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 19 XR COMMUNICATIONS, LLC,
 20 dba VIVATO TECHNOLOGIES

21 **UNITED STATES DISTRICT COURT**
 22 **CENTRAL DISTRICT OF CALIFORNIA**

23 XR COMMUNICATIONS, LLC, dba
 24 VIVATO TECHNOLOGIES,

25 *Plaintiff,*

26 *v.*

27 BELKIN INTERNATIONAL, INC.,
 28 and LINKSYS USA, INC.

Defendants.

Case No. 8:2017-cv-00596

**FIRST AMENDED COMPLAINT
 FOR PATENT INFRINGEMENT**

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1 **I. JURISDICTION AND VENUE**

2 1. This is an action for patent infringement. This Court has subject matter
3 jurisdiction pursuant to 28 U.S.C. §§ 1331 and 1338(a) because this action arises
4 under the patent laws of the United States, 35 U.S.C. §§ 101 *et seq.*

5 **II. THE PARTIES**

6 2. Plaintiff XR Communications LLC d/b/a Vivato Technologies (“Vivato”
7 or “Plaintiff”) is a limited liability company organized and existing under the laws
8 of Delaware with its principal place of business at 2809 Ocean Front Walk, Venice,
9 California 90291. Vivato is the sole owner by assignment of all right, title, and
10 interest in each Asserted Patent.

11 3. Vivato was founded in 2000 as a \$80+ million venture-backed company
12 with several key innovators in the wireless communication field including Siavash
13 Alamouti, Ken Biba, William Crilly, James Brennan, Edward Casas, and Vahid
14 Tarokh, among many others. At that time, and as remains the case today, “Wi-Fi” or
15 “802.11” had become the ubiquitous means of wireless connection to the Internet,
16 integrated into hundreds of millions of mobile devices globally. Vivato was founded
17 to leverage its talent to generate intellectual property and deliver Wi-Fi/802.11
18 wireless connectivity solutions to service the growing demand for bandwidth.

19 4. Vivato has accomplished significant innovations in the field of wireless
20 communications technology. One area of focus at Vivato was the development of
21 advanced wireless systems with sophisticated antenna designs to improve wireless
22 speed, coverage, and reliability. Vivato also focused on designing wireless systems
23 that maximize the efficient use of spectrum and wireless resources for large numbers
24 of connected mobile devices.

25 5. Among many fundamental breakthroughs achieved by Vivato are
26 inventions that allow for intelligent and adaptive beamforming based on up-to-date
27 information about the wireless medium. Through these and many other inventions,
28 Vivato’s engineers pioneered a wireless technology that provides for simultaneous

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1 transmission and reception, a significant leap forward over conventional wireless
2 technology.

3 6. Over the years, Vivato has developed proven technology, with over 400
4 deployments globally, including private, public and government, and it has become
5 a recognized provider of extended range Wi-Fi network infrastructure solutions.
6 Vivato's wireless base stations integrate beamforming phased array antenna design
7 with packet steering technology to deliver high-bandwidth extended range
8 connections to serve multiple users and multiple devices

9 7. Vivato's patent portfolio includes over 17 issued patents and pending
10 patent applications. The patent at issue in this case are directed to specific aspects of
11 wireless communication, including adaptively steered antenna technology and beam
12 switching technology.

13 8. Belkin International, Inc. ("Belkin") is a corporation organized and
14 existing under the laws of Delaware with its principal place of business at 12045 E.
15 Waterfront Dr., Playa Vista, California 90094. Belkin has a registered agent for
16 service of process at National Registered Agents, Inc. 12045 E. Waterfront Dr.,
17 Playa Vista, California 90094. Vivato is informed and believes that Belkin's
18 activities relating to the Linksys branded products accused in this action are
19 conducted, controlled, and directed at the Linksys headquarters located at 121
20 Theory Drive, Irvine, CA 92617.

21 9. Linksys USA, Inc. ("Linksys") is a corporation organized and existing
22 under the laws of Delaware with its principal place of business at 121 Theory Drive,
23 Suite 200, Irvine, CA 92617. Linksys has a registered agent for service of process at
24 1505 Corporation CSC-Lawyers Incorporating Service, 2710 Gateway Oaks Dr.,
25 Sacramento, CA 95833.

26 10. This Court has personal jurisdiction over Belkin and Linksys (collectively,
27 "Defendants") because they each have their principal place of business in California.
28

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1 11. Venue is proper in this federal district pursuant to 28 U.S.C. §§ 1391(b)-
2 (d) and 1400(b) in that Defendants are subject to jurisdiction in this District, have
3 done business in this District, have regular and established places of business in this
4 District, have committed acts of infringement in this District, and continue to commit
5 acts of infringement in this District, entitling Plaintiff to relief.

6 **III. BACKGROUND OF THE TECHNOLOGY**

7 12. This complaint arises from Defendants’ unlawful infringement of the
8 following United States patent owned by Vivato, which generally relates to wireless
9 communications technology: United States Patent No. 10,594,376 (the “376 Patent”
10 or the “Asserted Patent”).

11 13. Countless electronic devices today connect to the Internet wirelessly.
12 Beyond just connecting our devices together, wireless networks have become an
13 inseparable part of our lives in our homes, our offices, and our neighborhood coffee
14 shops. In even our most crowded spaces, today’s wireless technology allows all of
15 us to communicate with each other, on our own devices, at virtually the same time.
16 Our connected world would be unrecognizable without the ubiquity of sophisticated
17 wireless networking technology.

18 14. Just a few decades ago, wireless technology of this kind could only be
19 found in science fiction. The underlying science behind wireless communications
20 can be traced back to the development of “wireless telegraphy” in the nineteenth
21 century. Guglielmo Marconi is credited with developing the first practical radio, and
22 in 1896, Guglielmo Marconi was awarded British patent 12039, Improvements in
23 transmitting electrical impulses and signals and in apparatus there-for, the first patent
24 to issue for a Herzian wave-based wireless telegraphic system. Marconi would go
25 on to win the Nobel Prize in Physics in 1909 for his contributions to the field.

26 15. One of Marconi’s preeminent contemporaries was Dr. Karl Ferdinand
27 Braun, who shared the 1909 Nobel Prize in Physics with Marconi. In his Nobel
28 lecture dated December 11, 1909, Braun explained that he was inspired to work on

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1 wireless technology by Marconi’s own experiments. Braun had observed that the
2 signal strength in Marconi’s radio was limited beyond a certain distance, and
3 wondered why increasing the voltage on Marconi’s radio did not result in a stronger
4 transmission at greater distances. Braun thus dedicated himself to developing
5 wireless devices with a stronger, more effective transmission capability.

6 16. In 1905, Braun invented the first phased array antenna. This phased array
7 antenna featured three antennas carefully positioned relative to one another with a
8 specific phase relationship so that the radio waves output from each antenna could
9 add together to increase radiation in a desired direction. This design allowed Braun’s
10 phased array antenna to transmit a directed signal.

11 17. Building on the fundamental breakthrough that radio transmissions can be
12 directed according to a specific radiation pattern through the use of a phased array
13 antenna, directed wireless communication technology has developed many
14 applications over the years. Braun’s invention of the phased array antenna led to the
15 development of radar, smart antennas, and, eventually, to a technology known as
16 “MIMO,” or “multiple-input, multiple-output,” which would ultimately allow a
17 single radio channel to receive and transmit multiple data signals simultaneously.
18 Along the way, engineers have worked tirelessly to overcome limitations and
19 roadblocks directed wireless communication technology.

20 18. At the beginning of the twenty-first century, the vast majority of wireless
21 networks still did not yet take advantage of directed wireless communications.
22 Instead, “omnidirectional” access points were ubiquitous. Omnidirectional access
23 points transmit radio waves uniformly around the access point in every direction and
24 do not steer the signal in particular directions. Omnidirectional antennas access
25 points do typically achieve 360 degrees of coverage around the access point, but
26 with a reduced coverage distance. Omnidirectional access points also lack
27 sophisticated approaches to overcome certain types of interference in the
28 environment. As only one example, the presence of solid obstructions, such as a

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1 concrete wall, ceiling, or pillar, can limit signal penetration. As another example,
2 interference arises when radio waves are reflected, refracted, or diffracted based on
3 obstacles present between the transmitter and receiver. The multiple paths that radio
4 waves can travel between the transmitter and receiver often result in signal
5 interference that decreases performance, and omnidirectional access points lack
6 advanced solutions to overcome these “multipath” effects.

7 19. Moving from omnidirectional networks to modern networks has required
8 an additional series of advancements that harness the capabilities of directed wireless
9 technology. These advancements range from conceiving various ways to steer and
10 modify radiation patterns, to enhancing the transmission signal power in a desired
11 direction, to suppressing radiation in undesired directions, to minimizing signal
12 “noise,” and then applying these new approaches into communications networks
13 with multiple, heterogenous transmitters and receivers.

14 20. Harnessing the capabilities of directed wireless technology resulted in a
15 significant leap forward in the signal strength, reliability, concurrent users, and/or
16 data transmission capability of a wireless network. One of the fundamental building
17 blocks of this latest transition was the development of improvements to MIMO and
18 “beamforming,” which are the subject matter of the patent in this infringement
19 action. The patent in this action resulted from the investment of tens of millions of
20 dollars and years of tireless effort by a group of engineers who built a technology
21 company slightly ahead of its time. Their patented innovations laid the groundwork
22 for today’s networks, and are infringed by Defendants’ accused products.

23 **IV. COUNT ONE: INFRINGEMENT OF UNITED STATES**
24 **PATENT NO. 10,594,376**

25 21. Vivato realleges and incorporates by reference the foregoing paragraphs as
26 if fully set forth herein.

27 22. On March 17, 2020, United States Patent No. 10,594,376 (“the ’376
28 Patent”) was duly and legally issued for inventions entitled “Directed Wireless

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1 Communication.” Vivato owns the ’376 Patent and holds the right to sue and recover
2 damages for infringement thereof. A copy of the ’376 Patent is attached hereto as
3 Exhibit B.

4 23. Defendants have directly infringed and continue to directly infringe
5 numerous claims of the ’376 Patent, including at least claim 1, by manufacturing,
6 using, selling, offering to sell, and/or importing into the United States Wi-Fi 6 access
7 points and routers supporting MU-MIMO, including without limitation access points
8 and routers utilizing the IEEE 802.11ax / “Wi-Fi 6” standard, and/or the IEEE
9 802.11ac standard because WiFi 6 is backward compatible (*e.g.*, Defendants’ Belkin
10 brand RT1800 and RT3200 routers; Defendants’ Linksys brand LAPAC1300C,
11 LAPAC1300CE, and LAPAC2600C business access points; Defendants’ Linksys
12 brand MX12600, MX8503, MX4200, MX5 Velop AX, MX10 Velop AX,
13 WHW0303, WHW0302, WHW0302B, WHW0103, WHW0102, WHW0301, and
14 WHW0101 mesh WiFi systems; Defendants’ Linksys brand MR9600, MR9000,
15 MR8300, MR7500, MR7350, MR6350, EA8300, EA8100, EA7450, E7350,
16 EA7300, EA7200, E8450, E5600, and EA7500 wireless routers; and Defendants’
17 Linksys brand RE7350, WHW010P, RE9000, and RE7000 WiFi extenders)
18 (collectively, the “’376 Accused Products”). Defendants are liable for infringement
19 of the ’376 Patent pursuant to 35 U.S.C. § 271(a).

20 24. The ’376 Accused Products satisfy all claim limitations of numerous
21 claims of the ’376 Patent, including Claim 1. The following paragraphs compare
22 limitations of Claim 1 to an exemplary ’376 Accused Product, the Linksys Dual-
23 Band Mesh WiFi 6 Router (MR9600).

24 25. Each of the ’376 Accused Products comprises a data-communications
25 networking apparatus. For example, the Linksys Dual-Band Mesh WiFi 6 Router
26 (MR9600) is a data-communications networking apparatus. *See, e.g.*, Linksys Dual-
27 Band Mesh WiFi 6 Router (MR9600) Webpage, which explains that the Linksys
28 MR9600 includes “Dual-Band (2.4GHz + 5 GHz), 4x4 WiFi 6,” “4x4 MU-MIMO,”

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1 “2.4 and 5GHz (Simultaneous Dual-Band)” Wi-Fi Bands, “OFDMA technology,”
2 “4x external adjustable antennas,” with a “1.8 GHz Quad Core Processor,”
3 supporting the “WiFi 5 (802.11ac)” and “WiFi 6 (802.11ax)” standards.
4 Additionally, the MR9600 provides “More Capacity to More Devices” because
5 “WiFi 6 sends and receives multiple streams of data simultaneously, providing up
6 to 4x more WiFi capacity to handle every ... device on your network” and also
7 “Minimizes Wi-Fi Congestion” by “Eliminate[ing] interference from neighboring
8 networks with advanced WiFi 6 technology that can isolate your network, reduce
9 congestion and deliver the strongest, clearest WiFi signal available.” *See also*
10 Linksys’ support page *Getting to know the Linksys MR9600 Max-Stream™ Dual-*
11 *Band WiFi 6 Router*, indicating: “The Linksys MR9600... delivers true Gigabit
12 speeds of up to 6 Gbps with eight-stream capacity throughout the entire home,” and
13 includes a “1.8 GHz quad-core CPU,” “4x4 spatial streams,” “MU-MIMO,” “Next-
14 generation Orthogonal Frequency-Division Multiple Access (OFDMA)
15 technology,” “Four adjustable antennas,” and “Supports 802.11ax.” *See also*
16 Linksys’ *What is AX?* Webpage, stating: “Thanks to 11AX, multiple devices can
17 simultaneously transmit data, using the same radio frequency and the same
18 network,” and that 11AX is “Up to eight times faster than non-MU-MIMO products
19 thanks to up link and down line (DL/UL) MU-MIMO.” *See also* Linksys’ *What is*
20 *MU-MIMO and Why Do You Need It?* Webpage,¹ stating: “Multi-user, multiple-
21 input, multiple-output technology—better known as MU-MIMO (a.k.a. Next-Gen
22 AC or AC Wave 2)—allows a Wi-Fi router to communicate with multiple devices
23 simultaneously... increases the capacity and efficiency of your router... allowing it
24 to handle more WiFi-intensive activities such as streaming and gaming.”

25 26. Each of the ’376 Accused Products comprises a processor configured to
26 generate a probing signal for transmission to at least a first client device and a second
27

28 ¹ Linksys’ *What is MU-MIMO?* Webpage is available at Defendants’ website:
<https://www.linksys.com/us/r/what-is-mu-mimo/> (last visited June 8, 2021).

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1 client device. For example, as with each '376 Accused Product, the Linksys Dual-
2 Band Mesh WiFi 6 Router (MR9600) has at least one processor (e.g., one or more
3 central processing units (CPUs), Wi-Fi processors, a baseband processor in the Wi-
4 Fi 6 radio, as examples) for generating signals for transmission. *See, e.g.,* Linksys
5 Dual-Band Mesh WiFi 6 Router (MR9600) Webpage, which explains that the
6 Linksys MR9600 includes “Dual-Band (2.4GHz + 5 GHz), 4x4 WiFi 6,” “4x4 MU-
7 MIMO,” “2.4 and 5GHz (Simultaneous Dual-Band)” Wi-Fi Bands, “OFDMA
8 technology,” “4x external adjustable antennas,” with a “1.8 GHz Quad Core
9 Processor,” supporting the “WiFi 5 (802.11ac)” and “WiFi 6 (802.11ax)” standards.
10 Additionally, the MR9600 provides “More Capacity to More Devices” because
11 “WiFi 6 sends and receives multiple streams of data simultaneously, providing up
12 to 4x more WiFi capacity to handle every... device on your network” and also
13 “Minimizes Wi-Fi Congestion” by “Eliminate[ing] interference from neighboring
14 networks with advanced WiFi 6 technology that can isolate your network, reduce
15 congestion and deliver the strongest, clearest WiFi signal available.” *See also*
16 Linksys’ support page *Getting to know the Linksys MR9600 Max-Stream™ Dual-*
17 *Band WiFi 6 Router*, indicating: “The Linksys MR9600... delivers true Gigabit
18 speeds of up to 6 Gbps with eight-stream capacity throughout the entire home,” and
19 includes a “1.8 GHz quad-core CPU,” “4x4 spatial streams,” “MU-MIMO,” “Next-
20 generation Orthogonal Frequency-Division Multiple Access (OFDMA)
21 technology,” “Four adjustable antennas,” and “Supports 802.11ax.” *See also*
22 Linksys’ *What is AX?* Webpage, stating: “Thanks to 11AX, multiple devices can
23 simultaneously transmit data, using the same radio frequency and the same
24 network,” and that 11AX is “Up to eight times faster than non-MU-MIMO products
25 thanks to up link and down line (DL/UL) MU-MIMO.” *See also* Linksys’ *What is*
26 *MU-MIMO and Why Do You Need It?* Webpage, stating: “Multi-user, multiple-
27 input, multiple-output technology—better known as MU-MIMO (a.k.a. Next-Gen
28 AC or AC Wave 2)—allows a Wi-Fi router to communicate with multiple devices

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1 simultaneously... increases the capacity and efficiency of your router... allowing it
2 to handle more WiFi-intensive activities such as streaming and gaming.” For a
3 further example, as with each ’376 Accused Product, the Linksys Dual-Band Mesh
4 WiFi 6 Router (MR9600) generates a probing signal for transmission (*e.g.*, a probing
5 signal transmission that triggers or elicits a responsive transmission from each of a
6 first client device and a second client device, such as NDP Announcement, HE
7 sounding NDP, Beamforming Report trigger frames pursuant to High Efficiency
8 (HE) channel sounding, including preamble training fields allowing an estimate of
9 the channel for MU-MIMO) to at least a first client device and a second client device
10 (*e.g.*, a first non-AP STA / HE beamformee and a second non-AP STA / HE
11 beamformee). *See, e.g.*, 802.11ax Standard, Sections 9.3.1.19, 9.3.1.22, 9.3.1.22.3,
12 9.4.1.64, 9.4.1.65, 9.4.1.66, 9.4.1.67, 9.6.31.2, 10.37, 26.7, 26.7.1, 26.7.2, 26.7.3,
13 26.7.4, 26.7.5, 27.1.1. *See, e.g.*, Section 26.7 (HE sounding protocol) (“Transmit
14 beamforming and DL MU-MIMO require knowledge of the channel state to
15 compute a steering matrix that is applied to the transmit signal to optimize reception
16 at one or more receivers. HE STAs use the HE sounding protocol to determine the
17 channel state information. The HE sounding protocol provides explicit feedback
18 mechanisms, defined as HE non-trigger-based (non-TB) sounding and HE trigger-
19 based (TB) sounding, where the HE beamformee measures the channel using a
20 training signal (*i.e.*, an HE sounding NDP) transmitted by the HE beamformer and
21 sends back a transformed estimate of the channel state. The HE beamformer uses
22 this estimate to derive the steering matrix. The HE beamformee returns an estimate
23 of the channel state in an HE compressed beamforming/CQI report carried in one or
24 more HE Compressed Beamforming/CQI frames.”); Section 26.7.3, Figures 26-6
25 and 26-7:

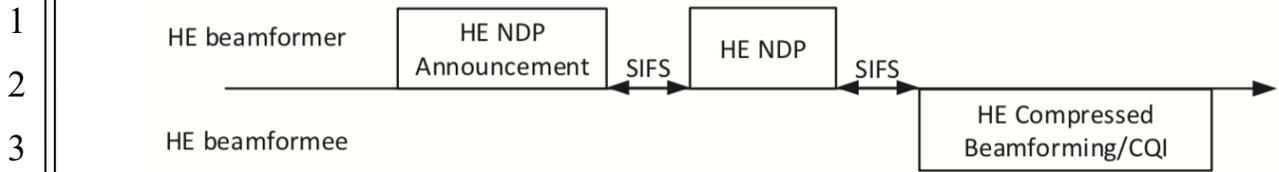


Figure 26-6—An example of the sounding protocol with a single HE beamformee

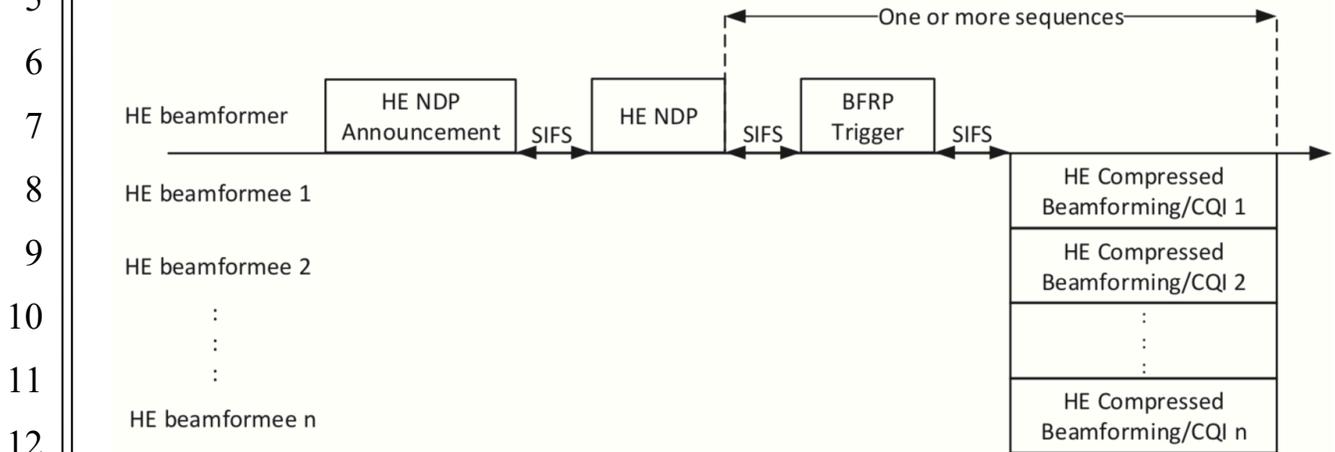


Figure 26-7—An example of the sounding protocol with more than one HE beamformee

; Section 26.7.3 (“An HE beamformee that receives an HE NDP Announcement frame from an HE beamformer with which it is associated and that contains the HE beamformee’s MAC address in the RA field and also receives an HE sounding NDP a SIFS after the HE NDP Announcement frame shall transmit its HE compressed beamforming/CQI report a SIFS after the HE sounding NDP. The TXVECTOR parameter CH_BANDWIDTH for the PPDU containing the HE compressed beamforming/CQI report shall be set to indicate a bandwidth not wider than that indicated by the RXVECTOR parameter CH_BANDWIDTH of the HE sounding NDP. An HE beamformee that receives an HE NDP Announcement frame as part of an HE TB sounding sequence with a STA Info field addressed to it soliciting SU or MU feedback shall generate an HE compressed beamforming/CQI report using the feedback type, N_g and codebook size indicated in the STA Info field. If the HE beamformee then receives a BFRP Trigger frame with a User Info field addressed to it, the HE beamformee transmits an HE TB PPDU containing the HE compressed beamforming/CQI report following the rules defined in 26.5.3.3 (Non-AP STA

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1 behavior for UL MU operation.”); Section 26.5.3 (UL MU operation) (“UL MU
2 operation allows an AP to solicit simultaneous immediate response frames from one
3 or more non-AP HE STAs”); Section 27.3.10.10 (HE-LTF) (“The HE-LTF field
4 provides a means for the receiver to estimate the MIMO channel between the set of
5 constellation mapper outputs (or, if STBC is applied, the STBC encoder outputs)
6 and the receive chains. In an HE SU PPDU and HE ER SU PPDU, the transmitter
7 provides training for N_{STS} space-time streams (spatial mapper inputs) used for the
8 transmission of the PSDU. In an HE MU PPDU, the transmitter provides training
9 for $N_{STS,r,total}$ space-time streams used for the transmission of the PSDU(s) in the r -th
10 RU. In an HE TB PPDU, the transmitter of user u in the r -th RU provides training
11 for $N_{STS,r,u}$ space-time streams used for the transmission of the PSDU. For each tone
12 in the r -th RU, the MIMO channel that can be estimated is an $N_{RX} \times N_{STS,r,total}$ matrix.
13 An HE transmission has a preamble that contains HE-LTF symbols, where the data
14 tones of each HE-LTF symbol are multiplied by entries belonging to a matrix P_{HE-}
15 LTF , to enable channel estimation at the receiver.... In an HE SU PPDU, HE MU
16 PPDU and HE ER SU PPDU, the combination of HE-LTF type and GI duration is
17 indicated in HE-SIG-A field. In an HE TB PPDU, the combination of HE-LTF type
18 and GI duration is indicated in the Trigger frame that triggers transmission of the
19 PPDU. If an HE PPDU is an HE sounding NDP, the combinations of HE-LTF types
20 and GI durations are listed in 27.3.18 (Transmit specification). If an HE PPDU is an
21 HE TB feedback NDP, the combination of HE-LTF types and GI durations are listed
22 in 27.3.4 (HE PPDU formats.”); Section 27.3.15.1 (SU-MIMO and DL-MIMO
23 beamforming) (“The DL MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user,r}-1}]$
24 can be detected by the beamformer using the beamforming feedback for subcarrier
25 k from beamformee u , where $u = 0, 1, \dots, N_{user,r} - 1$. The feedback report format is
26 described in 9.4.1.65 (HE Compressed Beamforming Report field) and 9.4.1.66 (HE
27 MU Exclusive Beamforming Report field). The steering matrix that is computed (or
28 updated) using new beamforming feedback from some or all of participating

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1 beamformees might replace the existing steering matrix Q_k for the next DL MU-
2 MIMO data transmission. For SU-MIMO beamforming, the steering matrix Q_k can
3 be determined from the beamforming feedback matrix V_k that is sent back to the
4 beamformer by the beamformee using the compressed beamforming feedback
5 matrix format as defined in 19.3.12.3.6 (Compressed beamforming feedback
6 matrix). The feedback report format is described in 9.4.1.65 (HE Compressed
7 Beamforming Report field.”). Section 9.4.1.65 (HE Compressed Beamforming
8 Report field) (“The HE Compressed Beamforming Report field carries the average
9 SNR of each space-time stream and compressed beamforming feedback matrices V
10 for use by a transmit beamformer to determine steering matrices Q , as described in
11 10.32.3 (Explicit feedback beamforming) and 19.3.12.3 (Explicit feedback
12 beamforming”); Section 9.1.4.66 (HE MU Exclusive Beamforming Report field)
13 (“The HE MU Exclusive Beamforming Report field carries explicit feedback in the
14 form of delta SNRs. The information in the HE Compressed Beamforming Report
15 field and the HE MU Exclusive Beamforming Report field can be used by the
16 transmit MU beamformer to determine the steering matrices Q , as described in
17 27.3.3.1 (DL MU-MIMO)”); Section 9.4.1.67 (HE CQI Report Field) (“The HE CQI
18 Report field carries the per-RU average SNRs of each space-time stream, where each
19 per-RU average SNR is the arithmetic mean of the SNR in decibels over a 26-tone
20 RU for which the feedback is being requested.”). For a further example, as with each
21 ’376 Accused Product, the Linksys Dual-Band Mesh WiFi 6 Router (MR9600)
22 generates a probing signal for transmission (e.g., a probing signal transmission that
23 triggers or elicits a responsive transmission from each of a first client device and a
24 second client device, such as NDP Announcement pursuant to Very High
25 Throughput (VHT) channel sounding, including preamble training fields allowing
26 an estimate of the channel for MU-MIMO) to at least a first client device and a
27 second client device (e.g., a first non-AP STA / VHT beamformee and a second non-
28 AP STA / VHT beamformee). *See, e.g.*, 802.11ac Standard Clause 9.31.5.2 (“A VHT

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1 beamformer shall initiate a sounding feedback sequence by transmitting a VHT NDP
2 Announcement frame followed by a VHT NDP after a SIFS. The VHT beamformer
3 shall include in the VHT NDP Announcement frame one STA Info field for each
4 VHT beamformee that is expected to prepare VHT Compressed Beamforming
5 feedback and shall identify the VHT beamformee by including the VHT
6 beamformee's AID in the AID subfield of the STA Info field. The VHT NDP
7 Announcement frame shall include at least one STA Info field.”); *id.* (“A non-AP
8 VHT beamformee that receives a VHT NDP Announcement frame... shall transmit
9 its VHT Compressed Beamforming feedback a SIFS after receiving a Beamforming
10 Report Poll with RA matching its MAC address and a non-bandwidth signaling TA
11 obtained from the TA field matching the MAC address of the VHT beamformer.”);
12 *id.* Clause 8.5.23.2 (defining format and subfields within the VHT Compressed
13 Beamforming frame); *id.* Clause 8.4.1.48 (including Tables 8-53(d)-(h)) (“Each
14 SNR value per tone in stream i (before being averaged) corresponds to the SNR
15 associated with the column i of the beamforming feedback matrix V determined at
16 the beamformee”); *id.* Clause 8.4.1.49 (including Table 8-53i – MU Exclusive
17 Beamforming Report information); *id.* Clauses 8.4.1.24, 9.31.5.1, 9.31.5.2; *id.*

18 Clause 22.3.8.3.5; *id.* Clause 22.3.11.2:

19 Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in
20 Table 22-11 from the measured channel before computing a set of matrices for feedback to the beamformer.
21 The beamforming feedback matrix, $V_{k,u}$, found by the beamformee u for subcarrier k shall be compressed in
22 the form of angles using the method described in 20.3.12.3.6. The angles, $\phi(k,u)$ and $\psi(k,u)$, are quantized
23 according to Table 8-53e. The number of bits for quantization is chosen by the beamformee, based on the
24 indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DL-
25 MU-MIMO beamforming. The compressed beamforming feedback using 20.3.12.3.6 is the only Clause 22
26 beamforming feedback format defined.

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

29 After receiving the angle information, $\phi(k,u)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation
30 (20-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering
31 matrix Q_k . For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix
32 $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user}-1}]$ using $V_{k,u}$ and $SNR_{k,u}$ ($0 \leq u \leq N_{user} - 1$) in order to suppress crosstalk
33 between participating beamformees. The method used by the beamformer to calculate the steering matrix Q_k
34 is implementation specific.

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1 27. Each of the '376 Accused Products comprises a processor configured to
2 generate a first data stream for transmission to the first client device and generate a
3 second data stream for transmission to the second client device. For example, as with
4 each Accused Product, the Linksys Dual-Band Mesh WiFi 6 Router (MR9600) has
5 at least one processor and Wi-Fi 6 radio functionality (e.g., the CPU(s) and/or Wi-
6 Fi processors and/or baseband processor(s) in the Wi-Fi 6 radio) configured to
7 generate a first data stream for transmission to the first client device (“non-AP STA”
8 or “non-Access Point Station”) and a second data stream for transmission to a second
9 client device (non-AP STA) pursuant to MU-MIMO transmissions. *See, e.g.,*
10 Linksys Dual-Band Mesh WiFi 6 Router (MR9600) Webpage, which explains that
11 the Linksys MR9600 includes “Dual-Band (2.4GHz + 5 GHz), 4x4 WiFi 6,” “4x4
12 MU-MIMO,” “2.4 and 5GHz (Simultaneous Dual-Band)” Wi-Fi Bands, “OFDMA
13 technology,” “4x external adjustable antennas,” with a “1.8 GHz Quad Core
14 Processor,” supporting the “WiFi 5 (802.11ac)” and “WiFi 6 (802.11ax)” standards.
15 Additionally, the MR9600 provides “More Capacity to More Devices” because
16 “WiFi 6 sends and receives multiple streams of data simultaneously, providing up
17 to 4x more WiFi capacity to handle every ... device on your network” and also
18 “Minimizes Wi-Fi Congestion” by “Eliminate[ing] interference from neighboring
19 networks with advanced WiFi 6 technology that can isolate your network, reduce
20 congestion and deliver the strongest, clearest WiFi signal available.” *See also*
21 Linksys’ support page *Getting to know the Linksys MR9600 Max-Stream™ Dual-*
22 *Band WiFi 6 Router*, indicating: “The Linksys MR9600... delivers true Gigabit
23 speeds of up to 6 Gbps with eight-stream capacity throughout the entire home,” and
24 includes a “1.8 GHz quad-core CPU,” “4x4 spatial streams,” “MU-MIMO,” “Next-
25 generation Orthogonal Frequency-Division Multiple Access (OFDMA)
26 technology,” “Four adjustable antennas,” and “Supports 802.11ax.” *See also*
27 Linksys’ *What is AX?* Webpage, stating: “Thanks to 11AX, multiple devices can
28 simultaneously transmit data, using the same radio frequency and the same

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1 network,” and that 11AX is “Up to eight times faster than non-MU-MIMO products
2 thanks to up link and down line (DL/UL) MU-MIMO.” *See also* Linksys’ *What is*
3 *MU-MIMO and Why Do You Need It?* Webpage, stating: “Multi-user, multiple-
4 input, multiple-output technology—better known as MU-MIMO (a.k.a. Next-Gen
5 AC or AC Wave 2)—allows a Wi-Fi router to communicate with multiple devices
6 simultaneously ... increases the capacity and efficiency of your router... allowing it
7 to handle more WiFi-intensive activities such as streaming and gaming.” *See, e.g.,*
8 IEEE 802.11ax Standard, at Sections 26.5, 26.5.1, 26.5.2, 26.5.3, 27.1.1, 27.3.1,
9 27.3.2.5, 27.3.2.6, 27.3.5, 27.3.6.11.4, 27.3.10.7, 27.3.10.8, 27.3.10.9, 27.3.15,
10 including Tables 27-19, 27-20, 27-21, 27-24, 27-25, 27-26, 27-27, 27-28, 27-29,
11 Figures 27-19, 27-20, and other transmitter block diagrams for MU-MIMO
12 transmission. *See, e.g.,* Section 27.1.1 (“The HE PHY extends the maximum number
13 of users supported for DL MU-MIMO transmissions up to 8 users per resource unit
14 (RU) and provides support for DL and UL orthogonal frequency division multiple
15 access (OFDMA) as well as for UL MU-MIMO. Both DL and UL MU-MIMO
16 transmissions are supported on portions of the PPDU bandwidth (on resource units
17 greater than or equal to 106 tones). In an MU-MIMO resource unit, there is support
18 for up to 8 users with up to 4 space-time streams per user with the total not exceeding
19 8 space-time streams”); Section 27.3.1.1 (“DL MU transmission allows an AP to
20 simultaneously transmit information to more than one non-AP STA. For a DL MU
21 transmission, the AP uses the HE MU PPDU format and employs either DL
22 OFDMA, DL MU-MIMO, or a mixture of both.”); Section 27.3.10.8.1 (“The HE-
23 SIG-B field provides the OFDMA and DL MU-MIMO resource allocation
24 information to allow the STAs to look up the corresponding resources to be used in
25 the data portion of the frame.”); Section 27.3.2.5 (“If there is more than one User
26 field (see Table 27-28 (User field for an MU-MIMO allocation)) for an RU in the
27 HE-SIG-B content channel, then the number of allocated spatial streams for each
28 user in the RU is indicated by the Spatial Configuration field of the User field in HE-

1 SIG-B...In each HE-SIG-B content channel, the User fields are first ordered in the
 2 order of RUs (from lower frequency to higher frequency) as described by the RU
 3 Allocation field if the HE-SIG-B contains the Common field. If an RU has multiple
 4 User fields in an HE-SIG-B content channel, the User fields of the RU are ordered
 5 in the order of spatial stream index, from lower to higher spatial stream, as indicated
 6 in the Spatial Configuration field. The STA-ID field in each User field indicates the
 7 intended recipient user of the corresponding spatial streams and the RU.”); *See, e.g.*,
 8 IEEE 802.11ax Standard, Section 27.3.5 (Transmitter block diagram), at, *e.g.*, Figure
 9 27-19:

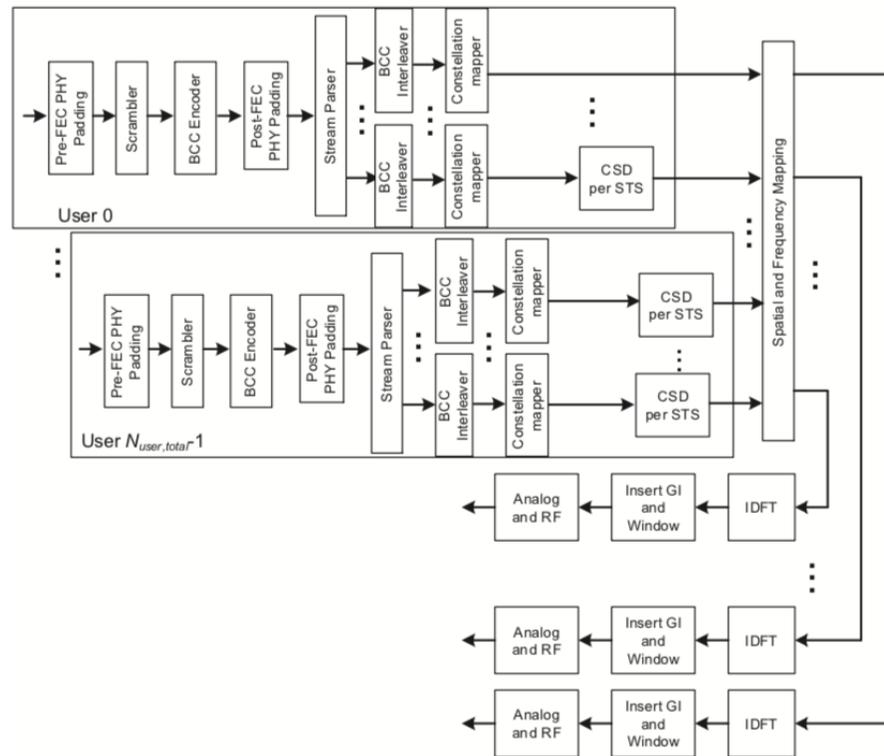


Figure 27-19—Transmitter block diagram for the Data field of an HE DL MU-MIMO transmission in a 106-, 242-, 484- or 996-tone RU with BCC encoding

See, e.g., Section 27.3.6.11.4 – 27.3.7:

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1 **27.3.6.11.4 Combining to form an HE MU PPDU**

2 The per user data is combined as follows:

- 3 a) Spatial mapping: The Q matrix is applied as described in 27.3.11.14 (OFDM modulation). The combining of all user data of an RU is done in this block.
- 4 b) IDFT: Compute the inverse discrete Fourier transform.
- 5 c) Insert GI and apply windowing: Prepend a GI determined by the TXVECTOR parameter GI_TYPE and apply windowing as described in 27.3.9 (Mathematical description of signals).
- 6 d) Analog and RF: Upconvert the resulting complex baseband waveform with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to 27.3.9 (Mathematical description of signals) and 27.3.10 (HE preamble) for details.

7 **27.3.7 HE modulation and coding schemes (HE-MCSs)**

8 The HE-MCS is a compact representation of the modulation and coding used in the Data field of the PPDU. For an HE SU PPDU and an HE ER SU PPDU it is carried in the HE-SIG-A field. For an HE MU PPDU it is carried per user in the User Specific field of the HE-SIG-B field. For an HE TB PPDU, it is carried in the User Info field of the Trigger frame soliciting the HE TB PPDU.

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10
11 For a further example, as with each Accused Product, the Linksys Dual-Band Mesh
12 WiFi 6 Router (MR9600) has at least one processor and Wi-Fi radio functionality
13 (e.g., the CPU and/or baseband processor(s) in the Wi-Fi radio) configured to
14 generate a first data stream for transmission to the first client device (“non-AP STA”
15 or “non-Access Point Station”) and a second data stream for transmission to a second
16 client device (non-AP STA) pursuant to MU-MIMO transmissions. *See, e.g.,*
17 802.11ac Standard Clause 9.31.5.1 (“Transmit beamforming and DL-MU-MIMO
18 require knowledge of the channel state to compute a steering matrix that is applied
19 to the transmitted signal to optimize reception at one or more receivers. The STA
20 transmitting using the steering matrix is called the VHT beamformer and a STA for
21 which reception is optimized is called a VHT beamformee. An explicit feedback
22 mechanism is used where the VHT beamformee directly measures the channel from
23 the training symbols transmitted by the VHT beamformer and sends back a
24 transformed estimate of the channel state to the VHT beamformer. The VHT
25 beamformer then uses this estimate, perhaps combining estimates from multiple
26 VHT beamformees, to derive the steering matrix.”); *id.* Clauses 22.3.4.6(d),
27 22.3.4.7(e), 22.3.4.8(l), 22.3.4.9.1(m), 22.3.4.9.2(m), 22.3.4.10.4(a) (“Spatial
28 mapping: Apply the Q matrix as described in 22.3.10.11.1.”); *id.* Clause

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1 22.3.10.11.1; IEEE 802.11-2012 Standard Clause 20.3.12.3.6; 802.11ac Standard
2 Clauses 8.4.1.24, 9.31.5.1, 9.31.5.2; *id.* Clause 22.3.11.1, 22.3.11.2.

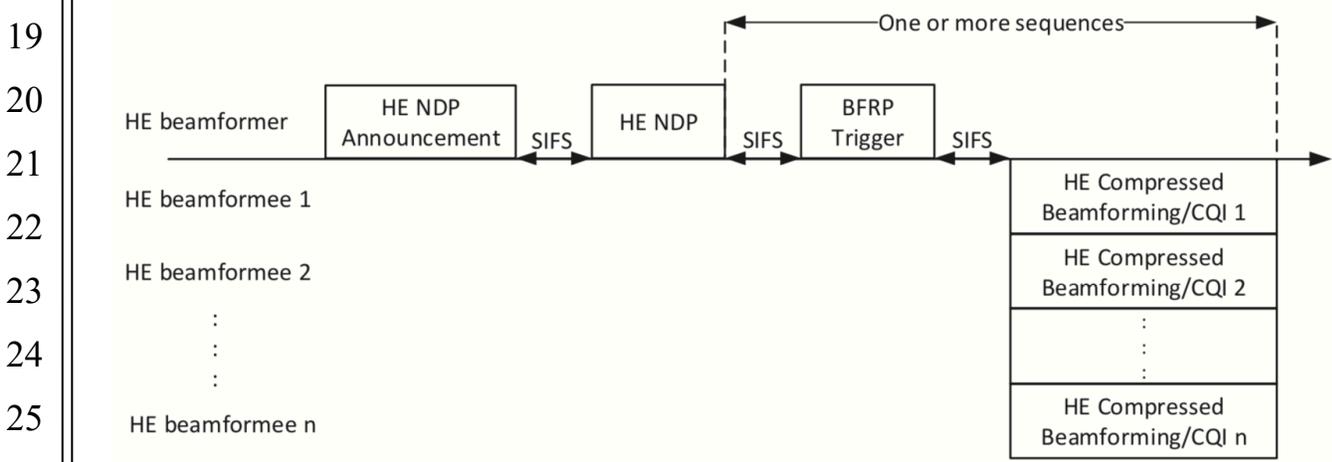
3 28. Each of the '376 Accused Products comprises a transceiver operatively
4 coupled to the processor and configured to: transmit the probing signal to at least the
5 first client device and the second client device via a smart antenna; wherein the smart
6 antenna is operatively coupled to the transceiver and comprises a first antenna
7 element and a second antenna element. For example, as with each '376 Accused
8 Product, the Linksys Dual-Band Mesh WiFi 6 Router (MR9600) has a Wi-Fi 6 radio
9 with a transceiver operatively coupled to the processor (*e.g.*, the Wi-Fi 6 radio
10 generates signals for transmission and processes received signals with, *e.g.*, the CPU,
11 Wi-Fi processors, and/or baseband processor in the Wi-Fi 6 radio, and the radio
12 comprises a transceiver that transmits and receives signals via a smart antenna); and,
13 as with each '376 Accused Product, the Linksys Dual-Band Mesh WiFi 6 Router
14 (MR9600) has a Wi-Fi 6 radio transceiver operatively coupled to the processor and
15 to a smart antenna, wherein the smart antenna is operatively coupled to the Wi-Fi 6
16 radio and comprises a first antenna element and a second antenna element. *See, e.g.*,
17 Linksys Dual-Band Mesh WiFi 6 Router (MR9600) Webpage, which explains that
18 the Linksys MR9600 includes “Dual-Band (2.4GHz + 5 GHz), 4x4 WiFi 6,” “4x4
19 MU-MIMO,” “2.4 and 5GHz (Simultaneous Dual-Band)” Wi-Fi Bands, “OFDMA
20 technology,” “4x external adjustable antennas,” with a “1.8 GHz Quad Core
21 Processor,” supporting the “WiFi 5 (802.11ac)” and “WiFi 6 (802.11ax)” standards.
22 Additionally, the MR9600 provides “More Capacity to More Devices” because
23 “WiFi 6 sends and receives multiple streams of data simultaneously, providing up
24 to 4x more WiFi capacity to handle every... device on your network” and also
25 “Minimizes Wi-Fi Congestion” by “Eliminate[ing] interference from neighboring
26 networks with advanced WiFi 6 technology that can isolate your network, reduce
27 congestion and deliver the strongest, clearest WiFi signal available.” *See also*
28 Linksys’ support page *Getting to know the Linksys MR9600 Max-Stream™ Dual-*

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1 *Band WiFi 6 Router*, indicating: “The Linksys MR9600... delivers true Gigabit
2 speeds of up to 6 Gbps with eight-stream capacity throughout the entire home,” and
3 includes a “1.8 GHz quad-core CPU,” “4x4 spatial streams,” “MU-MIMO,” “Next-
4 generation Orthogonal Frequency-Division Multiple Access (OFDMA)
5 technology,” “Four adjustable antennas,” and “Supports 802.11ax.” *See also*
6 Linksys’ *What is AX?* Webpage, stating: “Thanks to 11AX, multiple devices can
7 simultaneously transmit data, using the same radio frequency and the same
8 network,” and that 11AX is “Up to eight times faster than non-MU-MIMO products
9 thanks to up link and down line (DL/UL) MU-MIMO.” *See also* Linksys’ *What is*
10 *MU-MIMO and Why Do You Need It?* Webpage, stating: “Multi-user, multiple-
11 input, multiple-output technology—better known as MU-MIMO (a.k.a. Next-Gen
12 AC or AC Wave 2)—allows a Wi-Fi router to communicate with multiple devices
13 simultaneously ... increases the capacity and efficiency of your router ... allowing
14 it to handle more WiFi-intensive activities such as streaming and gaming.” For a
15 further example, as with each ’376 Accused Product, the Linksys Dual-Band Mesh
16 WiFi 6 Router (MR9600) transmits the probing signal (*e.g.*, a probing signal
17 transmission that triggers or elicits a responsive transmission from each of a first
18 client device and a second client device, such as NDP Announcement, HE sounding
19 NDP, Beamforming Report trigger frames pursuant to High Efficiency (HE) channel
20 sounding, including preamble training fields allowing an estimate of the channel for
21 MU-MIMO) to at least the first client device and the second client device (*e.g.*, the
22 first non-AP STA and the second non-AP STA) via the smart antenna. *See, e.g.*,
23 802.11ax Standard, Sections 9.3.1.19, 9.3.1.22, 9.3.1.22.3, 9.4.1.64, 9.4.1.65,
24 9.4.1.66, 9.4.1.67, 9.6.31.2, 10.37, 26.7, 26.7.1, 26.7.2, 26.7.3, 26.7.4, 26.7.5, 27.1.1.
25 *See, e.g.*, Section 26.7.5 (HE sounding NDP transmission) (setting forth
26 TXVECTOR parameters for HE sounding NDP); Section 27.3.10.10 (HE-LTF)
27 (“The HE-LTF field provides a means for the receiver to estimate the MIMO channel
28 between the set of constellation mapper outputs (or, if STBC is applied, the STBC

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1 encoder outputs) and the receive chains. In an HE SU PPDU and HE ER SU PPDU,
 2 the transmitter provides training for N_{STS} space-time streams (spatial mapper inputs)
 3 used for the transmission of the PSDU. In an HE MU PPDU, the transmitter provides
 4 training for $N_{STS,r,total}$ space-time streams used for the transmission of the PSDU(s)
 5 in the r -th RU. In an HE TB PPDU, the transmitter of user u in the r -th RU provides
 6 training for $N_{STS,r,u}$ space-time streams used for the transmission of the PSDU. For
 7 each tone in the r -th RU, the MIMO channel that can be estimated is an $N_{RX} \times$
 8 $N_{STS,r,total}$ matrix. An HE transmission has a preamble that contains HE-LTF symbols,
 9 where the data tones of each HE-LTF symbol are multiplied by entries belonging to
 10 a matrix P_{HE-LTF} , to enable channel estimation at the receiver.... In an HE SU PPDU,
 11 HE MU PPDU and HE ER SU PPDU, the combination of HE-LTF type and GI
 12 duration is indicated in HE-SIG-A field. In an HE TB PPDU, the combination of
 13 HE-LTF type and GI duration is indicated in the Trigger frame that triggers
 14 transmission of the PPDU. If an HE PPDU is an HE sounding NDP, the
 15 combinations of HE-LTF types and GI durations are listed in 27.3.18 (Transmit
 16 specification). If an HE PPDU is an HE TB feedback NDP, the combination of HE-
 17 LTF types and GI durations are listed in 27.3.4 (HE PDU formats.”). See, e.g.,
 18 Section 26.7.3, Figure 26-7:



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Figure 26-7—An example of the sounding protocol with more than one HE beamformee
 27 ; Section 9.4.1.65 (HE Compressed Beamforming Report field) (“The HE
 28 Compressed Beamforming Report field carries the average SNR of each space-time

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1 stream and compressed beamforming feedback matrices V for use by a transmit
2 beamformer to determine steering matrices Q , as described in 10.32.3 (Explicit
3 feedback beamforming) and 19.3.12.3 (Explicit feedback beamforming)"); Section
4 9.1.4.66 (HE MU Exclusive Beamforming Report field) ("The HE MU Exclusive
5 Beamforming Report field carries explicit feedback in the form of delta SNRs. The
6 information in the HE Compressed Beamforming Report field and the HE MU
7 Exclusive Beamforming Report field can be used by the transmit MU beamformer
8 to determine the steering matrices Q , as described in 27.3.3.1 (DL MU-MIMO)");
9 Section 9.4.1.67 (HE CQI Report Field) ("The HE CQI Report field carries the per-
10 RU average SNRs of each space-time stream, where each per-RU average SNR is
11 the arithmetic mean of the SNR in decibels over a 26-tone RU for which the feedback
12 is being requested."). *See, e.g.*, 802.11ac Standard Clause 9.31.5.2 ("A VHT
13 beamformer shall initiate a sounding feedback sequence by transmitting a VHT NDP
14 Announcement frame followed by a VHT NDP after a SIFS. The VHT beamformer
15 shall include in the VHT NDP Announcement frame one STA Info field for each
16 VHT beamformee that is expected to prepare VHT Compressed Beamforming
17 feedback and shall identify the VHT beamformee by including the VHT
18 beamformee's AID in the AID subfield of the STA Info field. The VHT NDP
19 Announcement frame shall include at least one STA Info field."); *id.* ("A non-AP
20 VHT beamformee that receives a VHT NDP Announcement frame... shall transmit
21 its VHT Compressed Beamforming feedback a SIFS after receiving a Beamforming
22 Report Poll with RA matching its MAC address and a non-bandwidth signaling TA
23 obtained from the TA field matching the MAC address of the VHT beamformer.");
24 *id.* Clause 8.5.23.2 (defining format and subfields within the VHT Compressed
25 Beamforming frame); *id.* Clause 8.4.1.48 (including Tables 8-53(d)-(h)) ("Each
26 SNR value per tone in stream i (before being averaged) corresponds to the SNR
27 associated with the column i of the beamforming feedback matrix V determined at
28 the beamformee"); *id.* Clause 8.4.1.49 (including Table 8-53i – MU Exclusive

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1 Beamforming Report information); *id.* Clauses 8.4.1.24, 9.31.5.1, 9.31.5.2; *id.*
2 Clause 22.3.8.3.5; *id.* Clause 22.3.11.2.

3 29. Each of the '376 Accused Products comprises a data-communications
4 networking apparatus wherein one or more of the processor, the transceiver, or the
5 smart antenna is further configured to: receive a first feedback information from the
6 first client device in response to the transmission of the probing signal; receive a
7 second feedback information from the second client device in response to
8 transmission of the probing signal. For example, as with each '376 Accused Product,
9 the Linksys Dual-Band Mesh WiFi 6 Router (MR9600) comprises one or more of
10 the processor, the transceiver, or the smart antenna further configured to receive
11 channel state information and estimates of the channel state and MU MIMO-related
12 feedback information from each of the first non-AP STA and the second non-AP
13 STA pursuant to HE MU-MIMO sounding procedures. This feedback information,
14 carried in one or more HE Compressed Beamforming/CQI frames, is in response to
15 the transmission of the probing signal (*e.g.*, a probing signal transmission that
16 triggers or elicits a responsive transmission from each of a first client device and a
17 second client device, such as NDP Announcement, HE sounding NDP,
18 Beamforming Report trigger frames pursuant to High Efficiency (HE) channel
19 sounding, including preamble training fields allowing an estimate of the channel for
20 MU-MIMO). *See, e.g.*, 802.11ax Standard, Sections 9.3.1.19, 9.3.1.22, 9.3.1.22.3,
21 9.4.1.64, 9.4.1.65, 9.4.1.66, 9.4.1.67, 9.6.31.2, 10.37, 26.7, 26.7.1, 26.7.2, 26.7.3,
22 26.7.4, 26.7.5, 27.1.1, 27.3.15.1 – 27.3.15.3. *See, e.g.*, Section 9.4.1.65 (HE
23 Compressed Beamforming Report field) (“The HE Compressed Beamforming
24 Report field carries the average SNR of each space-time stream and compressed
25 beamforming feedback matrices V for use by a transmit beamformer to determine
26 steering matrices Q , as described in 10.32.3 (Explicit feedback beamforming) and
27 19.3.12.3 (Explicit feedback beamforming)”); Section 9.1.4.66 (HE MU Exclusive
28 Beamforming Report field) (“The HE MU Exclusive Beamforming Report field

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1 carries explicit feedback in the form of delta SNRs. The information in the HE
2 Compressed Beamforming Report field and the HE MU Exclusive Beamforming
3 Report field can be used by the transmit MU beamformer to determine the steering
4 matrices Q , as described in 27.3.3.1 (DL MU-MIMO)”; Section 9.4.1.67 (HE CQI
5 Report Field) (“The HE CQI Report field carries the per-RU average SNRs of each
6 space-time stream, where each per-RU average SNR is the arithmetic mean of the
7 SNR in decibels over a 26-tone RU for which the feedback is being requested.”);
8 Section 27.3.15.1 (“SU-MIMO and DL-MU-MIMO beamforming are techniques
9 used by a STA with multiple antennas (the beamformer) to steer signals using
10 knowledge of the channel to improve throughput. With SU-MIMO beamforming all
11 space-time streams in the transmitted signal are intended for reception at a single
12 STA in an RU. With DL MU-MIMO beamforming, disjoint subsets of the space-
13 time streams are intended for reception at different STAs in an RU of size greater
14 than or equal to 106-tones...The DL MU-MIMO steering matrix $Q_k = [Q_{k,0},$
15 $Q_{k,1}, \dots, Q_{k,N_{user,r}-1}]$ can be detected by the beamformer using the beamforming
16 feedback for subcarrier k from beamformee u , where $u = 0, 1, \dots, N_{user,r} - 1$. The
17 feedback report format is described in 9.4.1.65 (HE Compressed Beamforming
18 Report field) and 9.4.1.66 (HE MU Exclusive Beamforming Report field). The
19 steering matrix that is computed (or updated) using new beamforming feedback from
20 some or all of participating beamformees might replace the existing steering matrix
21 Q_k for the next DL MU-MIMO data transmission.”); Section 27.3.15.2 (“Upon
22 receipt of an HE sounding NDP, the beamformee computes a set of matrices for
23 feedback to the beamformer as described in 21.3.11.2 (Beamforming Feedback
24 Matrix V). The eligible beamformees shall remove the space-time stream CSD in
25 Table 21-11 (Cyclic shift values for the VHT modulated fields of a PPDU) from the
26 measured channel before computing a set of matrices for feedback to the
27 beamformer.”); *See, e.g.*, Section 26.7.3, Figure 26-7:

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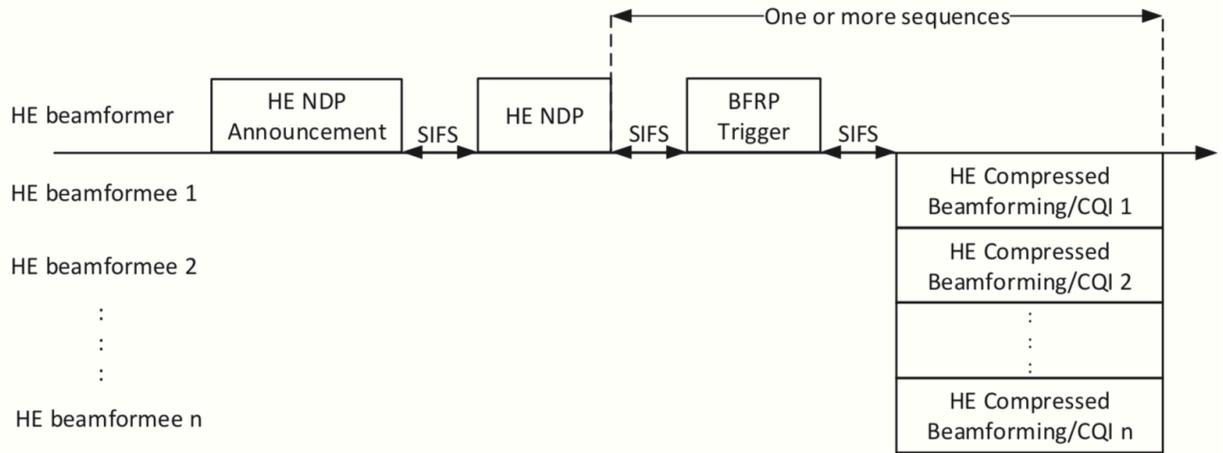


Figure 26-7—An example of the sounding protocol with more than one HE beamformee

For a further example, as with each '376 Accused Product, the Linksys Dual-Band Mesh WiFi 6 Router (MR9600) comprises one or more of the processor, the transceiver, or the smart antenna further configured to receive channel state information and estimates of the channel state and MU MIMO-related feedback information from each of the first non-AP STA and the second non-AP STA pursuant to MU-MIMO sounding procedures. This feedback information, carried in one or more compressed beamforming frames, is in response to the transmission of the probing signal (e.g., a probing signal transmission that triggers or elicits a responsive transmission from each of a first client device and a second client device, such as NDP Announcement pursuant to Very High Throughput (VHT) channel sounding, including preamble training fields allowing an estimate of the channel for MU-MIMO). *See, e.g.*, 802.11ac Standard Clause 9.31.5.2 (“A VHT beamformer shall initiate a sounding feedback sequence by transmitting a VHT NDP Announcement frame followed by a VHT NDP after a SIFS. The VHT beamformer shall include in the VHT NDP Announcement frame one STA Info field for each VHT beamformee that is expected to prepare VHT Compressed Beamforming feedback and shall identify the VHT beamformee by including the VHT beamformee’s AID in the AID subfield of the STA Info field. The VHT NDP Announcement frame shall include at least one STA Info field.”); *id.* (“A non-AP VHT beamformee that receives a VHT NDP Announcement frame... shall transmit

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1 its VHT Compressed Beamforming feedback a SIFS after receiving a Beamforming
 2 Report Poll with RA matching its MAC address and a non-bandwidth signaling TA
 3 obtained from the TA field matching the MAC address of the VHT beamformer.”);
 4 *id.* Clause 8.5.23.2 (defining format and subfields within the VHT Compressed
 5 Beamforming frame); *id.* Clause 8.4.1.48 (including Tables 8-53(d)-(h)) (“Each
 6 SNR value per tone in stream i (before being averaged) corresponds to the SNR
 7 associated with the column i of the beamforming feedback matrix V determined at
 8 the beamformee”); *id.* Clause 8.4.1.49 (including Table 8-53i – MU Exclusive
 9 Beamforming Report information); *id.* Clauses 8.4.1.24, 9.31.5.1, 9.31.5.2; *id.*
 10 Clause 22.3.8.3.5; *id.* Clause 22.3.11.2:

11 Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in
 12 Table 22-11 from the measured channel before computing a set of matrices for feedback to the beamformer.
 13 The beamforming feedback matrix, $V_{k,u}$, found by the beamformee u for subcarrier k shall be compressed in
 14 the form of angles using the method described in 20.3.12.3.6. The angles, $\phi(k,u)$ and $\psi(k,u)$, are quantized
 15 according to Table 8-53e. The number of bits for quantization is chosen by the beamformee, based on the
 16 indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DL-
 17 MU-MIMO beamforming. The compressed beamforming feedback using 20.3.12.3.6 is the only Clause 22
 18 beamforming feedback format defined.

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

21 After receiving the angle information, $\phi(k,u)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation
 22 (20-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering
 23 matrix Q_k . For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix
 24 $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user}-1}]$ using $V_{k,u}$ and $SNR_{k,u}$ ($0 \leq u \leq N_{user} - 1$) in order to suppress crosstalk
 25 between participating beamformees. The method used by the beamformer to calculate the steering matrix Q_k
 26 is implementation specific.

27 30. Each of the '376 Accused Products comprises a data-communications
 28 networking apparatus wherein one or more of the processor, the transceiver, or the
 smart antenna is further configured to: determine where to place transmission peaks
 and transmission nulls within one or more spatially distributed patterns of
 electromagnetic signals based in part on the first and the second feedback
 information. For example, as with each '376 Accused Product, the Linksys Dual-
 Band Mesh WiFi 6 Router (MR9600) comprises one or more of the processor, the
 transceiver, or the smart antenna further configured to determine where to place

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1 transmission peaks and transmission nulls within one or more spatially distributed
2 patterns of electromagnetic signals based in part on the first and the second feedback
3 information, including, *e.g.*, where it determines where to place transmission peaks
4 and transmission nulls through a beamforming steering matrix pursuant to
5 beamforming and MU-MIMO spatial multiplexing, which beamforming steering
6 matrix is determined based on the received CSI (channel state information) and
7 MIMO-related feedback from the first client device (first non-AP STA) and the
8 second client device (second non-AP STA) pursuant to HE MU-MIMO sounding.
9 [DATA SHEET]. *See, e.g.*, 802.11ax Standard, Sections 9.3.1.19, 9.4.1.64, 9.4.1.65,
10 9.4.1.66, 9.4.1.67, 9.6.31.2, 10.37, 26.7, 26.7.1, 26.7.2, 26.7.3, 26.7.4, 26.7.5, 27.1.1,
11 27.3.15.1, 27.3.15.2, 27.3.15.3. *See, e.g.*, Section 9.4.1.65 (HE Compressed
12 Beamforming Report field) (“The HE Compressed Beamforming Report field
13 carries the average SNR of each space-time stream and compressed beamforming
14 feedback matrices V for use by a transmit beamformer to determine steering matrices
15 Q , as described in 10.32.3 (Explicit feedback beamforming) and 19.3.12.3 (Explicit
16 feedback beamforming)”); Section 9.1.4.66 (HE MU Exclusive Beamforming
17 Report field) (“The HE MU Exclusive Beamforming Report field carries explicit
18 feedback in the form of delta SNRs. The information in the HE Compressed
19 Beamforming Report field and the HE MU Exclusive Beamforming Report field can
20 be used by the transmit MU beamformer to determine the steering matrices Q , as
21 described in 27.3.3.1 (DL MU-MIMO)”); Section 9.4.1.67 (HE CQI Report Field)
22 (“The HE CQI Report field carries the per-RU average SNRs of each space-time
23 stream, where each per-RU average SNR is the arithmetic mean of the SNR in
24 decibels over a 26-tone RU for which the feedback is being requested.”); Section
25 27.3.15.1 (“SU-MIMO and DL-MU-MIMO beamforming are techniques used by a
26 STA with multiple antennas (the beamformer) to steer signals using knowledge of
27 the channel to improve throughput. With SU-MIMO beamforming all space-time
28 streams in the transmitted signal are intended for reception at a single STA in an RU.

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1 With DL MU-MIMO beamforming, disjoint subsets of the space-time streams are
2 intended for reception at different STAs in an RU of size greater than or equal to
3 106-tones...The DL MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user,r}-1}]$ can be
4 detected by the beamformer using the beamforming feedback for subcarrier k from
5 beamformee u , where $u = 0, 1, \dots, N_{user,r} - 1$. The feedback report format is described in
6 9.4.1.65 (HE Compressed Beamforming Report field) and 9.4.1.66 (HE MU
7 Exclusive Beamforming Report field). The steering matrix that is computed (or
8 updated) using new beamforming feedback from some or all of participating
9 beamformees might replace the existing steering matrix Q_k for the next DL MU-
10 MIMO data transmission.”); Section 27.3.15.2 (“Upon receipt of an HE sounding
11 NDP, the beamformee computes a set of matrices for feedback to the beamformer
12 as described in 21.3.11.2 (Beamforming Feedback Matrix V). The eligible
13 beamformees shall remove the space-time stream CSD in Table 21-11 (Cyclic shift
14 values for the VHT modulated fields of a PPDU) from the measured channel before
15 computing a set of matrices for feedback to the beamformer. The beamforming
16 feedback matrix $V_{k,u}$ found by the beamformee u for subcarrier k in RU r shall be
17 compressed in the form of angles using the method described in 19.3.12.3.6
18 (Compressed beamforming feedback matrix). The angles $\phi(k,u)$ and $\psi(k,u)$, are
19 quantized according to Table 9-68 (Quantization of angles)... The beamformee
20 shall generate the beamforming feedback matrices with the number of rows (Nr)
21 equal to the N_{STS} of the HE sounding NDP. After receiving the angle information,
22 $\phi(k,u)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-
23 MIMO beamforming, the beamformer uses $V_{k,0}$ matrix to determine the steering
24 matrix Q_k . For DL MU-MIMO beamforming, the beamformer may calculate a
25 steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user,r}-1}]$ using $V_{k,u}$ and Delta $\Delta SNR_{k,u}$ (0
26 $\leq u \leq N_{user,r} - 1$) in order to suppress crosstalk between participating beamformees. The
27 method used by the beamformer to calculate the steering matrix Q_k is
28 implementation specific.”). *See, e.g.*, 802.11ac Standard Clause 9.31.5.1 (“Transmit

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1 beamforming and DL-MU-MIMO require knowledge of the channel state to
 2 compute a steering matrix that is applied to the transmitted signal to optimize
 3 reception at one or more receivers. The STA transmitting using the steering matrix
 4 is called the VHT beamformer and a STA for which reception is optimized is called
 5 a VHT beamformee. An explicit feedback mechanism is used where the VHT
 6 beamformee directly measures the channel from the training symbols transmitted by
 7 the VHT beamformer and sends back a transformed estimate of the channel state to
 8 the VHT beamformer. The VHT beamformer then uses this estimate, perhaps
 9 combining estimates from multiple VHT beamformees, to derive the steering
 10 matrix.”); *id.* Clauses 22.3.4.6(d), 22.3.4.7(e), 22.3.4.8(l), 22.3.4.9.1(m),
 11 22.3.4.9.2(m), 22.3.4.10.4(a) (“Spatial mapping: Apply the Q matrix as described in
 12 22.3.10.11.1.”); *id.* Clause 22.3.10.11.1; IEEE 802.11-2012 Standard Clause
 13 20.3.12.3.6; 802.11ac Standard Clauses 8.4.1.24, 9.31.5.1, 9.31.5.2; *id.* Clause
 14 22.3.11.1:

15 The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user}-1}]$ can be determined by the
 16 beamformer using the beamforming feedback matrices for subcarrier k from beamformee u , $V_{k,u}$, and SNR
 17 information for subcarrier k from beamformee u , $SNR_{k,u}$, where $u = 0, 1, \dots, N_{user} - 1$. The steering matrix
 18 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 22.3.8.3.3 and 22.3.11.4).

19 , Clause 22.3.11.2:

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1 Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in
2 Table 22-11 from the measured channel before computing a set of matrices for feedback to the beamformer.
3 The beamforming feedback matrix, $V_{k,u}$, found by the beamformee u for subcarrier k shall be compressed in
4 the form of angles using the method described in 20.3.12.3.6. The angles, $\phi(k,u)$ and $\psi(k,u)$, are quantized
5 according to Table 8-53e. The number of bits for quantization is chosen by the beamformee, based on the
6 indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DL-
7 MU-MIMO beamforming. The compressed beamforming feedback using 20.3.12.3.6 is the only Clause 22
8 beamforming feedback format defined.

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

11 After receiving the angle information, $\phi(k,u)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation
12 (20-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering
13 matrix Q_k . For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix
14 $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user}-1}]$ using $V_{k,u}$ and $SNR_{k,u}$ ($0 \leq u \leq N_{user} - 1$) in order to suppress crosstalk
15 between participating beamformees. The method used by the beamformer to calculate the steering matrix Q_k
16 is implementation specific.

17 31. Each of the '376 Accused Products comprises a data-communications
18 networking apparatus wherein one or more of the processor, the transceiver, or the
19 smart antenna is further configured to: transmit the first data stream to the first client
20 device via the one or more spatially distributed patterns of electromagnetic signals;
21 and transmit the second data stream to the second client device via the one or more
22 spatially distributed patterns of electromagnetic signals; wherein transmission of the
23 first data stream and transmission of at least part of the second data stream occur at
24 the same time; and wherein the one or more spatially distributed patterns of
25 electromagnetic signals are configured to exhibit a first transmission peak at a
26 location of the first client device and a second transmission peak at a location of the
27 second client device. For example, as with each '376 Accused Product, the Linksys
28 Dual-Band Mesh WiFi 6 Router (MR9600) comprises one or more of the processor,
the transceiver, or the smart antenna further configured to transmit the first data
stream to the first client device (e.g., the first non-AP STA) via the one or more
spatially distributed patterns of electromagnetic signals (e.g., transmission of data to
the first non-AP STA pursuant to HE MU-MIMO beamforming where a
beamforming steering matrix is applied); and transmit the second data stream to the
second client device (e.g., the second non-AP STA) via the one or more spatially

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1 distributed patterns of electromagnetic signals (e.g., transmission of data to the
2 second non-AP STA pursuant to HE MU-MIMO beamforming where a
3 beamforming steering matrix is applied); wherein transmission of the first data
4 stream and transmission of at least part of the second data stream occur at the same
5 time (e.g., simultaneous HE DL MU-MIMO transmissions); and wherein the one or
6 more spatially distributed patterns of electromagnetic signals are configured to
7 exhibit a first transmission peak at a location of the first client device and a second
8 transmission peak at a location of the second client device (e.g., through HE MU-
9 MIMO beamforming, radio energy is directed at each of the first client device and
10 the second client device to form a transmission peak at the location of each device,
11 and including, e.g., where the beamforming steering matrix is applied, a first space-
12 time stream (“STS”) intended for reception at the first client device and a second
13 STS intended for reception at the second client device is representative of a first
14 transmission peak being placed at the location of the first client device and a second
15 transmission peak being placed at the location of second client device). *See, e.g.,*
16 *Linksys Dual-Band Mesh WiFi 6 Router (MR9600) Webpage*, which explains that
17 the Linksys MR9600 includes “Dual-Band (2.4GHz + 5 GHz), 4x4 WiFi 6,” “4x4
18 MU-MIMO,” “2.4 and 5GHz (Simultaneous Dual-Band)” Wi-Fi Bands, “OFDMA
19 technology,” “4x external adjustable antennas,” with a “1.8 GHz Quad Core
20 Processor,” supporting the “WiFi 5 (802.11ac)” and “WiFi 6 (802.11ax)” standards.
21 Additionally, the MR9600 provides “More Capacity to More Devices” because
22 “WiFi 6 sends and receives multiple streams of data simultaneously, providing up
23 to 4x more WiFi capacity to handle every ... device on your network” and also
24 “Minimizes Wi-Fi Congestion” by “Eliminate[ing] interference from neighboring
25 networks with advanced WiFi 6 technology that can isolate your network, reduce
26 congestion and deliver the strongest, clearest WiFi signal available.” *See also*
27 *Linksys’ support page Getting to know the Linksys MR9600 Max-Stream™ Dual-*
28 *Band WiFi 6 Router*, indicating: “The Linksys MR9600... delivers true Gigabit

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1 speeds of up to 6 Gbps with eight-stream capacity throughout the entire home,” and
2 includes a “1.8 GHz quad-core CPU,” “4x4 spatial streams,” “MU-MIMO,” “Next-
3 generation Orthogonal Frequency-Division Multiple Access (OFDMA)
4 technology,” “Four adjustable antennas,” and “Supports 802.11ax.” *See also*
5 Linksys’ *What is AX?* Webpage, stating: “Thanks to 11AX, multiple devices can
6 simultaneously transmit data, using the same radio frequency and the same
7 network,” and that 11AX is “Up to eight times faster than non-MU-MIMO products
8 thanks to up link and down line (DL/UL) MU-MIMO.” *See also* Linksys’ *What is*
9 *MU-MIMO and Why Do You Need It?* Webpage, stating: “Multi-user, multiple-
10 input, multiple-output technology—better known as MU-MIMO (a.k.a. Next-Gen
11 AC or AC Wave 2)—allows a Wi-Fi router to communicate with multiple devices
12 simultaneously ... increases the capacity and efficiency of your router... allowing it
13 to handle more WiFi-intensive activities such as streaming and gaming.” *See, e.g.,*
14 IEEE 802.11ax Standard, Section 27.3.15.1 (“SU-MIMO and DL-MU-MIMO
15 beamforming are techniques used by a STA with multiple antennas (the
16 beamformer) to steer signals using knowledge of the channel to improve throughput.
17 With SU-MIMO beamforming all space-time streams in the transmitted signal are
18 intended for reception at a single STA in an RU. With DL MU-MIMO beamforming,
19 disjoint subsets of the space-time streams are intended for reception at different
20 STAs in an RU of size greater than or equal to 106-tones...The DL MU-MIMO
21 steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user,r}-1}]$ can be detected by the beamformer using
22 the beamforming feedback for subcarrier k from beamformee u , where $u =$
23 $0, 1, \dots, N_{user,r} - 1$. The feedback report format is described in 9.4.1.65 (HE Compressed
24 Beamforming Report field) and 9.4.1.66 (HE MU Exclusive Beamforming Report
25 field). The steering matrix that is computed (or updated) using new beamforming
26 feedback from some or all of participating beamformees might replace the existing
27 steering matrix Q_k for the next DL MU-MIMO data transmission.”); Section
28 27.3.15.2 (“The beamformee shall generate the beamforming feedback matrices with

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1 the number of rows (Nr) equal to the N_{STS} of the HE sounding NDP. After receiving
2 the angle information, $\phi(k,u)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using
3 Equation (19-79). For SU-MIMO beamforming, the beamformer uses $V_{k,0}$ matrix to
4 determine the steering matrix Q_k . For DL MU-MIMO beamforming, the beamformer
5 may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user,r}-1}]$ using $V_{k,u}$ and Delta
6 $\Delta SNR_{k,u}$ ($0 \leq u \leq N_{user,r}-1$) in order to suppress crosstalk between participating
7 beamformees. The method used by the beamformer to calculate the steering matrix
8 Q_k is implementation specific.”); Section 27.1.1 (“The HE PHY extends the
9 maximum number of users supported for DL MU-MIMO transmissions up to 8 users
10 per resource unit (RU) and provides support for DL and UL orthogonal frequency
11 division multiple access (OFDMA) as well as for UL MU-MIMO. Both DL and UL
12 MU-MIMO transmissions are supported on portions of the PPDU bandwidth (on
13 resource units greater than or equal to 106 tones). In an MU-MIMO resource unit,
14 there is support for up to 8 users with up to 4 space-time streams per user with the
15 total not exceeding 8 space-time streams”); Section 27.3.1.1 (“DL MU transmission
16 allows an AP to simultaneously transmit information to more than one non-AP STA.
17 For a DL MU transmission, the AP uses the HE MU PPDU format and employs
18 either DL OFDMA, DL MU-MIMO, or a mixture of both.”); Section 27.3.10.8.1
19 (“The HE-SIG-B field provides the OFDMA and DL MU-MIMO resource
20 allocation information to allow the STAs to look up the corresponding resources to
21 be used in the data portion of the frame.”); *See, e.g.*, IEEE 802.11ax Standard,
22 Section 27.3.5 (Transmitter block diagram), at, *e.g.*, Figure 27-19:

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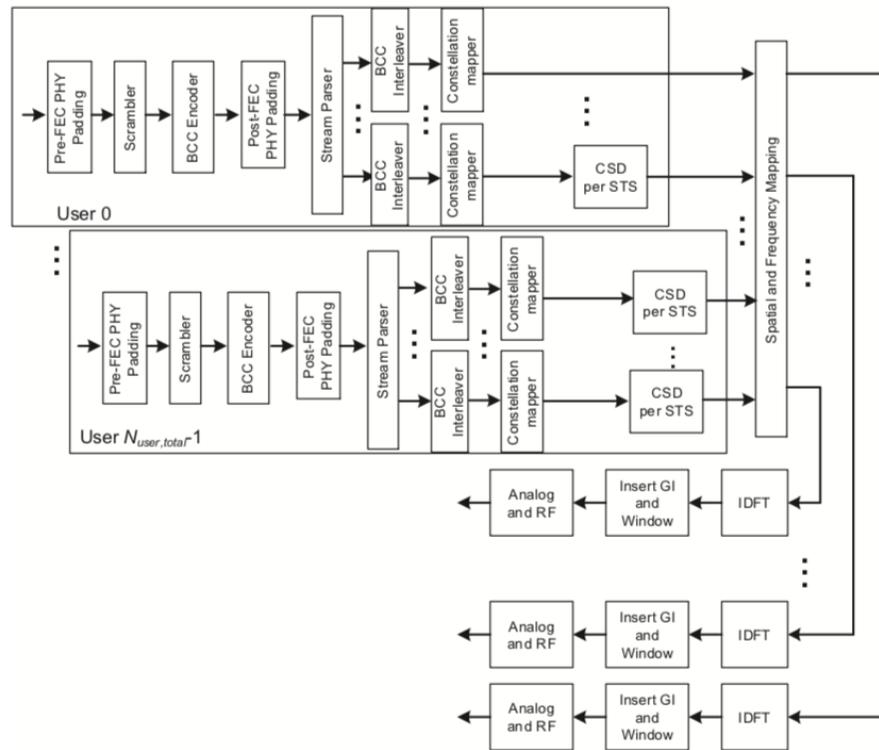


Figure 27-19—Transmitter block diagram for the Data field of an HE DL MU-MIMO transmission in a 106-, 242-, 484- or 996-tone RU with BCC encoding

; Section 9.4.1.65 (HE Compressed Beamforming Report field) (“The HE Compressed Beamforming Report field carries the average SNR of each space-time stream and compressed beamforming feedback matrices V for use by a transmit beamformer to determine steering matrices Q , as described in 10.32.3 (Explicit feedback beamforming) and 19.3.12.3 (Explicit feedback beamforming)”); Section 9.1.4.66 (HE MU Exclusive Beamforming Report field) (“The HE MU Exclusive Beamforming Report field carries explicit feedback in the form of delta SNRs. The information in the HE Compressed Beamforming Report field and the HE MU Exclusive Beamforming Report field can be used by the transmit MU beamformer to determine the steering matrices Q , as described in 27.3.3.1 (DL MU-MIMO)”); Section 9.4.1.67 (HE CQI Report Field) (“The HE CQI Report field carries the per-RU average SNRs of each space-time stream, where each per-RU average SNR is the arithmetic mean of the SNR in decibels over a 26-tone RU for which the feedback is being requested.”). *See, e.g.*, 802.11ac Standard Clause 9.31.5.1 (“Transmit

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1 beamforming and DL-MU-MIMO require knowledge of the channel state to
2 compute a steering matrix that is applied to the transmitted signal to optimize
3 reception at one or more receivers. The STA transmitting using the steering matrix
4 is called the VHT beamformer and a STA for which reception is optimized is called
5 a VHT beamformee. An explicit feedback mechanism is used where the VHT
6 beamformee directly measures the channel from the training symbols transmitted by
7 the VHT beamformer and sends back a transformed estimate of the channel state to
8 the VHT beamformer. The VHT beamformer then uses this estimate, perhaps
9 combining estimates from multiple VHT beamformees, to derive the steering
10 matrix.”); *id.* Clauses 22.3.4.6(d), 22.3.4.7(e), 22.3.4.8(l), 22.3.4.9.1(m),
11 22.3.4.9.2(m), 22.3.4.10.4(a) (“Spatial mapping: Apply the Q matrix as described in
12 22.3.10.11.1.”); *id.* Clause 22.3.10.11.1; IEEE 802.11-2012 Standard Clause
13 20.3.12.3.6; 802.11ac Standard Clauses 8.4.1.24, 9.31.5.1, 9.31.5.2; *id.* Clause
14 22.3.11.1, 22.3.11.2:

15 The DL-MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user}-1}]$ can be determined by the
16 beamformer using the beamforming feedback matrices for subcarrier k from beamformee u , $V_{k,u}$, and SNR
17 information for subcarrier k from beamformee u , $SNR_{k,u}$, where $u = 0, 1, \dots, N_{user} - 1$. The steering matrix
18 that is computed (or updated) using new beamforming feedback matrices and new SNR information from
19 some or all of participating beamformees might replace the existing steering matrix Q_k for the next DL-MU-
20 MIMO data transmission. The beamformee group for the MU transmission is signaled using the Group ID
21 field in VHT-SIG-A (see 22.3.8.3.3 and 22.3.11.4).

19 Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in
20 Table 22-11 from the measured channel before computing a set of matrices for feedback to the beamformer.
21 The beamforming feedback matrix, $V_{k,u}$, found by the beamformee u for subcarrier k shall be compressed in
22 the form of angles using the method described in 20.3.12.3.6. The angles, $\phi(k,u)$ and $\psi(k,u)$, are quantized
23 according to Table 8-53e. The number of bits for quantization is chosen by the beamformee, based on the
24 indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DL-
25 MU-MIMO beamforming. The compressed beamforming feedback using 20.3.12.3.6 is the only Clause 22
26 beamforming feedback format defined.

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

25 After receiving the angle information, $\phi(k,u)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation
26 (20-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering
27 matrix Q_k . For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix
28 $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user}-1}]$ using $V_{k,u}$ and $SNR_{k,u}$ ($0 \leq u \leq N_{user} - 1$) in order to suppress crosstalk
between participating beamformees. The method used by the beamformer to calculate the steering matrix Q_k
is implementation specific.

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1 32. Defendants also have been and are now knowingly and intentionally
2 inducing infringement of at least claim 1 of the '376 Patent in violation of 35 U.S.C.
3 § 271(b), in this district and elsewhere in the United States. Through the filing and
4 service of this Complaint, Defendants have had knowledge of the '376 Patent and
5 the infringing nature of the '376 Accused Products. More specifically, Defendants
6 have been and are now actively inducing direct infringement by other persons (*e.g.*,
7 Defendants' customers who use, sell or offer for sale the '376 Accused Products).

8 33. Despite this knowledge of the '376 Patent, Defendants continue to actively
9 encourage and instruct their customers and end users (for example, through user
10 manuals and online instruction materials on their website) to use the '376 Accused
11 Products in ways that directly infringe the '376 Patent. For example, Defendants'
12 website provided, and continues to provide, instructions for using the '376 Accused
13 Products on wireless communications systems, and to utilize their 802.11ax
14 beamforming and MU-MIMO functionalities. Defendants do so knowing and
15 intending that their customers and end users will commit these infringing acts.
16 Defendants also continue to make, use, offer for sale, sell, and/or import the '376
17 Accused Products, despite their knowledge of the '376 Patent, thereby specifically
18 intending for and inducing their customers to infringe the '376 Patent through the
19 customers' normal and customary use of the '376 Accused Products. Defendants
20 also knew or were willfully blind that their actions would induce direct infringement
21 by others and intended that their actions would induce direct infringement by others.
22 Accordingly, a reasonable inference is that Defendants specifically intended for
23 others, such as their customers, to directly infringe one or more claims of Vivato's
24 '376 Patent in the United States because Defendants had knowledge of the '376
25 Patent and actively induced others (*e.g.*, *their* customers) to directly infringe the '376
26 Patent.

27 34. Defendants also contributorily infringe by making, using, selling, offering
28 to sell, and/or importing the '376 Accused Products, knowing they constitute a

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1 material part of the invention, are especially made or adapted for use in infringing,
2 and that they are not staple articles of commerce capable of substantial non-
3 infringing use.

4 35. By making, using, offering for sale, selling and/or importing into the
5 United States the '376 Accused Products, Defendants have injured Vivato and are
6 liable for infringement of the '376 Patent pursuant to 35 U.S.C. § 271.

7 36. Defendants also infringe numerous additional claims of the '376 Patent,
8 including Claims 2 – 21 and 32 – 34, directly and through inducing infringement,
9 for similar reasons as explained above with respect to Claim 1.

10 37. Vivato's '376 Patent is valid and enforceable.

11 38. As a result of Defendants' infringement of the '376 Patent, Defendants
12 have damaged Vivato, and Vivato is entitled to monetary damages in an amount to
13 be determined at trial that is adequate to compensate for Defendants' infringement,
14 but in no event less than a reasonable royalty for the use made of the invention by
15 Defendant, together with interest and costs as fixed by the Court.

16 39. Defendants' infringing activities have injured and will continue to injure
17 Vivato, unless and until this Court enters an injunction prohibiting further
18 infringement of the '376 Patent, and, specifically, enjoining further manufacture,
19 use, sale, importation, and/or offers for sale that come within the scope of the patent
20 claims.

21 **PRAYER FOR RELIEF**

22 WHEREFORE, Vivato prays for the following relief:

23 (a) A judgment in favor of Vivato that Defendants have infringed and are
24 infringing U.S. Patent No. 10,594,376;

25 (b) An award of damages to Vivato arising out of Defendants' infringement
26 of U.S. Patent No. 10,594,376, together with prejudgment and post-judgment
27 interest, in an amount according to proof;

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1 (c) An award of an ongoing royalty for Defendants’ post-judgment
2 infringement in an amount according to proof;

3 (d) Granting Vivato its costs and further relief as the Court may deem just
4 and proper.

5 **DEMAND FOR JURY TRIAL**

6 Vivato demands a trial by jury of any and all issues triable of right before a
7 jury.

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10 DATED: February 6, 2024

Respectfully submitted,

11 **RUSS AUGUST & KABAT**

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13
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