 subcarrier cansmit signal	vecto 1-101) r <i>k</i> 1 for be	r in subca , where $x_k = 1$ for all <i>i</i> eamformee <i>i</i>	$\begin{array}{l} \text{miner} k \text{at} \\ = [x_{k,0}^T, x_{k,1}^T] \\ N_{user} \text{beau} \\ \ell. \end{array}$	beam 1,, x nforme	formee u , $\begin{bmatrix} T \\ k, N_{user} - 1 \end{bmatrix}^T$ ees, with

$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,1}, Q_{k,Nuser}-1] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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
<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k,Nuser}-1]$ 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 $u = 0, 1,, N_{user} - 1$. 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
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 undated based thereupon at time periods of less than one second
transmit power is repeatedry updated based thereupon at time periods of less than one second.
<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):
i
" $Q_{k,0}$ is a steering matrix for beamformee u in subcarrier k with dimensions
<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,Nuser}]$ 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 $u = 0, 1,, N_{user} - 1$.
<u>The steering matrix that is computed (or updated) using new beamforming feedback matrices and</u>
steering matrix O_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." <u>https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html</u>
96. The method of claim 95, wherein the instruction includes	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:
transmission signal includes a filtered first 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):
and further comprising.	 A VHT STA that is addressed by an RTS frame in a non-HT or non-HT duplicate PPDU that has a bandwidth signaling TA and that has the RXVECTOR parameter DYN_BANDWIDTH_IN_NON_HT equal to Dynamic behaves as follows: If the NAV indicates idle, then the STA shall respond with a CTS frame in a non-HT or non-HT duplicate PPDU after a SIFS. <u>The CTS frame's TXVECTOR parameters</u> <u>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</u>
	Page 1313 of 802.11-2016
	 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 Qk for DL-MU-MIMO, where k is one of the subcarriers, and Qk is consisted of sub-matrices Qk,u, each corresponding to one receiving STA u.

• IEEE 802.11-2016: 21.3.11.2 Beamforming Feedb	back Matrix V further specifies that
O_{ku} is dependent on the feedback matrix V_{ku} provide	led 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	s that each STA (beamformee) is getting
a different polling packet, based on which the feedb	back 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 VH	IT beamformee is shown in Figure 10-8.
VHTNDP to Beamforming to	e Beanforming to
Beamformer Announce-	Report Poll
Beamformee 1	↔ ↔
Beamtoming	VHT
Beamformee 2	Beamforming VHT
Beamformee 3	Compressed Beamforming
Figure 10-53—Example of the sounding protocol with	n more than one VHT beamformee
Pages 1490-2579 of 802.11-2016	
"21 3 11 SU-MIMO and DL-MU-MIMO Beamforming	
21.0.11 Se Millio and DE Me Millio Deamorning	
21.3.11.1 General	
SU MIMO and DL MIL MIMO beamforming are technique	use used by a STA with multiple
antennas (the beamformer) to steer signals using knowledge	e of the channel to improve throughout
With SU-MIMO beamforming all space-time streams in th	e transmitted signal are intended for
reception at a single STA. With DL-MU-MIMO beamform	ning, disjoint subsets of the space-time
streams are intended for reception at different STAs.	
1	
For SU-MIMO beamforming, the steering matrix Qk can be	e 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 , $y_{k,u} = [y_{k,0}, y_{k,1},, y_{k,N_{RX_u}-1}]^T$, is shown in Equation (21-101), where $x_k = [x_{k,0}^T, x_{k,1}^T,, x_{k,N_{user}-1}^T]^T$ denotes the transmit signal vector in subcarrier k for all N_{user} beamformees, with $x_{k,u} = [x_{k,0}, x_{k,1},, x_{k,N_{STS,u}-1}]^T$ being the transmit signal for beamformee u .
$Y_{k,u} = H_{k,u} \ge [Q_{k,0}, Q_{k,l} \dots, Q_{k,Nuser-1}] \ge x_k + n$
where
$H_{k,u}$ is the channel matrix from the beamformer to beamformee u in subcarrier k with dimensions $N_{RXu} \ge N_{TX}$
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
<i>Nuser</i> is the number of VHT MU PPDU recipients (see Table 21-6)
<i>n</i> is a vector of additive noise and may include interference
The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1},, Q_{k_kNuser}-1]$ 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 $u = 0, 1,, N_{user}-1$. 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	<u>Note</u> : See evidence cited earlier in independent claim (which is incorporated by reference), as well as the following (emphasis added, if any):
from a third node in the radio	"10.3.2.7 CTS and DMG CTS procedure
avoid using a different plurality of frequencies to transmit to the third node;	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 MUz channel, secondary 40 MUz channel, and secondary 80 MUz 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 PIES 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, 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	Note: See evidence cited earlier in independent claim (which is incorporated by reference), as well
signal to remove power from the	as the following (emphasis added, if any):
each frequency in the different	"21.3.11 SU-MIMO and DL-MU-MIMO Beamforming
avoided; and	21.3.11.1 General
	SU-MIMO and DL-MU-MIMO beamforming are techniques used by a STA with multiple antennas (the beamformer) to steer signals using knowledge of the channel to improve throughput. With SU-MIMO beamforming all space-time streams in the transmitted signal are intended for reception at a single STA. With DL-MU-MIMO beamforming, disjoint subsets of the space-time streams are intended for reception at different STAs.

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

	<u>MU transmission is signaled using the Group ID field in VHT-SIG-A (see 21.3.8.3.3 and 21.3.11.4).</u> "
	Pages 2578-2579 of 802.11-2016
	"19.3.12.3 Explicit feedback beamforming
	19.3.12.3.1 General
	In explicit beamforming, in order for STA A to transmit a beamformed packet to STA B, STA B measures the channel matrices and sends STA A either the effective channel, $H_{eff,k}$, or the beamforming feedback matrix, V_k , for STA A to determine a steering matrix, $Q_{steer,k} = Q_k V_k$, with V_k found from $H_k Q_k$, where Q_k is the orthonormal spatial mapping matrix that was used to transmit the sounding packet that elicited the V_k feedback. The effective channel, $H_{eff,k} = H_k Q_k$, is the product of the spatial mapping matrix used on transmit with the channel matrix. When new steering matrix $Q_{steer,k}$ is found, $Q_{steer,k}$ may replace Q_k for the next beamformed data transmission. NOTE— $Q_{steer,k}$ is a mathematical term to update a new steering matrix for Q_k in the next beamformed data transmission." Page 2396 of 802.11-2016
transmitting the filtered second	Note: See evidence cited earlier in independent claim (which is incorporated by reference), as well
node	as the following (emphasis added, if any):
noue.	"21.3.19 PHY transmit procedure
	There are two paths for the transmit PHV 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.



Page: 424 Page 424 of 426

•••
"After the PHY preamble transmission is started, the PHY entity immediately initiates data scrambling and data encoding. <u>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</u> ."
Page 2596 of 802.11-2016
"21.3.17 VHT transmit specification
21.3.17.1 Transmit spectrum mask
NOTE 1—In the presence of additional regulatory restrictions, the device has to meet both the regulatory requirements and the mask defined in this subclause. NOTE 2—Transmit spectral mask figures in this subclause are not drawn to scale. NOTE 3—For rules regarding TX center frequency leakage levels, see 21.3.17.4.2. The spectral mask requirements in this subclause do not apply to the RF LO.
For a 20 MHz mask PPDU of non-HT, HT or VHT format, the interim transmit spectral mask shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth of 18 MHz, -20 dBr at 11 MHz frequency offset, -28 dBr at 20 MHz frequency offset, and -40 dBr at 30 MHz frequency offset and above. The interim transmit spectral mask for frequency offsets in between 9 and 11 MHz, 11 and 20 MHz, and 20 and 30 MHz shall be linearly interpolated in dB domain from the requirements for 9 MHz, 11 MHz, 20 MHz, and 30 MHz frequency offsets. The transmit spectrum shall not exceed the maximum of the interim transmit spectral mask and -53 dBm/MHz at any frequency offset. Figure 21-29 shows an example of the resulting overall spectral mask when the -40 dBr spectrum level is above -53 dBm/MHz.

