

RUSS, AUGUST & KABAT

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

23 XR COMMUNICATIONS, LLC, dba
 24 VIVATO TECHNOLOGIES,

25 *Plaintiff,*

26 *v.*

27 D-LINK SYSTEMS, INC.,

28 *Defendant.*

Case No. 8:21-cv-01063

**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 patents at issue in this case are directed to specific aspects
11 of wireless communication, including adaptively steered antenna technology and
12 beam switching technology.

13 8. D-Link Systems, Inc. ("D-Link" or "Defendant") is a corporation
14 organized and existing under the laws of California with its principal place of
15 business at 14420 Myford Road, Suite 100, Irvine, CA 92606.

16 9. This Court has personal jurisdiction over Defendant because it has its
17 principal place of business in California.

18 10. Venue is proper in this federal district pursuant to 28 U.S.C. §§ 1391(b)-
19 (d) and 1400(b) in that Defendant is subject to jurisdiction in this District, has done
20 business in this District, has regular and established places of business in this
21 District, has committed acts of infringement in this District, and continues to commit
22 acts of infringement in this District, entitling Plaintiff to relief.

23 **III. BACKGROUND OF THE TECHNOLOGY**

24 11. This complaint arises from Defendant's unlawful infringement of the
25 following United States patents owned by Vivato, each of which generally relate to
26 wireless communications technology: United States Patent Nos. 7,729,728 (the
27 "728 Patent") and 10,594,376 (the "376 Patent") (collectively, the "Asserted
28 Patents").

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

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

16 14. One of Marconi’s preeminent contemporaries was Dr. Karl Ferdinand
17 Braun, who shared the 1909 Nobel Prize in Physics with Marconi. In his Nobel
18 lecture dated December 11, 1909, Braun explained that he was inspired to work on
19 wireless technology by Marconi’s own experiments. Braun had observed that the
20 signal strength in Marconi’s radio was limited beyond a certain distance, and
21 wondered why increasing the voltage on Marconi’s radio did not result in a stronger
22 transmission at greater distances. Braun thus dedicated himself to developing
23 wireless devices with a stronger, more effective transmission capability.

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

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

10 17. At the beginning of the twenty-first century, the vast majority of wireless
11 networks still did not yet take advantage of directed wireless communications.
12 Instead, “omnidirectional” access points were ubiquitous. Omnidirectional access
13 points transmit radio waves uniformly around the access point in every direction and
14 do not steer the signal in particular directions. Omnidirectional antennas access
15 points do typically achieve 360 degrees of coverage around the access point, but
16 with a reduced coverage distance. Omnidirectional access points also lack
17 sophisticated approaches to overcome certain types of interference in the
18 environment. As only one example, the presence of solid obstructions, such as a
19 concrete wall, ceiling, or pillar, can limit signal penetration. As another example,
20 interference arises when radio waves are reflected, refracted, or diffracted based on
21 obstacles present between the transmitter and receiver. The multiple paths that radio
22 waves can travel between the transmitter and receiver often result in signal
23 interference that decreases performance, and omnidirectional access points lack
24 advanced solutions to overcome these “multipath” effects.

25 18. Moving from omnidirectional networks to modern networks has required
26 an additional series of advancements that harness the capabilities of directed wireless
27 technology. These advancements range from conceiving various ways to steer and
28 modify radiation patterns, to enhancing the transmission signal power in a desired

1 direction, to suppressing radiation in undesired directions, to minimizing signal
2 “noise,” and then applying these new approaches into communications networks
3 with multiple, heterogenous transmitters and receivers.

4 19. Harnessing the capabilities of directed wireless technology resulted in a
5 significant leap forward in the signal strength, reliability, concurrent users, and/or
6 data transmission capability of a wireless network. One of the fundamental building
7 blocks of this latest transition was the development of improvements to MIMO and
8 “beamforming,” which are the subject matter of patents in this infringement action.
9 The patents in this action resulted from the investment of tens of millions of dollars
10 and years of tireless effort by a group of engineers who built a technology company
11 slightly ahead of its time. Their patented innovations laid the groundwork for
12 today’s networks, and are infringed by Defendant’s accused products.

13 **IV. COUNT ONE: INFRINGEMENT OF UNITED STATES**
14 **PATENT NO. 7,729,728**

15 20. Vivato realleges and incorporates by reference the foregoing paragraphs as
16 if fully set forth herein.

17 21. On June 1, 2010, United States Patent No. 7,729,728 (“the ’728 Patent”) was
18 duly and legally issued by the United States Patent and Trademark Office for
19 inventions entitled “Forced Beam Switching in Wireless Communication Systems
20 Having Smart Antennas.” Vivato owns the ’728 Patent and holds the right to sue and
21 recover damages for infringement thereof. A copy of the ’728 Patent is attached
22 hereto as Exhibit A.

23 22. Vivato has complied with 35 U.S.C. § 287 and it does not bar recovery of
24 pre-suit damages at least because Vivato only asserts method claims from the ’728
25 Patent.

26 23. Defendant has directly infringed and continues to directly infringe
27 numerous claims of the ’728 Patent, including at least claim 4, by manufacturing,
28 using, selling, offering to sell, and/or importing into the United States Wi-Fi 6 access

1 points and routers supporting MU-MIMO, including without limitation access points
2 and routers utilizing the IEEE 802.11ax or “Wi-Fi 6” standard (*e.g.*, DIR-X1560,
3 DIR-X1860, DIR-X1870, DIR-X4860, DIR-X5460, DIR-X6060, DIR-LX1870,
4 DBA-X2830P, DBA-X1230P, DAP-X1860, DAP-X1870, DAP-X2810, DAP-
5 X2850, DWL-X8630AP, COVR-X1874, COVR-X1873, COVR-X1872, COVR-
6 X1870, COVR-X1870 Series, COVR-X1860 Series, COVR-X1860, COVR-X1862,
7 COVR-X1863, COVR-X1864, D-Link AI M32) (collectively the “’728 Accused
8 Products”). Defendant is liable for infringement of the ’728 Patent pursuant to 35
9 U.S.C. § 271(a).

10 24. The Accused Products satisfy all claim limitations of Claims 3, 4, 5,
11 and 12 of the ’728 Patent. The following paragraphs compare limitations of Claim 4
12 to an exemplary ’728 Accused Product, the D-Link DAP-X2810¹ wireless access
13 point.

14 25. Each of the Accused Products comprises a wireless communication
15 system and performs a method for use in a wireless communication system. For
16 example, the D-Link DAP-X2810 is a wireless access point for use in a Wi-Fi
17 network.

18 26. Each of the Accused Products comprises a phased array antenna
19 configured to selectively allow a receiving device to operatively associate with a
20 beam downlink transmittable to the receiving device via a phased array antenna of
21 an access point. For example, as with each Accused Product, the D-Link DAP-
22 X2810 selectively allows a receiving device (*e.g.*, station, abbreviated “STA”) to
23 operatively associate (*e.g.*, connect) with a beam downlink transmittable to the
24 receiving device (*e.g.*, SU-MIMO, DL MU-MIMO or UL MU-MIMO
25 beamforming) via a phased array antenna of an access point (*e.g.*, the antenna array
26 and supporting mechanisms of the D-Link DAP-X2810). *See, e.g.*, D-Link Nuclias
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28 ¹ *See* D-Link DAP-X2810 Datasheet, available at <https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf>.

1 Connect AX1800 Wi-Fi 6 Access Point DAP-X2810,
2 [https://www.dlink.com/en/products/dap-x2810-nuclias-connect-ax1800-wi-fi-6-](https://www.dlink.com/en/products/dap-x2810-nuclias-connect-ax1800-wi-fi-6-access-point)
3 [access-point](https://www.dlink.com/en/products/dap-x2810-nuclias-connect-ax1800-wi-fi-6-access-point) (“The DAP-X2810 is empowered with next generation Wi-Fi 6.
4 Enhanced MU-MIMO with even more uplink and downlink streams serves more
5 devices simultaneously. OFDMA dramatically increases transmission efficiency and
6 1024-QAM packs even more data, bringing unadulterated speed increases of a
7 searing 25%.”); D-Link DAP-X2810 Datasheet, available at
8 [https://www.dlink.com/-/media/global-pdfs/global-](https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf)
9 [datasheets/dap/dapx2810a1datasheetv100ww.pdf](https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf) (“Wi-Fi 6 delivers greater
10 network efficiency and lower latency, with nearly four times the capacity of previous
11 Wi-Fi standards”; “MU-MIMO slices through congestion, reducing wait time for all
12 users”; “2 x dual-band internal antennas”). *See, e.g.*, IEEE 802.11ax Standard, at
13 Sections 9.3.1.22, 26.5, 26.5.1, 26.5.2, 26.5.3, 27.1.1, 27.3.1, 27.3.2.5, 27.3.2.6,
14 27.3.5, 27.3.10.7, 27.3.10.8, 27.3.10.9, 27.3.15, including Tables 27-19, 27-20, 27-
15 21, 27-24, 27-25, 27-26, 27-27, 27-28, 27-29, Annex G at G.5, Annex Z. *See, e.g.*,
16 IEEE 802.11ax Standard, Section 27.3.1.1 (“The transmission within an RU in a
17 PPDU may be single stream to one user, spatially multiplexed to one user (SU-
18 MIMO), or spatially multiplexed to multiple users (MU-MIMO).”); Section 27.3.2.5
19 (“The number of users in the MU-MIMO group is indicated in the Number Of HE-
20 SIG-B Symbols Or MU-MIMO Users field in HE-SIG-A. The allocated spatial
21 streams for each user and the total number of spatial streams are indicated in the
22 Spatial Configuration field of User field in HE-SIG-B containing the STA-ID of the
23 designated MU-MIMO STA as defined in Table 27-29 (Spatial Configuration
24 subfield encoding)...[i]f there is only one User field (see Table 27-27 (User field
25 format for a non-MU-MIMO allocation)) for an RU in the HE-SIG-B content
26 channel, then the number of spatial streams for the user in the RU is indicated by the
27 NSTS field in the User field. If there is more than one User field (see Table 27-28
28 (User field for an MU-MIMO allocation)) for an RU in the HE-SIG-B content

1 channel, then the number of allocated spatial streams for each user in the RU is
2 indicated by the Spatial Configuration field of the User field in HE-SIG-B.”);
3 Section 27.3.2.6 (“UL MU transmissions are preceded by a Trigger frame or frame
4 carrying a TRS Control subfield from the AP. The Trigger frame or frame carrying
5 the TRS Control subfield indicates the parameters, such as the duration of the HE
6 TB PPDU, RU allocation, target RSSI and MCS (see 9.3.1.22 (Trigger frame
7 format), 9.2.4.6a.1 (TRS Control) and 26.5.3.3 (Non-AP STA behavior for UL MU
8 operation)), required to transmit an HE TB PPDU”); Section 27.3.10.8 (HE-SIG-B)
9 (“The HE-SIG-B field provides the OFDMA and DL MU-MIMO resource
10 allocation information to allow the STAs to look up the corresponding resources to
11 be used in the data portion of the frame.”); Section 27.3.15 (“SU-MIMO and DL-
12 MU-MIMO beamforming are techniques used by a STA with multiple antennas (the
13 beamformer) to steer signals using knowledge of the channel to improve throughput.
14 With SU-MIMO beamforming all space-time streams in the transmitted signal are
15 intended for reception at a single STA in an RU. With DL MU-MIMO beamforming,
16 disjoint subsets of the space-time streams are intended for reception at different
17 STAs in an RU of size greater than or equal to 106-tones”); Section 27.3.10.8.5 (HE-
18 SIG-B per user content) (“The User Specific field consists of multiple User fields.
19 The User fields follow the Common field of HE-SIG-B. The RU Allocation field in
20 the Common field and the position of the User field in the User Specific field
21 together identify the RU used to transmit a STA’s data...

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Table 27-27—User field format for a non-MU-MIMO allocation

Bit	Subfield	Number of bits	Description
B0–B10	STA-ID	11	Set to a value of the element indicated from TXVECTOR parameter STA_ID_LIST (see 26.11.1 (STA_ID_LIST)).
B11–B13	NSTS	3	Number of space-time streams. Set to the number of space-time streams minus 1.
B14	Beamformed	1	Use of transmit beamforming. Set to 1 if a beamforming steering matrix is applied to the waveform in an SU transmission. Set to 0 otherwise.
B15–B18	MCS	4	Modulation and coding scheme Set to n for MCS n , where $n = 0, 1, 2, \dots, 11$ Values 12 to 15 are reserved

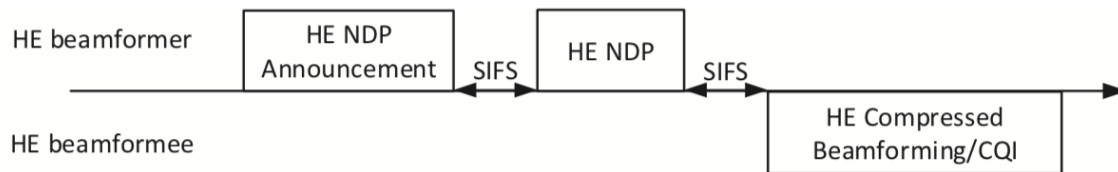
Table 27-28—User field for an MU-MIMO allocation

Bit	Subfield	Number of bits	Description
B0–B10	STA-ID	11	Set to a value of element indicated from TXVECTOR parameter STA_ID_LIST (see 26.11.1 (STA_ID_LIST)).
B11–B14	Spatial Configuration	4	Indicates the number of spatial streams for a STA in an MU-MIMO allocation (see Table 27-29 (Spatial Configuration subfield encoding)).
B15–B18	MCS	4	Modulation and coding scheme. Set to n for MCS n , where $n = 0, 1, 2, \dots, 11$ Values 12 to 15 are reserved
B19	Reserved	1	Reserved and set to 0
B20	Coding	1	Indicates whether BCC or LDPC is used. Set to 0 for BCC Set to 1 for LDPC
NOTE—If the STA-ID subfield is set to 2046, then the other subfields can be set to arbitrary values.			

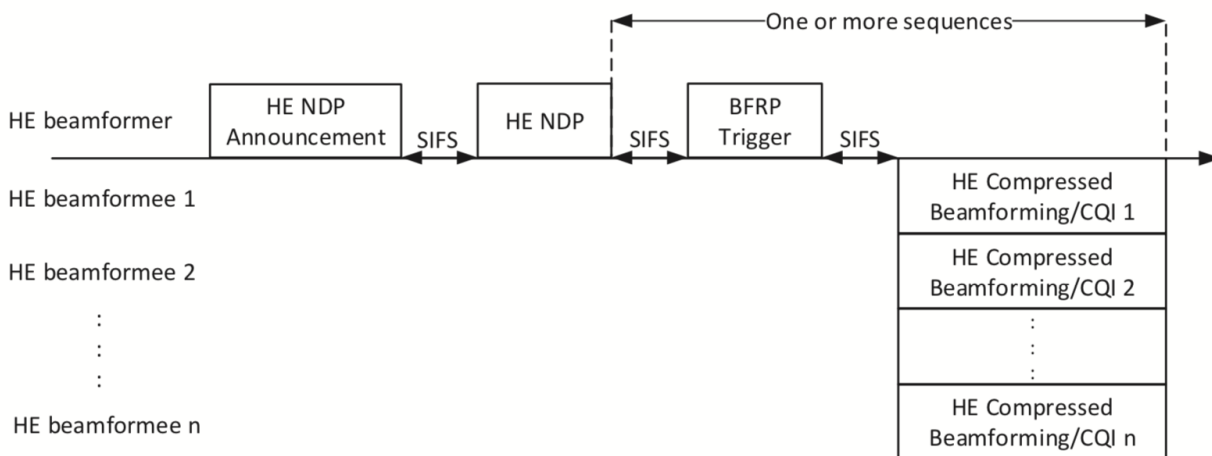
Section 9.3.1.22 (Trigger frame format) (“A Trigger frame allocates resources for and solicits one or more HE TB PPDU transmissions. The Trigger frame also carries other information required by the responding STA to send an HE TB PPDU... The SS Allocation subfield of the User Info field indicates the spatial streams of the solicited HE TB PPDU and the format is defined in Figure 9-64e (SS Allocation subfield format).

1 27. Each of the Accused Products is configured to receive an uplink
2 transmission from the receiving device through the phased array antenna. For
3 example, as with each Accused Product, the D-Link DAP-X2810 is configured to
4 receive an uplink transmission (*e.g.*, receiving an uplink transmission in response to
5 a trigger frame soliciting an uplink transmission, including, *e.g.*, HE TB PPDU, *e.g.*,
6 HE TB feedback NDP, further including, *e.g.*, receiving an uplink transmission that
7 includes information regarding an estimate of the channel state in, *e.g.*, an HE
8 compressed beamforming/CQI report carried in one or more HE Compressed
9 Beamforming/CQI frames) from the receiving device (*e.g.*, a STA, or HE
10 beamformee) through the phased array antenna. See, *e.g.*, 802.11ax Standard,
11 Sections 9.3.1.19, 9.3.1.22, 9.3.1.22.3, 9.4.1.64, 9.4.1.65, 9.4.1.66, 9.4.1.67,
12 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, 27.3.10.10. See,
13 *e.g.*, Section 26.7 (HE sounding protocol) (“Transmit beamforming and DL MU-
14 MIMO require knowledge of the channel state to compute a steering matrix that is
15 applied to the transmit signal to optimize reception at one or more receivers. HE
16 STAs use the HE sounding protocol to determine the channel state information. The
17 HE sounding protocol provides explicit feedback mechanisms, defined as HE non-
18 trigger-based (non-TB) sounding and HE trigger-based (TB) sounding, where the
19 HE beamformee measures the channel using a training signal (*i.e.*, an HE sounding
20 NDP) transmitted by the HE beamformer and sends back a transformed estimate of
21 the channel state. The HE beamformer uses this estimate to derive the steering
22 matrix. The HE beamformee returns an estimate of the channel state in an HE
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1 compressed beamforming/CQI report carried in one or more HE Compressed
 2 Beamforming/CQI frames.”); Section 26.7.3, Figures 26-6 and 26-7:



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



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

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18 ; Section 26.7.3 (“An HE beamformee that receives an HE NDP Announcement
 19 frame from an HE beamformer with which it is associated and that contains the HE
 20 beamformee’s MAC address in the RA field and also receives an HE sounding NDP
 21 a SIFS after the HE NDP Announcement frame shall transmit its HE compressed
 22 beamforming/CQI report a SIFS after the HE sounding NDP. The TXVECTOR
 23 parameter CH_BANDWIDTH for the PPDU containing the HE compressed
 24 beamforming/CQI report shall be set to indicate a bandwidth not wider than that
 25 indicated by the RXVECTOR parameter CH_BANDWIDTH of the HE sounding
 26 NDP. An HE beamformee that receives an HE NDP Announcement frame as part of
 27 an HE TB sounding sequence with a STA Info field addressed to it soliciting SU or
 28 MU feedback shall generate an HE compressed beamforming/CQI report using the

1 feedback type, Ng and codebook size indicated in the STA Info field. If the HE
 2 beamformee then receives a BFRP Trigger frame with a User Info field addressed
 3 to it, the HE beamformee transmits an HE TB PPDU containing the HE compressed
 4 beamforming/CQI report following the rules defined in 26.5.3.3 (Non-AP STA
 5 behavior for UL MU operation.”); Section 26.5.3 (UL MU operation) (“UL MU
 6 operation allows an AP to solicit simultaneous immediate response frames from one
 7 or more non-AP HE STAs”); Section 27.3.10.10 (HE-LTF) (“The HE-LTF field
 8 provides a means for the receiver to estimate the MIMO channel between the set of
 9 constellation mapper outputs (or, if STBC is applied, the STBC encoder outputs)
 10 and the receive chains. In an HE SU PPDU and HE ER SU PPDU, the transmitter
 11 provides training for NSTS space-time streams (spatial mapper inputs) used for the
 12 transmission of the PSDU. In an HE MU PPDU, the transmitter provides training
 13 for NSTS_{r,total} space-time streams used for the transmission of the PSDU(s) in the
 14 r-th RU. In an HE TB PPDU, the transmitter of user u in the r-th RU provides training
 15 for NSTS_{r,u} space-time streams used for the transmission of the PSDU. For each
 16 tone in the r-th RU, the MIMO channel that can be estimated is an $N_{RX} \times$
 17 $N_{STS,r,total}$ matrix. An HE transmission has a preamble that contains HE-LTF
 18 symbols, where the data tones of each HE-LTF symbol are multiplied by entries
 19 belonging to a matrix PHE-LTF, to enable channel estimation at the receiver.... In
 20 an HE SU PPDU, HE MU PPDU and HE ER SU PPDU, the combination of HE-
 21 LTF type and GI duration is indicated in HE-SIG-A field. In an HE TB PPDU, the
 22 combination of HE-LTF type and GI duration is indicated in the Trigger frame that
 23 triggers transmission of the PPDU. If an HE PPDU is an HE sounding NDP, the
 24 combinations of HE-LTF types and GI durations are listed in 27.3.18 (Transmit
 25 specification). If an HE PPDU is an HE TB feedback NDP, the combination of HE-
 26 LTF types and GI durations are listed in 27.3.4 (HE PPDU formats.”); Section
 27 27.3.15.1 (SU-MIMO and DL-MIMO beamforming) (“The DL MU-MIMO steering
 28 matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user,r}-1}]$ can be detected by the beamformer using

1 the beamforming feedback for subcarrier k from beamformee u , where $u =$
 2 $0, 1, \dots, N_{\text{user}, r} - 1$. The feedback report format is described in 9.4.1.65 (HE
 3 Compressed Beamforming Report field) and 9.4.1.66 (HE MU Exclusive
 4 Beamforming Report field). The steering matrix that is computed (or updated) using
 5 new beamforming feedback from some or all of participating beamformees might
 6 replace the existing steering matrix Q_k for the next DL MU-MIMO data
 7 transmission. For SU-MIMO beamforming, the steering matrix Q_k can be
 8 determined from the beamforming feedback matrix V_k that is sent back to the
 9 beamformer by the beamformee using the compressed beamforming feedback
 10 matrix format as defined in 19.3.12.3.6 (Compressed beamforming feedback
 11 matrix). The feedback report format is described in 9.4.1.65 (HE Compressed
 12 Beamforming Report field.”)

13 28. Each of the Accused Products is configured to determine from the uplink
 14 transmission if the receiving device should operatively associate with a different
 15 beam downlink transmittable via the phased array antenna. For example, the D-Link
 16 DAP-X2810 is configured to determine from information contained in the uplink
 17 transmission (*e.g.*, an uplink transmission received in response to a trigger frame
 18 soliciting an uplink transmission, including, *e.g.*, HE TB PPDU, *e.g.*, HE TB
 19 feedback NDP, further including, *e.g.*, an uplink transmission that includes
 20 information regarding an estimate of the channel state in, *e.g.*, an HE compressed
 21 beamforming/CQI report carried in one or more HE Compressed Beamforming/CQI
 22 frames) if the receiving device (*e.g.*, STA, or HE beamformee) that sent the uplink
 23 transmission should operatively associate with a different beam downlink
 24 transmittable via the phased array antenna. *See, e.g.*, D-Link Nuclias Connect
 25 AX1800 Wi-Fi 6 Access Point DAP-X2810,
 26 [https://www.dlink.com/en/products/dap-x2810-nuclias-connect-ax1800-wi-fi-6-](https://www.dlink.com/en/products/dap-x2810-nuclias-connect-ax1800-wi-fi-6-access-point)
 27 [access-point](https://www.dlink.com/en/products/dap-x2810-nuclias-connect-ax1800-wi-fi-6-access-point) (“The DAP-X2810 is empowered with next generation Wi-Fi 6.
 28 Enhanced MU-MIMO with even more uplink and downlink streams serves more

1 devices simultaneously. OFDMA dramatically increases transmission efficiency and
 2 1024-QAM packs even more data, bringing unadulterated speed increases of a
 3 searing 25%."); D-Link DAP-X2810 Datasheet, available at
 4 [https://www.dlink.com/-/media/global-pdfs/global-](https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf)
 5 [datasheets/dap/dapx2810a1datasheetv100ww.pdf](https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf) (“Wi-Fi 6 delivers greater
 6 network efficiency and lower latency, with nearly four times the capacity of previous
 7 Wi-Fi standards”; “MU-MIMO slices through congestion, reducing wait time for all
 8 users”; “2 x dual-band internal antennas”). *See, e.g.*, IEEE 802.11ax Standard, at
 9 Sections 9.3.1.22, 9.4.1.64, 9.4.1.65, 9.4.1.66, 9.4.1.67, 26.5, 26.5.1, 26.5.2, 26.5.3,
 10 26.7, 26.7.1, 26.7.3, 26.7.3, 26.7.4, 26.7.5, 27.1.1, 27.3.1, 27.3.2.5, 27.3.2.6, 27.3.5,
 11 27.3.10.7, 27.3.10.8, 27.3.10.9, 27.3.10.10, 27.3.15 – 27.3.15.3. *See, e.g.*, IEEE
 12 802.11ax Standard at Section 26.7.1 (“Transmit beamforming and DL MU-MIMO
 13 require knowledge of the channel state to compute a steering matrix that is applied
 14 to the transmit signal to optimize reception at one or more receivers. HE STAs use
 15 the HE sounding protocol to determine the channel state information. The HE
 16 sounding protocol provides explicit feedback mechanisms, defined as HE non-
 17 trigger-based (non-TB) sounding and HE trigger-based (TB) sounding, where the
 18 HE beamformee measures the channel using a training signal (*i.e.*, an HE sounding
 19 NDP) transmitted by the HE beamformer and sends back a transformed estimate of
 20 the channel state. The HE beamformer uses this estimate to derive the steering
 21 matrix.”); Section 27.3.15.1 (SU-MIMO and DL-MIMO beamforming) (“The DL
 22 MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user,r}-1}]$ can be detected by
 23 the beamformer using the beamforming feedback for subcarrier k from beamformee
 24 u , where $u = 0, 1, \dots, N_{user,r} - 1$. The feedback report format is described in 9.4.1.65
 25 (HE Compressed Beamforming Report field) and 9.4.1.66 (HE MU Exclusive
 26 Beamforming Report field). The steering matrix that is computed (or updated) using
 27 new beamforming feedback from some or all of participating beamformees might
 28 replace the existing steering matrix Q_k for the next DL MU-MIMO data

1 transmission. For SU-MIMO beamforming, the steering matrix Q_k can be
2 determined from the beamforming feedback matrix V_k that is sent back to the
3 beamformer by the beamformee using the compressed beamforming feedback
4 matrix format as defined in 19.3.12.3.6 (Compressed beamforming feedback
5 matrix). The feedback report format is described in 9.4.1.65 (HE Compressed
6 Beamforming Report field.”); Section 9.4.1.65 (HE Compressed Beamforming
7 Report field) (“The HE Compressed Beamforming Report field carries the average
8 SNR of each space-time stream and compressed beamforming feedback matrices V
9 for use by a transmit beamformer to determine steering matrices Q , as described in
10 10.32.3 (Explicit feedback beamforming) and 19.3.12.3 (Explicit feedback
11 beamforming”); Section 9.1.4.66 (HE MU Exclusive Beamforming Report field)
12 (“The HE MU Exclusive Beamforming Report field carries explicit feedback in the
13 form of delta SNRs. The information in the HE Compressed Beamforming Report
14 field and the HE MU Exclusive Beamforming Report field can be used by the
15 transmit MU beamformer to determine the steering matrices Q , as described in
16 27.3.3.1 (DL MU-MIMO)”); Section 9.4.1.67 (HE CQI Report Field) (“The HE CQI
17 Report field carries the per-RU average SNRs of each space-time stream, where each
18 per-RU average SNR is the arithmetic mean of the SNR in decibels over a 26-tone
19 RU for which the feedback is being requested.”); Section 27.3.10.10 (HE-LTF)
20 (“The HE-LTF field provides a means for the receiver to estimate the MIMO channel
21 between the set of constellation mapper outputs (or, if STBC is applied, the STBC
22 encoder outputs) and the receive chains. In an HE SU PPDU and HE ER SU PPDU,
23 the transmitter provides training for NSTS space-time streams (spatial mapper
24 inputs) used for the transmission of the PSDU. In an HE MU PPDU, the transmitter
25 provides training for NSTS_{r,total} space-time streams used for the transmission of
26 the PSDU(s) in the r-th RU. In an HE TB PPDU, the transmitter of user u in the r-th
27 RU provides training for NSTS_{r,u} space-time streams used for the transmission of
28 the PSDU. For each tone in the r-th RU, the MIMO channel that can be estimated is

1 an $\text{NRX} \times \text{NSTS}_{r,\text{total}}$ matrix. An HE transmission has a preamble that contains
 2 HE-LTF symbols, where the data tones of each HE-LTF symbol are multiplied by
 3 entries belonging to a matrix PHE-LTF, to enable channel estimation at the
 4 receiver.... In an HE SU PPDU, HE MU PPDU and HE ER SU PPDU, the
 5 combination of HE-LTF type and GI duration is indicated in HE-SIG-A field. In an
 6 HE TB PPDU, the combination of HE-LTF type and GI duration is indicated in the
 7 Trigger frame that triggers transmission of the PPDU. If an HE PPDU is an HE
 8 sounding NDP, the combinations of HE-LTF types and GI durations are listed in
 9 27.3.18 (Transmit specification). If an HE PPDU is an HE TB feedback NDP, the
 10 combination of HE-LTF types and GI durations are listed in 27.3.4 (HE PPDU
 11 formats.”).

12 29. Each of the Accused Products is configured to allow the receiving device
 13 to operatively associate with the different beam downlink if determining that the
 14 receiving device should operatively associate with the different beam downlink. For
 15 example, as with each Accused Product, the D-Link DAP-X2810 is configured to
 16 allow the receiving device (*e.g.*, STA or HE beamformee) to operatively associate
 17 with a different beam downlink if determining that the receiving device should
 18 operatively associate with the different beam downlink. *See, e.g.*, IEEE 802.11ax
 19 Standard, at Sections 9.3.1.22, 9.4.1.64, 9.4.1.65, 9.4.1.66, 9.4.1.67, 26.5, 26.5.1,
 20 26.5.2, 26.5.3, 26.7, 26.7.1, 26.7.3, 26.7.3, 26.7.4, 26.7.5, 27.1.1, 27.3.1, 27.3.2.5,
 21 27.3.2.6, 27.3.5, 27.3.10.7, 27.3.10.8, 27.3.10.9, 27.3.10.10, 27.3.15 – 27.3.15.3.
 22 *See, e.g.*, IEEE 802.11ax Standard, 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

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 27.3.15.2 (“After receiving the angle
 8 information, $\phi(k,u)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-
 9 79). For SU-MIMO beamforming, the beamformer uses $V_{k,0}$ matrix to determine the
 10 steering matrix Q_k . For DL MU-MIMO beamforming, the beamformer may calculate
 11 a 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
 12 $\leq u \leq N_{user,r}-1$) in order to suppress crosstalk between participating beamformees. The
 13 method used by the beamformer to calculate the steering matrix Q_k is
 14 implementation specific.”); Section 27.3.2.5 (Resource indication and User
 15 identification in an HE MU PPDU) (“The number of users in the MU-MIMO group
 16 is indicated in the Number Of HE-SIG-B Symbols Or MU-MIMO Users field in HE-
 17 SIG-A. The allocated spatial streams for each user and the total number of spatial
 18 streams are indicated in the Spatial Configuration field of User field in HE-SIG-B
 19 containing the STA-ID of the designated MU-MIMO STA as defined in Table 27-
 20 29 (Spatial Configuration subfield encoding)...[i]f there is only one User field (see
 21 Table 27-27 (User field format for a non-MU-MIMO allocation)) for an RU in the
 22 HE-SIG-B content channel, then the number of spatial streams for the user in the
 23 RU is indicated by the N_{STS} field in the User field. If there is more than one User
 24 field (see Table 27-28 (User field for an MU-MIMO allocation)) for an RU in the
 25 HE-SIG-B content channel, then the number of allocated spatial streams for each
 26 user in the RU is indicated by the Spatial Configuration field of the User field in HE-
 27 SIG-B.”); Section 27.3.2.6 (“UL MU transmissions are preceded by a Trigger frame
 28 or frame carrying a TRS Control subfield from the AP. The Trigger frame or frame

1 carrying the TRS Control subfield indicates the parameters, such as the duration of
2 the HE TB PDU, RU allocation, target RSSI and MCS (see 9.3.1.22 (Trigger frame
3 format), 9.2.4.6a.1 (TRS Control) and 26.5.3.3 (Non-AP STA behavior for UL MU
4 operation)), required to transmit an HE TB PDU.”); Section 9.3.1.22 (Trigger
5 frame format) (“A Trigger frame allocates resources for and solicits one or more HE
6 TB PDU transmissions. The Trigger frame also carries other information required
7 by the responding STA to send an HE TB PDU... The SS Allocation subfield of
8 the User Info field indicates the spatial streams of the solicited HE TB PDU and
9 the format is defined in Figure 9-64e (SS Allocation subfield format).”); Section
10 26.5.3.3.3 (TXVECTOR parameters for HE TB PDU response to Trigger frame).

11 30. Each of the Accused Products is configured to actively probe the receiving
12 device by generating a signal to initiate that the phased array antenna transmits at
13 least one downlink transmittable message over the different beam downlink, and
14 gathering signal parameter information from uplink transmittable messages received
15 from the receiving device through the phased array antenna. For example, as with
16 each Accused Product, the D-Link DAP-X2810 actively probes the receiving device
17 by generating a signal causing the phased array antenna to transmit at least one
18 downlink transmittable message over the different beam downlink (*e.g.*, one or more
19 messages sent to elicit a responsive uplink transmission from the receiving STA,
20 including, *e.g.*, HE PDU that carries a trigger frame, *e.g.*, messages soliciting
21 feedback or including parameters for feedback from HE beamformee(s) such as, *e.g.*,
22 messages pursuant to HE non-TB or HE TB sounding, such as, *e.g.*, NDP
23 Announcement, HE sounding NDP frame, Trigger frame), and gathering signal
24 parameter information (*e.g.*, information in an HE compressed beamforming/CQI
25 report, RSSI, SNR, delta SNR measurements for spatial stream(s), or information
26 gathered from training fields in uplink PDUs) from uplink transmittable messages
27 received from the receiving device (*e.g.*, STA or HE beamformee) through the
28 phased array antenna (*e.g.*, uplink transmittable messages received from the STA

1 such as in response to a trigger frame soliciting an uplink transmission, including,
2 *e.g.*, HE TB PPDUs, further including, *e.g.*, an uplink transmission that includes
3 information regarding an estimate of the channel state in, *e.g.*, an HE compressed
4 beamforming/CQI report carried in one or more HE Compressed Beamforming/CQI
5 frames). See, *e.g.*, IEEE 802.11ax Standard, Sections 9.6.31.2, 9.4.1.64, 9.4.1.65,
6 9.4.1.66, 9.4.1.67, 26.7.1 – 26.7.5, 27.3.1, 27.3.1.1, 27.3.2.5, 27.3.2.6, 27.3.3,
7 27.3.3.1, 27.3.3.1.1, 27.3.3.1.2, 27.3.3.2.2, - 27.3.3.2.4, 27.3.4, 9.3.1.22, 26.5.3,
8 27.3.10.8, 27.3.10.8.5, 27.3.10.10, 27.3.15, 27.3.16, 27.3.17. See, *e.g.*, IEEE
9 802.11ax Standard, Section 26.7 (“Transmit beamforming and DL MU-MIMO
10 require knowledge of the channel state to compute a steering matrix that is applied
11 to the transmit signal to optimize reception at one or more receivers. HE STAs use
12 the HE sounding protocol to determine the channel state information. The HE
13 sounding protocol provides explicit feedback mechanisms, defined as HE non-
14 trigger-based (non-TB) sounding and HE trigger-based (TB) sounding, where the
15 HE beamformee measures the channel using a training signal (*i.e.*, an HE sounding
16 NDP) transmitted by the HE beamformer and sends back a transformed estimate of
17 the channel state. The HE beamformer uses this estimate to derive the steering
18 matrix.”); Section 27.3.2.5 (“HE-LTF symbols in the DL HE MU PPDUs are used to
19 measure the channel for the space-time streams intended for the STA and can also
20 be used to measure the channel for the interfering space-time streams.”); Section
21 27.3.4 (HE PPDUs formats) (“Four HE PPDUs formats are defined: HE SU PDU,
22 HE MU PDU, HE ER SU PDU, and HE TB PDU. The HE sounding NDP is a
23 variant of the HE SU PDU and defined in 27.3.16 (HE sounding NDP). The HE
24 TB feedback NDP is a variant of the HE TB PDU and defined in 27.3.17 (HE TB
25 feedback NDP)”; Section 27.3.10.10 (HE-LTF) (“The HT-LTF field provides a
26 means for the receiver to estimate the MIMO channel between the set of
27 constellation mapper outputs (or, if STBC is applied, the STBC encoder outputs)
28 and the receive chains.”); Section 26.5.3.3.3 (TXVECTOR parameters for HE TB

1 PPDU response to Trigger frame); Section 27.3.2.6 (“UL MU transmissions are
2 preceded by a Trigger frame or frame carrying a TRS Control subfield from the AP.
3 The Trigger frame or frame carrying the TRS Control subfield indicates the
4 parameters, such as the duration of the HE TB PDU, RU allocation, target RSSI
5 and MCS (see 9.3.1.22 (Trigger frame format), 9.2.4.6a.1 (TRS Control) and
6 26.5.3.3 (Non-AP STA behavior for UL MU operation)), required to transmit an HE
7 TB PDU.”); Section 9.3.1.22 (Trigger frame format) (“A Trigger frame allocates
8 resources for and solicits one or more HE TB PDU transmissions. The Trigger
9 frame also carries other information required by the responding STA to send an HE
10 TB PDU... The SS Allocation subfield of the User Info field indicates the spatial
11 streams of the solicited HE TB PDU and the format is defined in Figure 9-64e (SS
12 Allocation subfield format).”) Section 27.2.2 (TXVECTOR and RXVECTOR
13 parameters) (EXPANSION_MAT, CHAN_MAT, DELTA_SNR, SNR, CQI,
14 STBC, GI_TYPE, RSSI, RSSI_LEGACY, NUM_STS, RU_ALLOCATION,
15 BEAMFORMED, HE_LTF_TYPE, HE_LTF_MODE, NUM_HE_LTF,
16 STARTING_STS_NUM, PREAMBLE_TYPE, TRIGGER_METHOD,
17 BEAM_CHANGE, BSS_COLOR, UPLINK_FLAG, STA_ID_LIST,
18 NDP_REPORT, FEEDBACK_STATUS, RU_TONE_SET_INDEX); Section
19 26.5.3.2.4 (Allowed settings of the Trigger frame fields and TRS Control subfield)
20 (“An AP shall transmit an HE PDU that carries a Trigger frame or frame that
21 includes a TRS Control subfield with the TXVECTOR parameter
22 BEAM_CHANGE set to 1.”). Section 26.5.3.3 (Non-AP STA behavior for UL MU
23 operation) (“UL MU operation allows an AP to solicit simultaneous immediate
24 response frames from one or more non-AP STAs. A non-AP STA shall follow the
25 rules in this subclause for the transmission of response frames in an HE TB PDU
26 unless the Trigger frame is an MU-RTS Trigger frame, in which case the response
27 is a CTS frame sent in a non-HT PDU (see 26.2.6 (MU-RTS Trigger/CTS frame
28 exchange procedure)).”); Section 26.11 (Setting TXVECTOR parameters for an HE

1 PPDU); Section 26.11.3 (BEAM_CHANGE) (“An HE STA uses the TXVECTOR
 2 parameter BEAM_CHANGE to indicate a change in the spatial mapping of the pre-
 3 HE-STF portion of the PPDU and the first symbol of HE-LTF (see Table 27-1
 4 (TXVECTOR and RXVECTOR parameter)). An HE STA that transmits an HE SU
 5 PPDU or an HE ER SU PPDU shall set the TXVECTOR parameter
 6 BEAM_CHANGE to 1 if one or more of the following conditions are met: - The
 7 number of spatial streams is greater than 2; - The PPDU is the first PPDU in a TXOP;
 8 - The PPDU carries a Trigger frame.”).

9 31. The Accused Products determine a current position of the receiving device
 10 relative to the phased array antenna from the uplink transmission received from the
 11 receiving device through the phased array antenna. For example, as with each
 12 Accused Product, the D-Link DAP-X2810 determines a current position of the
 13 receiving device (*e.g.*, STA or HE beamformee) relative to the phased array antenna
 14 from the uplink transmission received from the receiving device through the phased
 15 array antenna (*e.g.*, uplink transmission received from the STA such as in response
 16 to a trigger frame soliciting an uplink transmission, including, *e.g.*, HE TB PPDUs,
 17 further including, *e.g.*, an uplink transmission that includes information regarding an
 18 estimate of the channel state in, *e.g.*, an HE compressed beamforming/CQI report
 19 carried in one or more HE Compressed Beamforming/CQI frames). *See, e.g.*, D-Link
 20 Nuclias Connect AX1800 Wi-Fi 6 Access Point DAP-X2810,
 21 [https://www.dlink.com/en/products/dap-x2810-nuclias-connect-ax1800-wi-fi-6-](https://www.dlink.com/en/products/dap-x2810-nuclias-connect-ax1800-wi-fi-6-access-point)
 22 [access-point](https://www.dlink.com/en/products/dap-x2810-nuclias-connect-ax1800-wi-fi-6-access-point) (“The DAP-X2810 is empowered with next generation Wi-Fi 6.
 23 Enhanced MU-MIMO with even more uplink and downlink streams serves more
 24 devices simultaneously. OFDMA dramatically increases transmission efficiency and
 25 1024-QAM packs even more data, bringing unadulterated speed increases of a
 26 searing 25%.”); D-Link DAP-X2810 Datasheet, available at
 27 [https://www.dlink.com/-/media/global-pdfs/global-](https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf)
 28 [datasheets/dap/dapx2810a1datasheetv100ww.pdf](https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf) (“Wi-Fi 6 delivers greater

1 network efficiency and lower latency, with nearly four times the capacity of previous
 2 Wi-Fi standards”; “MU-MIMO slices through congestion, reducing wait time for all
 3 users”; “2 x dual-band internal antennas”). *See, e.g.*, IEEE 802.11ax Standard,
 4 Sections 9.6.31.2, 9.4.1.64, 9.4.1.65, 9.4.1.66, 9.4.1.67, 26.7.1 – 26.7.5, 27.3.1,
 5 27.3.1.1, 27.3.2.5, 27.3.2.6, 27.3.3, 27.3.3.1, 27.3.3.1.1, 27.3.3.1.2, 27.3.3.2.2, -
 6 27.3.3.2.4, 27.3.4, 9.3.1.22, 26.5.3, 27.3.10.8, 27.3.10.8.5, 27.3.10.10, 27.3.15,
 7 27.3.16, 27.3.17, Table 27-1. *See, e.g.*, IEEE 802.11ax Standard, at Section 27.3.1.1
 8 (“The transmission within an RU in a PPDU may be single stream to one user,
 9 spatially multiplexed to one user (SU-MIMO), or spatially multiplexed to multiple
 10 users (MU-MIMO).”); Section 27.3.10.10 (HE-LTF) (“The HT-LTF field provides
 11 a means for the receiver to estimate the MIMO channel between the set of
 12 constellation mapper outputs (or, if STBC is applied, the STBC encoder outputs)
 13 and the receive chains.”); Section 27.3.15 (SU-MIMO and DL-MIMO
 14 beamforming); Section 27.3.15.1 (“SU-MIMO and DL-MU-MIMO beamforming
 15 are techniques used by a STA with multiple antennas (the beamformer) to steer
 16 signals using knowledge of the channel to improve throughput. With SU-MIMO
 17 beamforming all space-time streams in the transmitted signal are intended for
 18 reception at a single STA in an RU. With DL MU-MIMO beamforming, disjoint
 19 subsets of the space-time streams are intended for reception at different STAs in an
 20 RU of size greater than or equal to 106-tones.”); Section 27.3.15.2 (“After receiving
 21 the angle information, $\phi(k,u)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using
 22 Equation (19-79). For SU-MIMO beamforming, the beamformer uses $V_{k,0}$ matrix to
 23 determine the steering matrix Q_k . For DL MU-MIMO beamforming, the beamformer
 24 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
 25 $\Delta SNR_{k,u}$ ($0 \leq u \leq N_{user,r}-1$) in order to suppress crosstalk between participating
 26 beamformees. The method used by the beamformer to calculate the steering matrix
 27 Q_k is implementation specific.”).
 28

1 32. Defendant has been and is now indirectly infringing at least one claim of
2 the '728 Patent in accordance with 35 U.S.C. § 271(b) in this district and elsewhere
3 in the United States. More specifically, Defendant has been and is now actively
4 inducing direct infringement by other persons (*e.g.*, Defendant's customers who use,
5 sell or offer for sale the Accused Products).

6 33. By at least the filing and service of the original Complaint for patent
7 infringement in this United States District Court for the Central District of California
8 on April 19, 2017, and July 14, 2017, respectively, Defendant had knowledge of the
9 '728 Patent, and that its actions resulted in a direct infringement of the '728 Patent.
10 Defendant also knew or was willfully blind that its actions would induce direct
11 infringement by others and intended that its actions would induce direct
12 infringement by others.

13 34. Despite this knowledge of the '728 Patent, Defendant actively induced,
14 and continues to induce, such infringement by, among other things, providing user
15 manuals and other instruction material for its Accused Products that induce its
16 customers to use the Accused Products in their normal and customary way to
17 infringe the '728 Patent. For example, Defendant's website provided, and continues
18 to provide, instructions for using the Accused Products on wireless communication
19 systems, and to utilize their 802.11ax beamforming and MU-MIMO functionalities.
20 Defendant sold, and continues to sell, the Accused Products to customers despite its
21 knowledge of the '728 Patent. Defendant manufactured and imported into the United
22 States, and continues to do so, the Accused Products for sale and distribution to its
23 customers, despite its knowledge of the '728 Patent. Through its continued
24 manufacture, importation, and sales of its Accused Products, Defendant specifically
25 intended for its customers to infringe claims of the '728 Patent. Further, Defendant
26 was aware that these normal and customary activities would infringe the '728 Patent.
27 Defendant performed, and continues to perform, acts that constitute induced
28 infringement, and that would induce actual infringement, with knowledge of the

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1 '728 Patent and with the knowledge or willful blindness that the induced acts would
2 constitute direct infringement.

3 35. Accordingly, a reasonable inference is that Defendant specifically intended
4 for others, such as its customers, to directly infringe one or more claims of the '728
5 Patent in the United States because Defendant had knowledge of the '728 Patent and
6 actively induced others (*e.g.*, its customers) to directly infringe the '728 Patent by
7 using, selling, or offering to sell the Accused Products and the 802.11ax MU-MIMO
8 functionality within the Accused Products.

9 36. Defendant also contributorily infringes by making, using, selling, offering
10 to sell, and/or importing the Accused Products, knowing they constitute a material
11 part of the invention, are especially made or adapted for use in infringing, and that
12 they are not staple articles of commerce capable of substantial non-infringing use.

13 37. Defendant also infringes claims 3, 5, and 12, of the '728 Patent, directly
14 and through inducing infringement, for similar reasons as explained above with
15 respect to Claim 4.

16 38. The '728 Patent is valid and enforceable.

17 39. As a result of Defendant's infringement of the '728 Patent, Defendant's
18 infringement of the '728 Patent has damaged Vivato, and Defendant is liable to
19 Vivato in an amount to be determined at trial that compensates Vivato for the
20 infringement, which by law can be no less than a reasonable royalty, together with
21 interest and costs as fixed by the Court.

22 40. As a result of Defendant's infringement of the '728 Patent, Vivato has
23 suffered irreparable harm and will continue to suffer loss and injury. Defendant's
24 infringing activities have injured and will continue to injure Vivato, unless and until
25 this Court enters an injunction prohibiting further infringement of the '728 Patent,
26 and, specifically, enjoining further manufacture, use, sale, importation, and/or offers
27 for sale that come within the scope of the patent claims.

28

1 **V. COUNT TWO: INFRINGEMENT OF UNITED STATES**
2 **PATENT NO. 10,594,376**

3 41. Vivato realleges and incorporates by reference the foregoing paragraphs as
4 if fully set forth herein.

5 42. On March 17, 2020, United States Patent No. 10,594,376 (“the ’376
6 Patent”) was duly and legally issued for inventions entitled “Directed Wireless
7 Communication.” Vivato owns the ’376 Patent and holds the right to sue and recover
8 damages for infringement thereof. A copy of the ’376 Patent is attached hereto as
9 Exhibit B.

10 43. Defendant has directly infringed and continues to directly infringe
11 numerous claims of the ’376 Patent, including at least claim 1, by manufacturing,
12 using, selling, offering to sell, and/or importing into the United States Wi-Fi 6 access
13 points and routers supporting MU-MIMO, including without limitation access points
14 and routers utilizing the IEEE 802.11ax or “Wi-Fi 6” standard (*e.g.*, DIR-X1560,
15 DIR-X1860, DIR-X1870, DIR-X4860, DIR-X5460, DIR-X6060, DIR-LX1870,
16 DBA-X2830P, DBA-X1230P, DAP-X1860, DAP-X1870, DAP-X2810, DAP-
17 X2850, DWL-X8630AP, COVR-X1874, COVR-X1873, COVR-X1872, COVR-
18 X1870, COVR-X1870 Series, COVR-X1860 Series, COVR-X1860, COVR-X1862,
19 COVR-X1863, COVR-X1864, D-Link AI M32), as well as access points and routers
20 supporting MU-MIMO that utilize the IEEE 802.11ac standard (*e.g.*, DIR-822, DIR-
21 842, DIR-853, DIR-867, DIR-868L, DIR-878, DIR-882, DIR-885L, DIR-895L,
22 DIR-1260, DIR-1360, DIR-1750, DIR-1760, DIR-1950, DIR-1960, DIR-2150,
23 DIR-2640, DIR-2660, DIR-2680, DIR-3040, DIR-3060, DIR-L1900, DBA-1210P,
24 DBA-1510P, DBA-1520P, DBA-2520P, DBA-2620P, DBA-270P, DBA-2820P,
25 DBA3620P, DBA-3612P, DAP-1755, DAP-1820, DAP-1860, DAP-1955, DAP-
26 2610, DAP-2620, DAP-2622, DAP-2662, DAP-2680, DAP-2682, DAP-2695, DAP-
27 2720, DAP-3666, DWL-6620APS, DWL-6720AP, DWL-7620AP, DWL-8620AP,
28 DWL-8620APE, DWL-8720AP, DVG-5402G, DSL-3785, DSL-5300, COVR-

1 1100, COVR-1102, COVR-1103, COVR-C1202, COVR-C1203, COVR-C1210,
 2 COVR-C1213, COVR-1300E, COVR-2200, COVR-2202, COVR-2203, COVR-
 3 2600R, COVR-3902, COVR-P2500, COVR-P2502) (collectively, the “’376
 4 Accused Products”). Defendant is liable for infringement of the ’376 Patent pursuant
 5 to 35 U.S.C. § 271(a).

6 44. The ’376 Accused Products satisfy all claim limitations of numerous
 7 claims of the ’376 Patent, including Claim 1. The following paragraphs compare
 8 limitations of Claim 1 to an exemplary ’376 Accused Product, the D-Link DAP-
 9 X2810² wireless access point.

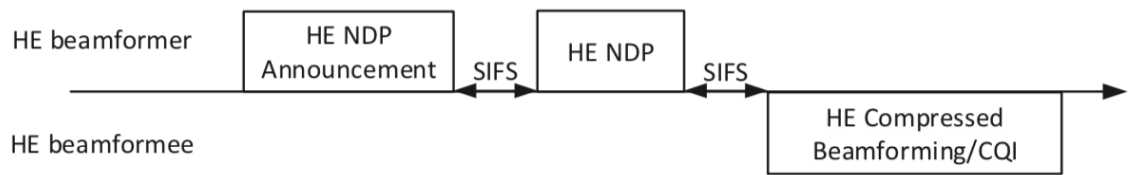
10 45. Each of the ’376 Accused Products comprises a data-communications
 11 networking apparatus. For example, the D-Link DAP-X2810 is a data-
 12 communications networking apparatus. *See, e.g.*, D-Link Nuclias Connect AX1800
 13 Wi-Fi 6 Access Point DAP-X2810, [https://www.dlink.com/en/products/dap-x2810-
 14 nuclias-connect-ax1800-wi-fi-6-access-point](https://www.dlink.com/en/products/dap-x2810-nuclias-connect-ax1800-wi-fi-6-access-point) (“The DAP-X2810 is empowered with
 15 next generation Wi-Fi 6. Enhanced MU-MIMO with even more uplink and downlink
 16 streams serves more devices simultaneously. OFDMA dramatically increases
 17 transmission efficiency and 1024-QAM packs even more data, bringing
 18 unadulterated speed increases of a searing 25%.”); D-Link DAP-X2810 Datasheet,
 19 available at [https://www.dlink.com/-/media/global-
 20 datasheets/dap/dapx2810a1datasheetv100ww.pdf](https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf) (“Wi-Fi 6 delivers greater
 21 network efficiency and lower latency, with nearly four times the capacity of previous
 22 Wi-Fi standards”; “MU-MIMO slices through congestion, reducing wait time for all
 23 users”; “2 x dual-band internal antennas”).

24 46. Each of the ’376 Accused Products comprises a processor configured to
 25 generate a probing signal for transmission to at least a first client device and a second
 26 client device. For example, as with each ’376 Accused Product, the D-Link DAP-
 27

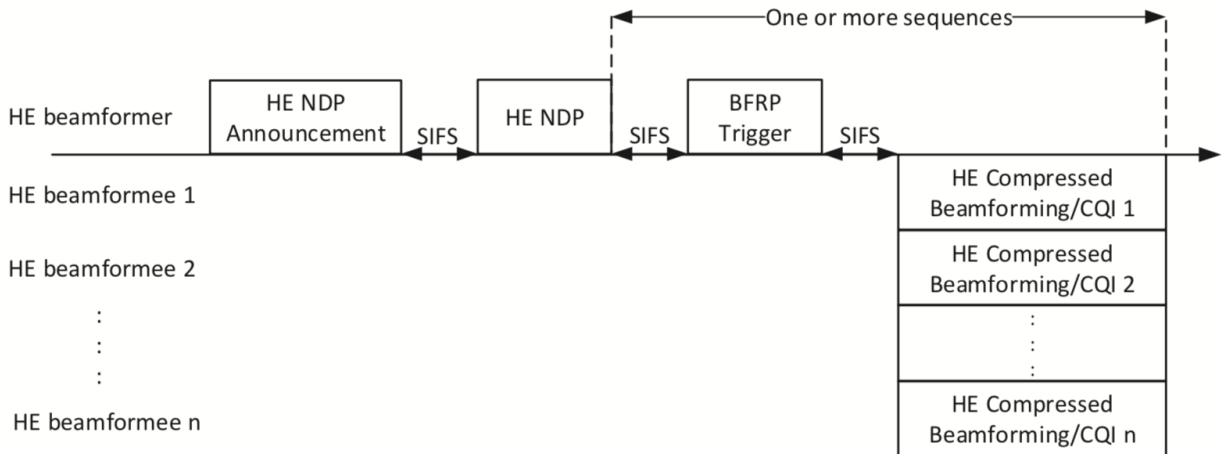
28 ² *See* D-Link DAP-X2810 Datasheet, available at [https://www.dlink.com/-/media/global-
 pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf](https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf).

1 X2810 has at least one processor (*e.g.*, one or more central processing units (CPUs),
2 Wi-Fi processors, a baseband processor in the Wi-Fi 6 radio, as examples) for
3 generating signals for transmission. *See, e.g.*, D-Link Nuclias Connect AX1800 Wi-
4 Fi 6 Access Point DAP-X2810, [https://www.dlink.com/en/products/dap-x2810-
5 nuclias-connect-ax1800-wi-fi-6-access-point](https://www.dlink.com/en/products/dap-x2810-nuclias-connect-ax1800-wi-fi-6-access-point) (“The DAP-X2810 is empowered with
6 next generation Wi-Fi 6. Enhanced MU-MIMO with even more uplink and downlink
7 streams serves more devices simultaneously. OFDMA dramatically increases
8 transmission efficiency and 1024-QAM packs even more data, bringing
9 unadulterated speed increases of a searing 25%.”); D-Link DAP-X2810 Datasheet,
10 available at [https://www.dlink.com/-/media/global-pdfs/global-
11 datasheets/dap/dapx2810a1datasheetv100ww.pdf](https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf) (“Wi-Fi 6 delivers greater
12 network efficiency and lower latency, with nearly four times the capacity of previous
13 Wi-Fi standards”; “MU-MIMO slices through congestion, reducing wait time for all
14 users”; “2 x dual-band internal antennas”). For a further example, as with each
15 Accused Product, the D-Link DAP-X2810 generates a probing signal for
16 transmission (*e.g.*, a probing signal transmission that triggers or elicits a responsive
17 transmission from each of a first client device and a second client device, such as
18 NDP Announcement, HE sounding NDP, Beamforming Report trigger frames
19 pursuant to High Efficiency (HE) channel sounding, including preamble training
20 fields allowing an estimate of the channel for MU-MIMO) to at least a first client
21 device and a second client device (*e.g.*, a first non-AP STA / HE beamformee and a
22 second non-AP STA / HE beamformee). *See, e.g.*, 802.11ax Standard, Sections
23 9.3.1.19, 9.3.1.22, 9.3.1.22.3, 9.4.1.64, 9.4.1.65, 9.4.1.66, 9.4.1.67, 9.6.31.2, 10.37,
24 26.7, 26.7.1, 26.7.2, 26.7.3, 26.7.4, 26.7.5, 27.1.1. *See, e.g.*, Section 26.7 (HE
25 sounding protocol) (“Transmit beamforming and DL MU-MIMO require knowledge
26 of the channel state to compute a steering matrix that is applied to the transmit signal
27 to optimize reception at one or more receivers. HE STAs use the HE sounding
28 protocol to determine the channel state information. The HE sounding protocol

1 provides explicit feedback mechanisms, defined as HE non-trigger-based (non-TB)
 2 sounding and HE trigger-based (TB) sounding, where the HE beamformee measures
 3 the channel using a training signal (*i.e.*, an HE sounding NDP) transmitted by the
 4 HE beamformer and sends back a transformed estimate of the channel state. The HE
 5 beamformer uses this estimate to derive the steering matrix. The HE beamformee
 6 returns an estimate of the channel state in an HE compressed beamforming/CQI
 7 report carried in one or more HE Compressed Beamforming/CQI frames.”); Section
 8 26.7.3, Figures 26-6 and 26-7



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



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

22 ; Section 26.7.3 (“An HE beamformee that receives an HE NDP Announcement
 23 frame from an HE beamformer with which it is associated and that contains the HE
 24 beamformee’s MAC address in the RA field and also receives an HE sounding NDP
 25 a SIFS after the HE NDP Announcement frame shall transmit its HE compressed
 26 beamforming/CQI report a SIFS after the HE sounding NDP. The TXVECTOR
 27 parameter CH_BANDWIDTH for the PPDU containing the HE compressed
 28 beamforming/CQI report shall be set to indicate a bandwidth not wider than that

1 indicated by the RXVECTOR parameter CH_BANDWIDTH of the HE sounding
 2 NDP. An HE beamformee that receives an HE NDP Announcement frame as part of
 3 an HE TB sounding sequence with a STA Info field addressed to it soliciting SU or
 4 MU feedback shall generate an HE compressed beamforming/CQI report using the
 5 feedback type, N_g and codebook size indicated in the STA Info field. If the HE
 6 beamformee then receives a BFRP Trigger frame with a User Info field addressed
 7 to it, the HE beamformee transmits an HE TB PPDU containing the HE compressed
 8 beamforming/CQI report following the rules defined in 26.5.3.3 (Non-AP STA
 9 behavior for UL MU operation.”); Section 26.5.3 (UL MU operation) (“UL MU
 10 operation allows an AP to solicit simultaneous immediate response frames from one
 11 or more non-AP HE STAs”); Section 27.3.10.10 (HE-LTF) (“The HE-LTF field
 12 provides a means for the receiver to estimate the MIMO channel between the set of
 13 constellation mapper outputs (or, if STBC is applied, the STBC encoder outputs)
 14 and the receive chains. In an HE SU PPDU and HE ER SU PPDU, the transmitter
 15 provides training for N_{STS} space-time streams (spatial mapper inputs) used for the
 16 transmission of the PSDU. In an HE MU PPDU, the transmitter provides training
 17 for $N_{STS,r,total}$ space-time streams used for the transmission of the PSDU(s) in the r -th
 18 RU. In an HE TB PPDU, the transmitter of user u in the r -th RU provides training
 19 for $N_{STS,r,u}$ space-time streams used for the transmission of the PSDU. For each tone
 20 in the r -th RU, the MIMO channel that can be estimated is an $N_{RX} \times N_{STS,r,total}$ matrix.
 21 An HE transmission has a preamble that contains HE-LTF symbols, where the data
 22 tones of each HE-LTF symbol are multiplied by entries belonging to a matrix P_{HE-}
 23 LTF , to enable channel estimation at the receiver.... In an HE SU PPDU, HE MU
 24 PPDU and HE ER SU PPDU, the combination of HE-LTF type and GI duration is
 25 indicated in HE-SIG-A field. In an HE TB PPDU, the combination of HE-LTF type
 26 and GI duration is indicated in the Trigger frame that triggers transmission of the
 27 PPDU. If an HE PPDU is an HE sounding NDP, the combinations of HE-LTF types
 28 and GI durations are listed in 27.3.18 (Transmit specification). If an HE PPDU is an

1 HE TB feedback NDP, the combination of HE-LTF types and GI durations are listed
2 in 27.3.4 (HE PPDU formats.”); Section 27.3.15.1 (SU-MIMO and DL-MIMO
3 beamforming) (“The DL MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user,r}-1}]$
4 can be detected by the beamformer using the beamforming feedback for subcarrier
5 k from beamformee u , where $u = 0, 1, \dots, N_{user,r} - 1$. The feedback report format is
6 described in 9.4.1.65 (HE Compressed Beamforming Report field) and 9.4.1.66 (HE
7 MU 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. For SU-MIMO beamforming, the steering matrix Q_k can
11 be determined from the beamforming feedback matrix V_k that is sent back to the
12 beamformer by the beamformee using the compressed beamforming feedback
13 matrix format as defined in 19.3.12.3.6 (Compressed beamforming feedback
14 matrix). The feedback report format is described in 9.4.1.65 (HE Compressed
15 Beamforming Report field.”). Section 9.4.1.65 (HE Compressed Beamforming
16 Report field) (“The HE Compressed Beamforming Report field carries the average
17 SNR of each space-time stream and compressed beamforming feedback matrices V
18 for use by a transmit beamformer to determine steering matrices Q , as described in
19 10.32.3 (Explicit feedback beamforming) and 19.3.12.3 (Explicit feedback
20 beamforming”); Section 9.4.1.66 (HE MU Exclusive Beamforming Report field)
21 (“The HE MU Exclusive Beamforming Report field carries explicit feedback in the
22 form of delta SNRs. The information in the HE Compressed Beamforming Report
23 field and the HE MU Exclusive Beamforming Report field can be used by the
24 transmit MU beamformer to determine the steering matrices Q , as described in
25 27.3.3.1 (DL MU-MIMO)”); Section 9.4.1.67 (HE CQI Report Field) (“The HE CQI
26 Report field carries the per-RU average SNRs of each space-time stream, where each
27 per-RU average SNR is the arithmetic mean of the SNR in decibels over a 26-tone
28 RU for which the feedback is being requested.”). For a further example, as with

1 each '376 Accused Product, the D-Link DAP-X2810 generates a probing signal for
2 transmission (*e.g.*, a probing signal transmission that triggers or elicits a responsive
3 transmission from each of a first client device and a second client device, such as
4 NDP Announcement pursuant to Very High Throughput (VHT) channel sounding,
5 including preamble training fields allowing an estimate of the channel for MU-
6 MIMO) to at least a first client device and a second client device (*e.g.*, a first non-
7 AP STA / VHT beamformee and a second non-AP STA / VHT beamformee). See,
8 *e.g.*, 802.11ac Standard Clause 9.31.5.2 (“A VHT beamformer shall initiate a
9 sounding feedback sequence by transmitting a VHT NDP Announcement frame
10 followed by a VHT NDP after a SIFS. The VHT beamformer shall include in the
11 VHT NDP Announcement frame one STA Info field for each VHT beamformee that
12 is expected to prepare VHT Compressed Beamforming feedback and shall identify
13 the VHT beamformee by including the VHT beamformee’s AID in the AID subfield
14 of the STA Info field. The VHT NDP Announcement frame shall include at least
15 one STA Info field.”); *id.* (“A non-AP VHT beamformee that receives a VHT NDP
16 Announcement frame... shall transmit its VHT Compressed Beamforming feedback
17 a SIFS after receiving a Beamforming Report Poll with RA matching its MAC
18 address and a non-bandwidth signaling TA obtained from the TA field matching the
19 MAC address of the VHT beamformer.”); *id.* Clause 8.5.23.2 (defining format and
20 subfields within the VHT Compressed Beamforming frame); *id.* Clause 8.4.1.48
21 (including Tables 8-53(d)-(h)) (“Each SNR value per tone in stream *i* (before being
22 averaged) corresponds to the SNR associated with the column *i* of the beamforming
23 feedback matrix *V* determined at the beamformee”); *id.* Clause 8.4.1.49 (including
24
25
26
27
28

1 Table 8-53i – MU Exclusive Beamforming Report information); *id.* Clauses
 2 8.4.1.24, 9.31.5.1, 9.31.5.2; *id.* Clause 22.3.8.3.5; *id.* Clause 22.3.11.2:

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

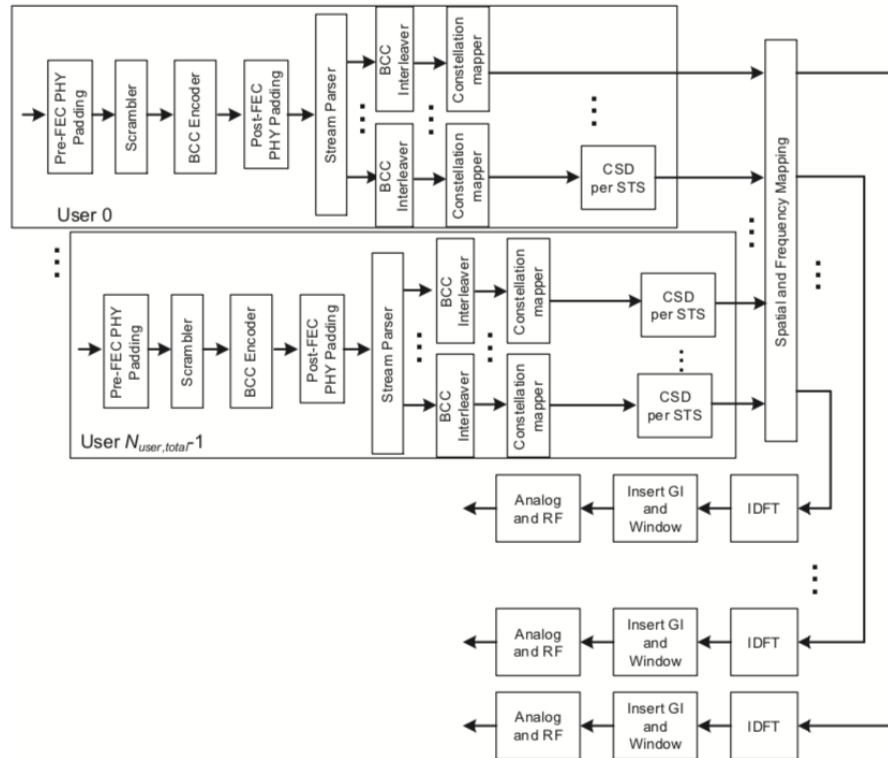
11 The beamformee shall generate the beamforming feedback matrices with the number of rows (N_r) equal to
 12 the N_{STS} of the NDP.

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

19 47. Each of the '376 Accused Products comprises a processor configured to
 20 generate a first data stream for transmission to the first client device and generate a
 21 second data stream for transmission to the second client device. For example, as with
 22 each Accused Product, the D-Link DAP-X2810 has at least one processor and Wi-
 23 Fi 6 radio functionality (*e.g.*, the CPU(s) and/or Wi-Fi processors and/or baseband
 24 processor(s) in the Wi-Fi 6 radio) configured to generate a first data stream for
 25 transmission to the first client device (“non-AP STA” or “non-Access Point
 26 Station”) and a second data stream for transmission to a second client device (non-
 27 AP STA) pursuant to MU-MIMO transmissions. *See, e.g.*, D-Link Nuclias Connect
 28 AX1800 Wi-Fi 6 Access Point DAP-X2810,
[https://www.dlink.com/en/products/dap-x2810-nuclias-connect-ax1800-wi-fi-6-
 access-point](https://www.dlink.com/en/products/dap-x2810-nuclias-connect-ax1800-wi-fi-6-access-point) (“The DAP-X2810 is empowered with next generation Wi-Fi 6.
 Enhanced MU-MIMO with even more uplink and downlink streams serves more
 devices simultaneously. OFDMA dramatically increases transmission efficiency and
 1024-QAM packs even more data, bringing unadulterated speed increases of a
 searing 25%."); D-Link DAP-X2810 Datasheet, available at

1 <https://www.dlink.com/-/media/global-pdfs/global->
2 [datasheets/dap/dapx2810a1datasheetv100ww.pdf](https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf) (“Wi-Fi 6 delivers greater
3 network efficiency and lower latency, with nearly four times the capacity of previous
4 Wi-Fi standards”; “MU-MIMO slices through congestion, reducing wait time for all
5 users”; “2 x dual-band internal antennas”). *See, e.g.*, IEEE 802.11ax Standard, at
6 Sections 26.5, 26.5.1, 26.5.2, 26.5.3, 27.1.1, 27.3.1, 27.3.2.5, 27.3.2.6, 27.3.5,
7 27.3.6.11.4, 27.3.10.7, 27.3.10.8, 27.3.10.9, 27.3.15, including Tables 27-19, 27-20,
8 27-21, 27-24, 27-25, 27-26, 27-27, 27-28, 27-29, Figures 27-19, 27-20, and other
9 transmitter block diagrams for MU-MIMO transmission. *See, e.g.*, Section 27.1.1
10 (“The HE PHY extends the maximum number of users supported for DL MU-MIMO
11 transmissions up to 8 users per resource unit (RU) and provides support for DL and
12 UL orthogonal frequency division multiple access (OFDMA) as well as for UL MU-
13 MIMO. Both DL and UL MU-MIMO transmissions are supported on portions of the
14 PPDU bandwidth (on resource units greater than or equal to 106 tones). In an MU-
15 MIMO resource unit, there is support for up to 8 users with up to 4 space-time
16 streams per user with the total not exceeding 8 space-time streams”); Section
17 27.3.1.1 (“DL MU transmission allows an AP to simultaneously transmit
18 information to more than one non-AP STA. For a DL MU transmission, the AP uses
19 the HE MU PPDU format and employs either DL OFDMA, DL MU-MIMO, or a
20 mixture of both.”); Section 27.3.10.8.1 (“The HE-SIG-B field provides the OFDMA
21 and DL MU-MIMO resource allocation information to allow the STAs to look up
22 the corresponding resources to be used in the data portion of the frame.”); Section
23 27.3.2.5 (“If there is more than one User field (see Table 27-28 (User field for an
24 MU-MIMO allocation)) for an RU in the HE-SIG-B content channel, then the
25 number of allocated spatial streams for each user in the RU is indicated by the Spatial
26 Configuration field of the User field in HE-SIG-B...In each HE-SIG-B content
27 channel, the User fields are first ordered in the order of RUs (from lower frequency
28 to higher frequency) as described by the RU Allocation field if the HE-SIG-B

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



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

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

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27.3.6.11.4 Combining to form an HE MU PPDU

The per user data is combined as follows:

- 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.
- b) IDFT: Compute the inverse discrete Fourier transform.
- 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).
- 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.

27.3.7 HE modulation and coding schemes (HE-MCSs)

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.

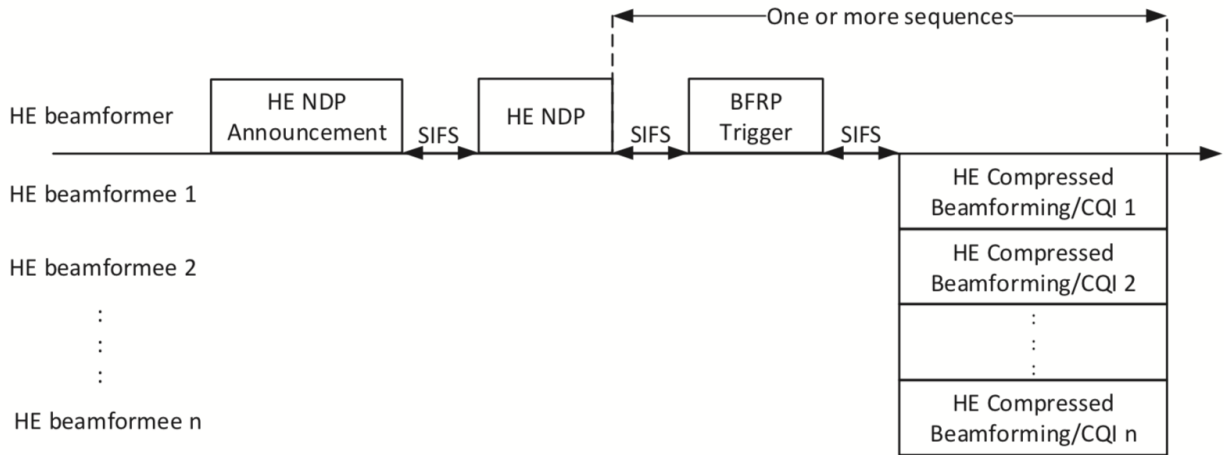
48. For a further example, as with each Accused Product, the D-Link DAP-X2810 has at least one processor and Wi-Fi radio functionality (*e.g.*, the CPU and/or baseband processor(s) in the Wi-Fi radio) configured to generate a first data stream for transmission to the first client device (“non-AP STA” or “non-Access Point Station”) and a second data stream for transmission to a second client device (non-AP STA) pursuant to MU-MIMO transmissions. *See, e.g.*, 802.11ac Standard Clause 9.31.5.1 (“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.”); *id.* Clauses 22.3.4.6(d), 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 mapping: Apply the Q matrix as described in 22.3.10.11.1.”); *id.* Clause 22.3.10.11.1; IEEE 802.11-2012 Standard Clause

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

3 49. 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 D-Link DAP-X2810 has a Wi-Fi 6 radio with a transceiver operatively
9 coupled to the processor (*e.g.*, the Wi-Fi 6 radio generates signals for transmission
10 and processes received signals with, *e.g.*, the CPU, Wi-Fi processors, and/or
11 baseband processor in the Wi-Fi 6 radio, and the radio comprises a transceiver that
12 transmits and receives signals via a smart antenna); and, as with each '376 Accused
13 Product, the D-Link DAP-X2810 has a Wi-Fi 6 radio transceiver operatively coupled
14 to the processor and to a smart antenna, wherein the smart antenna is operatively
15 coupled to the Wi-Fi 6 radio and comprises a first antenna element and a second
16 antenna element. *See, e.g.*, D-Link Nuclias Connect AX1800 Wi-Fi 6 Access Point
17 DAP-X2810, [https://www.dlink.com/en/products/dap-x2810-nuclias-connect-
18 ax1800-wi-fi-6-access-point](https://www.dlink.com/en/products/dap-x2810-nuclias-connect-ax1800-wi-fi-6-access-point) (“The DAP-X2810 is empowered with next generation
19 Wi-Fi 6. Enhanced MU-MIMO with even more uplink and downlink streams serves
20 more devices simultaneously. OFDMA dramatically increases transmission
21 efficiency and 1024-QAM packs even more data, bringing unadulterated speed
22 increases of a searing 25%.”); D-Link DAP-X2810 Datasheet, available at
23 [https://www.dlink.com/-/media/global-pdfs/global-
24 datasheets/dap/dapx2810a1datasheetv100ww.pdf](https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf) (“Wi-Fi 6 delivers greater
25 network efficiency and lower latency, with nearly four times the capacity of previous
26 Wi-Fi standards”; “MU-MIMO slices through congestion, reducing wait time for all
27 users”; “2 x dual-band internal antennas”). For a further example, as with each '376
28 Accused Product, the D-Link DAP-X2810 transmits the probing signal (*e.g.*, a

1 probing signal transmission that triggers or elicits a responsive transmission from
 2 each of a first client device and a second client device, such as NDP Announcement,
 3 HE sounding NDP, Beamforming Report trigger frames pursuant to High Efficiency
 4 (HE) channel sounding, including preamble training fields allowing an estimate of
 5 the channel for MU-MIMO) to at least the first client device and the second client
 6 device (*e.g.*, the first non-AP STA and the second non-AP STA) via the smart
 7 antenna. *See, e.g.*, 802.11ax Standard, Sections 9.3.1.19, 9.3.1.22, 9.3.1.22.3,
 8 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,
 9 26.7.4, 26.7.5, 27.1.1. *See, e.g.*, Section 26.7.5 (HE sounding NDP transmission)
 10 (setting forth TXVECTOR parameters for HE sounding NDP); Section 27.3.10.10
 11 (HE-LTF) (“The HE-LTF field provides a means for the receiver to estimate the
 12 MIMO channel between the set of constellation mapper outputs (or, if STBC is
 13 applied, the STBC encoder outputs) and the receive chains. In an HE SU PPDU and
 14 HE ER SU PPDU, the transmitter provides training for N_{STS} space-time streams
 15 (spatial mapper inputs) used for the transmission of the PSDU. In an HE MU PPDU,
 16 the transmitter provides training for $N_{STS,r,total}$ space-time streams used for the
 17 transmission of the PSDU(s) in the r -th RU. In an HE TB PPDU, the transmitter of
 18 user u in the r -th RU provides training for $N_{STS,r,u}$ space-time streams used for the
 19 transmission of the PSDU. For each tone in the r -th RU, the MIMO channel that can
 20 be estimated is an $N_{RX} \times N_{STS,r,total}$ matrix. An HE transmission has a preamble that
 21 contains HE-LTF symbols, where the data tones of each HE-LTF symbol are
 22 multiplied by entries belonging to a matrix P_{HE-LTF} , to enable channel estimation at
 23 the receiver.... In an HE SU PPDU, HE MU PPDU and HE ER SU PPDU, the
 24 combination of HE-LTF type and GI duration is indicated in HE-SIG-A field. In an
 25 HE TB PPDU, the combination of HE-LTF type and GI duration is indicated in the
 26 Trigger frame that triggers transmission of the PPDU. If an HE PPDU is an HE
 27 sounding NDP, the combinations of HE-LTF types and GI durations are listed in
 28 27.3.18 (Transmit specification). If an HE PPDU is an HE TB feedback NDP, the

1 combination of HE-LTF types and GI durations are listed in 27.3.4 (HE PPDU
 2 formats.’’). See, e.g., Section 26.7.3, Figure 26-7



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

11 ; Section 9.4.1.65 (HE Compressed Beamforming Report field) (“The HE
 12 Compressed Beamforming Report field carries the average SNR of each space-time
 13 stream and compressed beamforming feedback matrices V for use by a transmit
 14 beamformer to determine steering matrices Q , as described in 10.32.3 (Explicit
 15 feedback beamforming) and 19.3.12.3 (Explicit feedback beamforming)’’); Section
 16 9.1.4.66 (HE MU Exclusive Beamforming Report field) (“The HE MU Exclusive
 17 Beamforming Report field carries explicit feedback in the form of delta SNRs. The
 18 information in the HE Compressed Beamforming Report field and the HE MU
 19 Exclusive Beamforming Report field can be used by the transmit MU beamformer
 20 to determine the steering matrices Q , as described in 27.3.3.1 (DL MU-MIMO)’’);
 21 Section 9.4.1.67 (HE CQI Report Field) (“The HE CQI Report field carries the per-
 22 RU average SNRs of each space-time stream, where each per-RU average SNR is
 23 the arithmetic mean of the SNR in decibels over a 26-tone RU for which the feedback
 24 is being requested.’’). See, e.g., 802.11ac Standard Clause 9.31.5.2 (“A VHT
 25 beamformer shall initiate a sounding feedback sequence by transmitting a VHT NDP
 26 Announcement frame followed by a VHT NDP after a SIFS. The VHT beamformer
 27 shall include in the VHT NDP Announcement frame one STA Info field for each
 28 VHT beamformee that is expected to prepare VHT Compressed Beamforming

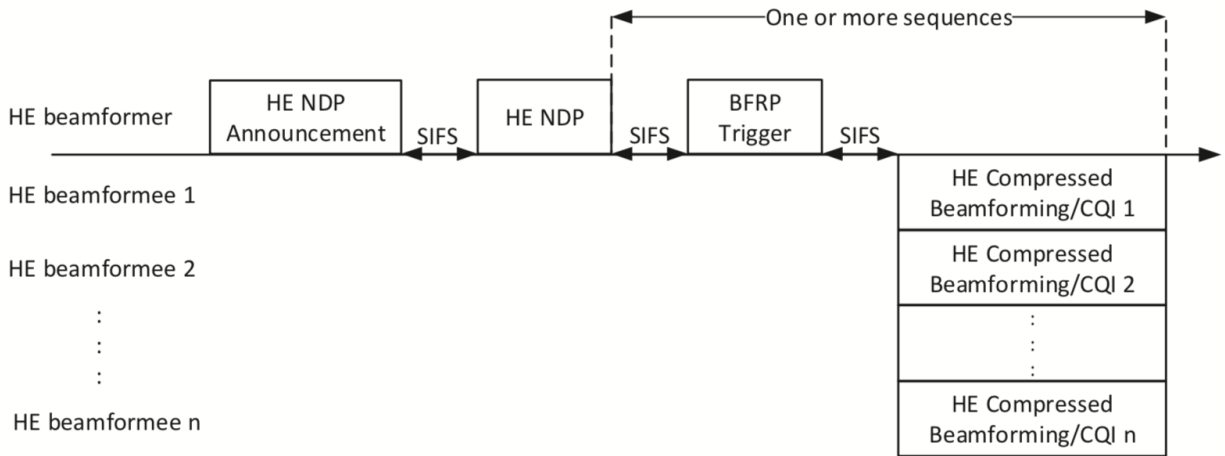
1 feedback and shall identify the VHT beamformee by including the VHT
2 beamformee's AID in the AID subfield of the STA Info field. The VHT NDP
3 Announcement frame shall include at least one STA Info field."); *id.* ("A non-AP
4 VHT beamformee that receives a VHT NDP Announcement frame... shall transmit
5 its VHT Compressed Beamforming feedback a SIFS after receiving a Beamforming
6 Report Poll with RA matching its MAC address and a non-bandwidth signaling TA
7 obtained from the TA field matching the MAC address of the VHT beamformer.");
8 *id.* Clause 8.5.23.2 (defining format and subfields within the VHT Compressed
9 Beamforming frame); *id.* Clause 8.4.1.48 (including Tables 8-53(d)-(h)) ("Each
10 SNR value per tone in stream *i* (before being averaged) corresponds to the SNR
11 associated with the column *i* of the beamforming feedback matrix *V* determined at
12 the beamformee"); *id.* Clause 8.4.1.49 (including Table 8-53i – MU Exclusive
13 Beamforming Report information); *id.* Clauses 8.4.1.24, 9.31.5.1, 9.31.5.2; *id.*
14 Clause 22.3.8.3.5; *id.* Clause 22.3.11.2.

15 50. Each of the '376 Accused Products comprises a data-communications
16 networking apparatus wherein one or more of the processor, the transceiver, or the
17 smart antenna is further configured to: receive a first feedback information from the
18 first client device in response to the transmission of the probing signal; receive a
19 second feedback information from the second client device in response to
20 transmission of the probing signal. For example, as with each '376 Accused Product,
21 the D-Link DAP-X2810 comprises one or more of the processor, the transceiver, or
22 the smart antenna further configured to receive channel state information and
23 estimates of the channel state and MU MIMO-related feedback information from
24 each of the first non-AP STA and the second non-AP STA pursuant to HE MU-
25 MIMO sounding procedures. This feedback information, carried in one or more HE
26 Compressed Beamforming/CQI frames, is in response to the transmission of the
27 probing signal (*e.g.*, a probing signal transmission that triggers or elicits a responsive
28 transmission from each of a first client device and a second client device, such as

1 NDP Announcement, HE sounding NDP, Beamforming Report trigger frames
 2 pursuant to High Efficiency (HE) channel sounding, including preamble training
 3 fields allowing an estimate of the channel for MU-MIMO). *See, e.g.*, 802.11ax
 4 Standard, Sections 9.3.1.19, 9.3.1.22, 9.3.1.22.3, 9.4.1.64, 9.4.1.65, 9.4.1.66,
 5 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,
 6 27.3.15.1 – 27.3.15.3. *See, e.g.*, Section 9.4.1.65 (HE Compressed Beamforming
 7 Report field) (“The HE Compressed Beamforming Report field carries the average
 8 SNR of each space-time stream and compressed beamforming feedback matrices V
 9 for use by a transmit beamformer to determine steering matrices Q , as described in
 10 10.32.3 (Explicit feedback beamforming) and 19.3.12.3 (Explicit feedback
 11 beamforming”); Section 9.1.4.66 (HE MU Exclusive Beamforming Report field)
 12 (“The HE MU Exclusive Beamforming Report field carries explicit feedback in the
 13 form of delta SNRs. The information in the HE Compressed Beamforming Report
 14 field and the HE MU Exclusive Beamforming Report field can be used by the
 15 transmit MU beamformer to determine the steering matrices Q , as described in
 16 27.3.3.1 (DL MU-MIMO)”); Section 9.4.1.67 (HE CQI Report Field) (“The HE CQI
 17 Report field carries the per-RU average SNRs of each space-time stream, where each
 18 per-RU average SNR is the arithmetic mean of the SNR in decibels over a 26-tone
 19 RU for which the feedback is being requested.”); Section 27.3.15.1 (“SU-MIMO and
 20 DL-MU-MIMO beamforming are techniques used by a STA with multiple antennas
 21 (the beamformer) to steer signals using knowledge of the channel to improve
 22 throughput. With SU-MIMO beamforming all space-time streams in the transmitted
 23 signal are intended for reception at a single STA in an RU. With DL MU-MIMO
 24 beamforming, disjoint subsets of the space-time streams are intended for reception
 25 at different STAs in an RU of size greater than or equal to 106-tones...The DL MU-
 26 MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user,r}-1}]$ can be detected by the
 27 beamformer using the beamforming feedback for subcarrier k from beamformee u ,
 28 where $u = 0, 1, \dots, N_{user,r} - 1$. The feedback report format is described in 9.4.1.65 (HE

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1 Compressed Beamforming Report field) and 9.4.1.66 (HE MU Exclusive
 2 Beamforming Report field). The steering matrix that is computed (or updated) using
 3 new beamforming feedback from some or all of participating beamformees might
 4 replace the existing steering matrix Q_k for the next DL MU-MIMO data
 5 transmission.”); Section 27.3.15.2 (“Upon receipt of an HE sounding NDP, the
 6 beamformee computes a set of matrices for feedback to the beamformer as described
 7 in 21.3.11.2 (Beamforming Feedback Matrix V). The eligible beamformees shall
 8 remove the space-time stream CSD in Table 21-11 (Cyclic shift values for the VHT
 9 modulated fields of a PPDU) from the measured channel before computing a set of
 10 matrices for feedback to the beamformer.”); *See, e.g.*, Section 26.7.3, Figure 26-7:



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

19 51. For a further example, as with each '376 Accused Product, the D-Link
 20 DAP-X2810 comprises one or more of the processor, the transceiver, or the smart
 21 antenna further configured to receive channel state information and estimates of the
 22 channel state and MU MIMO-related feedback information from each of the first
 23 non-AP STA and the second non-AP STA pursuant to MU-MIMO sounding
 24 procedures. This feedback information, carried in one or more compressed
 25 beamforming frames, is in response to the transmission of the probing signal (*e.g.*, a
 26 probing signal transmission that triggers or elicits a responsive transmission from
 27 each of a first client device and a second client device, such as NDP Announcement
 28 pursuant to Very High Throughput (VHT) channel sounding, including preamble

1 training fields allowing an estimate of the channel for MU-MIMO). See, e.g.,
2 802.11ac Standard Clause 9.31.5.2 (“A VHT beamformer shall initiate a sounding
3 feedback sequence by transmitting a VHT NDP Announcement frame followed by
4 a VHT NDP after a SIFS. The VHT beamformer shall include in the VHT NDP
5 Announcement frame one STA Info field for each VHT beamformee that is expected
6 to prepare VHT Compressed Beamforming feedback and shall identify the VHT
7 beamformee by including the VHT beamformee’s AID in the AID subfield of the
8 STA Info field. The VHT NDP Announcement frame shall include at least one STA
9 Info field.”); *id.* (“A non-AP VHT beamformee that receives a VHT NDP
10 Announcement frame... shall transmit its VHT Compressed Beamforming feedback
11 a SIFS after receiving a Beamforming Report Poll with RA matching its MAC
12 address and a non-bandwidth signaling TA obtained from the TA field matching the
13 MAC address of the VHT beamformer.”); *id.* Clause 8.5.23.2 (defining format and
14 subfields within the VHT Compressed Beamforming frame); *id.* Clause 8.4.1.48
15 (including Tables 8-53(d)-(h)) (“Each SNR value per tone in stream i (before being
16 averaged) corresponds to the SNR associated with the column i of the beamforming
17 feedback matrix V determined at the beamformee”); *id.* Clause 8.4.1.49 (including
18 Table 8-53i – MU Exclusive Beamforming Report information); *id.* Clauses
19 8.4.1.24, 9.31.5.1, 9.31.5.2; *id.* Clause 22.3.8.3.5; *id.* 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 52. 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: determine where to place transmission peaks
 20 and transmission nulls within one or more spatially distributed patterns of
 21 electromagnetic signals based in part on the first and the second feedback
 22 information. For example, as with each '376 Accused Product, the D-Link DAP-
 23 X2810 comprises one or more of the processor, the transceiver, or the smart antenna
 24 further configured to determine where to place transmission peaks and transmission
 25 nulls within one or more spatially distributed patterns of electromagnetic signals
 26 based in part on the first and the second feedback information, including, e.g., where
 27 it determines where to place transmission peaks and transmission nulls through a
 28 beamforming steering matrix pursuant to beamforming and MU-MIMO spatial
 multiplexing, which beamforming steering matrix is determined based on the
 received CSI (channel state information) and MIMO-related feedback from the first
 client device (first non-AP STA) and the second client device (second non-AP STA)
 pursuant to HE MU-MIMO sounding. [DATA SHEET]. See, e.g., 802.11ax
 Standard, Sections 9.3.1.19, 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, 26.7.4, 26.7.5, 27.1.1, 27.3.15.1, 27.3.15.2, 27.3.15.3.

1 See, e.g., Section 9.4.1.65 (HE Compressed Beamforming Report field) (“The HE
 2 Compressed Beamforming Report field carries the average SNR of each space-time
 3 stream and compressed beamforming feedback matrices V for use by a transmit
 4 beamformer to determine steering matrices Q , as described in 10.32.3 (Explicit
 5 feedback beamforming) and 19.3.12.3 (Explicit feedback beamforming)”); Section
 6 9.1.4.66 (HE MU Exclusive Beamforming Report field) (“The HE MU Exclusive
 7 Beamforming Report field carries explicit feedback in the form of delta SNRs. The
 8 information in the HE Compressed Beamforming Report field and the HE MU
 9 Exclusive Beamforming Report field can be used by the transmit MU beamformer
 10 to determine the steering matrices Q , as described in 27.3.3.1 (DL MU-MIMO)”);
 11 Section 9.4.1.67 (HE CQI Report Field) (“The HE CQI Report field carries the per-
 12 RU average SNRs of each space-time stream, where each per-RU average SNR is
 13 the arithmetic mean of the SNR in decibels over a 26-tone RU for which the feedback
 14 is being requested.”); 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 (“Upon receipt of an HE sounding NDP, the beamformee computes a set

1 of matrices for feedback to the beamformer as described in 21.3.11.2 (Beamforming
 2 Feedback Matrix V). The eligible beamformees shall remove the space-time stream
 3 CSD in Table 21-11 (Cyclic shift values for the VHT modulated fields of a PDU)
 4 from the measured channel before computing a set of matrices for feedback to the
 5 beamformer. The beamforming feedback matrix $V_{k,u}$ found by the beamformee u for
 6 subcarrier k in RU r shall be compressed in the form of angles using the method
 7 described in 19.3.12.3.6 (Compressed beamforming feedback matrix). The angles
 8 $\phi(k,u)$ and $\psi(k,u)$, are quantized according to Table 9-68 (Quantization of angles)....
 9 The beamformee shall generate the beamforming feedback matrices with the number
 10 of rows (Nr) equal to the N_{STS} of the HE sounding NDP. After receiving the angle
 11 information, $\phi(k,u)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-
 12 79). For SU-MIMO beamforming, the beamformer uses $V_{k,0}$ matrix to determine the
 13 steering matrix Q_k . For DL MU-MIMO beamforming, the beamformer may calculate
 14 a 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
 15 $\leq u \leq N_{user,r}-1$) in order to suppress crosstalk between participating beamformees. The
 16 method used by the beamformer to calculate the steering matrix Q_k is
 17 implementation specific.”). See, e.g., 802.11ac Standard Clause 9.31.5.1 (“Transmit
 18 beamforming and DL-MU-MIMO require knowledge of the channel state to
 19 compute a steering matrix that is applied to the transmitted signal to optimize
 20 reception at one or more receivers. The STA transmitting using the steering matrix
 21 is called the VHT beamformer and a STA for which reception is optimized is called
 22 a VHT beamformee. An explicit feedback mechanism is used where the VHT
 23 beamformee directly measures the channel from the training symbols transmitted by
 24 the VHT beamformer and sends back a transformed estimate of the channel state to
 25 the VHT beamformer. The VHT beamformer then uses this estimate, perhaps
 26 combining estimates from multiple VHT beamformees, to derive the steering
 27 matrix.”); *id.* Clauses 22.3.4.6(d), 22.3.4.7(e), 22.3.4.8(l), 22.3.4.9.1(m),
 28 22.3.4.9.2(m), 22.3.4.10.4(a) (“Spatial mapping: Apply the Q matrix as described in

1 22.3.10.11.1.”); *id.* Clause 22.3.10.11.1; IEEE 802.11-2012 Standard Clause
 2 20.3.12.3.6; 802.11ac Standard Clauses 8.4.1.24, 9.31.5.1, 9.31.5.2; *id.* Clause
 3 22.3.11.1:

4 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
 5 beamformer using the beamforming feedback matrices for subcarrier k from beamformee u , $V_{k,u}$, and SNR
 6 information for subcarrier k from beamformee u , $SNR_{k,u}$, where $u = 0, 1, \dots, N_{user} - 1$. The steering matrix
 7 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).

8 , Clause 22.3.11.2:

9 Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in
 10 Table 22-11 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
 11 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
 according to Table 8-53e. The number of bits for quantization is chosen by the beamformee, based on the
 12 indication from the beamformer as to whether the feedback is requested for SU-MIMO beamforming or DL-
 MU-MIMO beamforming. The compressed beamforming feedback using 20.3.12.3.6 is the only Clause 22
 beamforming feedback format defined.

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

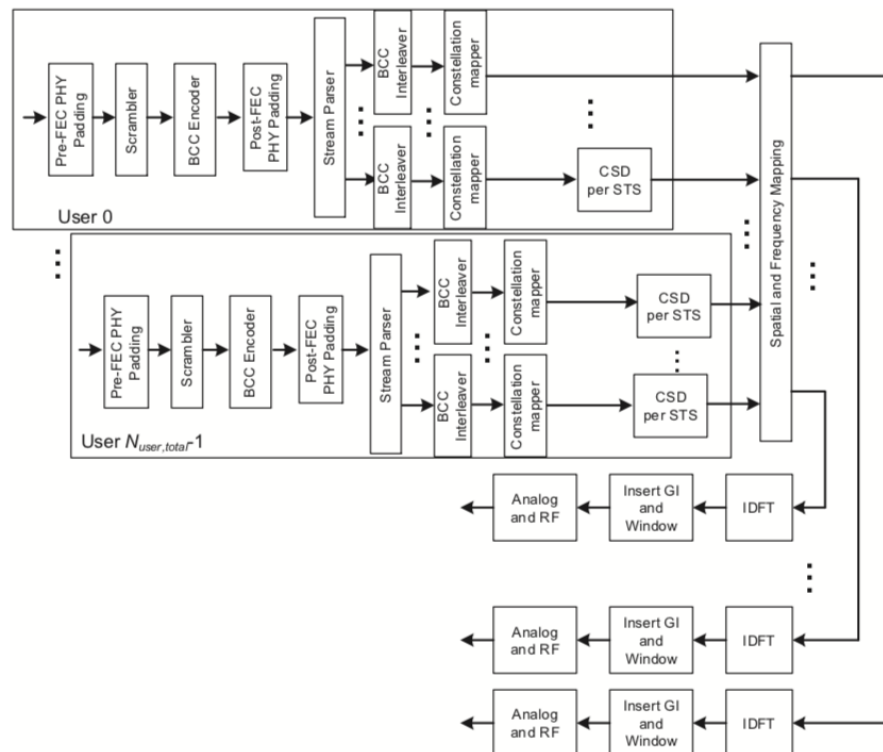
15 After receiving the angle information, $\phi(k,u)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation
 (20-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering
 16 matrix Q_k . For DL-MU-MIMO beamforming, the beamformer may calculate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

18 53. Each of the '376 Accused Products comprises a data-communications
 19 networking apparatus wherein one or more of the processor, the transceiver, or the
 20 smart antenna is further configured to: transmit the first data stream to the first client
 21 device via the one or more spatially distributed patterns of electromagnetic signals;
 22 and transmit the second data stream to the second client device via the one or more
 23 spatially distributed patterns of electromagnetic signals; wherein transmission of the
 24 first data stream and transmission of at least part of the second data stream occur at
 25 the same time; and wherein the one or more spatially distributed patterns of
 26 electromagnetic signals are configured to exhibit a first transmission peak at a
 27 location of the first client device and a second transmission peak at a location of the
 28 second client device. For example, as with each '376 Accused Product, the D-Link

1 DAP-X2810 comprises one or more of the processor, the transceiver, or the smart
2 antenna further configured to transmit the first data stream to the first client device
3 (*e.g.*, the first non-AP STA) via the one or more spatially distributed patterns of
4 electromagnetic signals (*e.g.*, transmission of data to the first non-AP STA pursuant
5 to HE MU-MIMO beamforming where a beamforming steering matrix is applied);
6 and transmit the second data stream to the second client device (*e.g.*, the second non-
7 AP STA) via the one or more spatially distributed patterns of electromagnetic signals
8 (*e.g.*, transmission of data to the second non-AP STA pursuant to HE MU-MIMO
9 beamforming where a beamforming steering matrix is applied); wherein
10 transmission of the first data stream and transmission of at least part of the second
11 data stream occur at the same time (*e.g.*, simultaneous HE DL MU-MIMO
12 transmissions); and wherein the one or more spatially distributed patterns of
13 electromagnetic signals are configured to exhibit a first transmission peak at a
14 location of the first client device and a second transmission peak at a location of the
15 second client device (*e.g.*, through HE MU-MIMO beamforming, radio energy is
16 directed at each of the first client device and the second client device to form a
17 transmission peak at the location of each device, and including, *e.g.*, where the
18 beamforming steering matrix is applied, a first space-time stream (“STS”) intended
19 for reception at the first client device and a second STS intended for reception at the
20 second client device is representative of a first transmission peak being placed at the
21 location of the first client device and a second transmission peak being placed at the
22 location of second client device). *See, e.g.*, D-Link Nuclias Connect AX1800 Wi-Fi
23 6 Access Point DAP-X2810, [https://www.dlink.com/en/products/dap-x2810-](https://www.dlink.com/en/products/dap-x2810-nuclias-connect-ax1800-wi-fi-6-access-point)
24 [nuclias-connect-ax1800-wi-fi-6-access-point](https://www.dlink.com/en/products/dap-x2810-nuclias-connect-ax1800-wi-fi-6-access-point) (“The DAP-X2810 is empowered with
25 next generation Wi-Fi 6. Enhanced MU-MIMO with even more uplink and downlink
26 streams serves more devices simultaneously. OFDMA dramatically increases
27 transmission efficiency and 1024-QAM packs even more data, bringing
28 unadulterated speed increases of a searing 25%.”); D-Link DAP-X2810 Datasheet,

1 available at [https://www.dlink.com/-/media/global-pdfs/global-](https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf)
2 [datasheets/dap/dapx2810a1datasheetv100ww.pdf](https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf) (“Wi-Fi 6 delivers greater
3 network efficiency and lower latency, with nearly four times the capacity of previous
4 Wi-Fi standards”; “MU-MIMO slices through congestion, reducing wait time for all
5 users”; “2 x dual-band internal antennas”). *See, e.g.*, IEEE 802.11ax Standard,
6 Section 27.3.15.1 (“SU-MIMO and DL-MU-MIMO beamforming are techniques
7 used by a STA with multiple antennas (the beamformer) to steer signals using
8 knowledge of the channel to improve throughput. With SU-MIMO beamforming all
9 space-time streams in the transmitted signal are intended for reception at a single
10 STA in an RU. With DL MU-MIMO beamforming, disjoint subsets of the space-
11 time streams are intended for reception at different STAs in an RU of size greater
12 than or equal to 106-tones...The DL MU-MIMO steering matrix $Q_k = [Q_{k,0},$
13 $Q_{k,1}, \dots, Q_{k,N_{user,r}-1}]$ can be detected by the beamformer using the beamforming
14 feedback for subcarrier k from beamformee u , where $u = 0, 1, \dots, N_{user,r} - 1$. The
15 feedback report format is described in 9.4.1.65 (HE Compressed Beamforming
16 Report field) and 9.4.1.66 (HE MU Exclusive Beamforming Report field). The
17 steering matrix that is computed (or updated) using new beamforming feedback from
18 some or all of participating beamformees might replace the existing steering matrix
19 Q_k for the next DL MU-MIMO data transmission.”); Section 27.3.15.2 (“The
20 beamformee shall generate the beamforming feedback matrices with the number of
21 rows (Nr) equal to the N_{STS} of the HE sounding NDP. After receiving the angle
22 information, $\phi(k, u)$ and $\psi(k, u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-
23 79). For SU-MIMO beamforming, the beamformer uses $V_{k,0}$ matrix to determine the
24 steering matrix Q_k . For DL MU-MIMO beamforming, the beamformer may calculate
25 a 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.”); Section 27.1.1 (“The HE PHY extends the maximum

1 number of users supported for DL MU-MIMO transmissions up to 8 users per
 2 resource unit (RU) and provides support for DL and UL orthogonal frequency
 3 division multiple access (OFDMA) as well as for UL MU-MIMO. Both DL and UL
 4 MU-MIMO transmissions are supported on portions of the PPDU bandwidth (on
 5 resource units greater than or equal to 106 tones). In an MU-MIMO resource unit,
 6 there is support for up to 8 users with up to 4 space-time streams per user with the
 7 total not exceeding 8 space-time streams"); Section 27.3.1.1 ("DL MU transmission
 8 allows an AP to simultaneously transmit information to more than one non-AP STA.
 9 For a DL MU transmission, the AP uses the HE MU PPDU format and employs
 10 either DL OFDMA, DL MU-MIMO, or a mixture of both."); Section 27.3.10.8.1
 11 ("The HE-SIG-B field provides the OFDMA and DL MU-MIMO resource
 12 allocation information to allow the STAs to look up the corresponding resources to
 13 be used in the data portion of the frame."); *See, e.g.*, IEEE 802.11ax Standard,
 14 Section 27.3.5 (Transmitter block diagram), at, *e.g.*, Figure 27-19:



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

1 ; Section 9.4.1.65 (HE Compressed Beamforming Report field) (“The HE
2 Compressed Beamforming Report field carries the average SNR of each space-time
3 stream and compressed beamforming feedback matrices V for use by a transmit
4 beamformer to determine steering matrices Q , as described in 10.32.3 (Explicit
5 feedback beamforming) and 19.3.12.3 (Explicit feedback beamforming)”); Section
6 9.1.4.66 (HE MU Exclusive Beamforming Report field) (“The HE MU Exclusive
7 Beamforming Report field carries explicit feedback in the form of delta SNRs. The
8 information in the HE Compressed Beamforming Report field and the HE MU
9 Exclusive Beamforming Report field can be used by the transmit MU beamformer
10 to determine the steering matrices Q , as described in 27.3.3.1 (DL MU-MIMO)”);
11 Section 9.4.1.67 (HE CQI Report Field) (“The HE CQI Report field carries the per-
12 RU average SNRs of each space-time stream, where each per-RU average SNR is
13 the arithmetic mean of the SNR in decibels over a 26-tone RU for which the feedback
14 is being requested.”). See, e.g., 802.11ac Standard Clause 9.31.5.1 (“Transmit
15 beamforming and DL-MU-MIMO require knowledge of the channel state to
16 compute a steering matrix that is applied to the transmitted signal to optimize
17 reception at one or more receivers. The STA transmitting using the steering matrix
18 is called the VHT beamformer and a STA for which reception is optimized is called
19 a VHT beamformee. An explicit feedback mechanism is used where the VHT
20 beamformee directly measures the channel from the training symbols transmitted by
21 the VHT beamformer and sends back a transformed estimate of the channel state to
22 the VHT beamformer. The VHT beamformer then uses this estimate, perhaps
23 combining estimates from multiple VHT beamformees, to derive the steering
24 matrix.”); *id.* Clauses 22.3.4.6(d), 22.3.4.7(e), 22.3.4.8(l), 22.3.4.9.1(m),
25 22.3.4.9.2(m), 22.3.4.10.4(a) (“Spatial mapping: Apply the Q matrix as described in
26 22.3.10.11.1.”); *id.* Clause 22.3.10.11.1; IEEE 802.11-2012 Standard Clause
27 20.3.12.3.6; 802.11ac Standard Clauses 8.4.1.24, 9.31.5.1, 9.31.5.2; *id.* Clause
28 22.3.11.1, 22.3.11.2:

1 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
 2 beamformer using the beamforming feedback matrices for subcarrier k from beamformee u , $V_{k,u}$, and SNR
 3 information for subcarrier k from beamformee u , $SNR_{k,u}$, where $u = 0, 1, \dots, N_{user} - 1$. The steering matrix
 4 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).

5 Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in
 6 Table 22-11 from the measured channel before computing a set of matrices for feedback to the beamformer.
 7 The beamforming feedback matrix, $V_{k,u}$, found by the beamformee u for subcarrier k shall be compressed in
 8 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
 according to Table 8-53e. 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 DL-
 MU-MIMO beamforming. The compressed beamforming feedback using 20.3.12.3.6 is the only Clause 22
 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
 (20-79). For SU-MIMO beamforming, the beamformer can use this $V_{k,0}$ matrix to determine the steering
 12 matrix Q_k . For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix
 13 $Q_k = [Q_{k,0}, Q_{k,1}, \dots, Q_{k,N_{user}-1}]$ using $V_{k,u}$ and $SNR_{k,u}$ ($0 \leq u \leq N_{user} - 1$) in order to suppress crosstalk
 14 between participating beamformees. The method used by the beamformer to calculate the steering matrix Q_k
 is implementation specific.

15 54. Defendant also has been and is now knowingly and intentionally inducing
 16 infringement of at least claim 1 of the '376 Patent in violation of 35 U.S.C. § 271(b),
 17 in this district and elsewhere in the United States. Through the filing and service of
 18 this Complaint, Defendant has had knowledge of the '376 Patent and the infringing
 19 nature of the Accused Products. More specifically, Defendant has been and is now
 20 actively inducing direct infringement by other persons (e.g., Defendant's customers
 21 who use, sell or offer for sale the Accused Products).

22 55. Despite this knowledge of the '376 Patent, Defendant continues to actively
 23 encourage and instruct its customers and end users (for example, through user
 24 manuals and online instruction materials on its website) to use the '376 Accused
 25 Products in ways that directly infringe the '376 Patent. For example, Defendant's
 26 website provided, and continues to provide, instructions for using the Accused
 27 Products on wireless communications systems, and to utilize their 802.11ax
 28 beamforming and MU-MIMO functionalities. Defendant does so knowing and

1 intending that its customers and end users will commit these infringing acts.
2 Defendant also continues to make, use, offer for sale, sell, and/or import the '376
3 Accused Products, despite its knowledge of the '376 Patent, thereby specifically
4 intending for and inducing its customers to infringe the '376 Patent through the
5 customers' normal and customary use of the '376 Accused Products. Defendant also
6 knew or was willfully blind that its actions would induce direct infringement by
7 others and intended that its actions would induce direct infringement by others.
8 Accordingly, a reasonable inference is that Defendant specifically intended for
9 others, such as its customers, to directly infringe one or more claims of Vivato's
10 '376 Patent in the United States because Defendant had knowledge of the '376 Patent
11 and actively induced others (*e.g.*, its customers) to directly infringe the '376 Patent.

12 56. Defendant also contributorily infringes by making, using, selling, offering
13 to sell, and/or importing the Accused Products, knowing they constitute a material
14 part of the invention, are especially made or adapted for use in infringing, and that
15 they are not staple articles of commerce capable of substantial non-infringing use.

16 57. By making, using, offering for sale, selling and/or importing into the
17 United States the Accused Products, Defendant has injured Vivato and is liable for
18 infringement of the '376 Patent pursuant to 35 U.S.C. § 271.

19 58. Defendant also infringes numerous additional claims of the '376 Patent,
20 including Claims 2 – 34, directly and through inducing infringement, for similar
21 reasons as explained above with respect to Claim 1.

22 59. Vivato's '376 Patent is valid and enforceable.

23 60. As a result of Defendant's infringement of the '376 Patent, Defendant has
24 damaged Vivato, and Vivato is entitled to monetary damages in an amount to be
25 determined at trial that is adequate to compensate for Defendant's infringement, but
26 in no event less than a reasonable royalty for the use made of the invention by
27 Defendant, together with interest and costs as fixed by the Court.
28

1 61. Defendant's infringing activities have injured and will continue to injure
2 Vivato, unless and until this Court enters an injunction prohibiting further
3 infringement of the '376 Patent, and, specifically, enjoining further manufacture,
4 use, sale, importation, and/or offers for sale that come within the scope of the patent
5 claims.

6 **VI. WILLFUL INFRINGEMENT**

7 62. Defendant had knowledge of Vivato's '728 Patent by at least the date of
8 the filing and service of the Complaint for Patent Infringement on April 3, 2017 in
9 the United States District Court for the Central District of California.

10 63. Despite Defendant's knowledge of Vivato's '728 Patent and its patent
11 portfolio, Defendant infringed and continues to infringe the '728 Patent with full and
12 complete knowledge of the patents' applicability to Defendant's MU-MIMO Wi-Fi
13 6 access point and router products without taking a license and without a good faith
14 belief that the '728 Patent are invalid and not infringed. Defendant's infringement
15 occurred, and continues to occur, with knowledge of infringement, objective
16 recklessness, or willful blindness toward its infringement.

17 64. Defendant sold, and continues to sell, its Accused Products (*e.g.*, Wi-Fi 6
18 / IEEE 802.11ax Access Points and routers such as the D-Link DAP-X2810) to
19 customers despite its knowledge of Vivato's Asserted Patents, such as on
20 www.dlink.com. Defendant also manufactured and imported into the United States,
21 and continues to do so, the Accused Products for sale and distribution to its
22 customers, despite its knowledge of Vivato's Asserted Patents, including without
23 limitation the '728 Patent.

24 65. Defendant's infringement of Vivato's '728 Patent is egregious because
25 despite its knowledge of the '728 Patent, Defendant deliberately and flagrantly
26 copied the invention claimed in the '728 Patent and implemented that patented
27 invention in its Accused Products. Further, despite Defendant's knowledge of the
28 '728 Patent, Defendant sold, offered for sale, manufactured, and imported, the

1 Accused Products—and continues to do so—without investigating the scope of the
 2 '728 Patent and without forming a good-faith belief that its Accused Products do not
 3 infringe or that the '728 Patent is invalid. Defendant has not taken any steps to
 4 remedy its infringement of the '728 Patent (*e.g.*, by removing the Accused Products
 5 from its sales channels). Instead, Defendant continues to sell its Accused Products
 6 to customers, such as its continued sale of its DAP-X2810, for example. Defendant's
 7 behavior is egregious because it engaged, and continues to engage, in misconduct
 8 beyond that of typical infringement. For example, in a typical infringement, an
 9 infringer would investigate the scope of the asserted patents and develop a good-
 10 faith belief that it does not infringe the asserted patents or that the asserted patents
 11 are invalid before selling (and continuing to sell) its accused products. An infringer
 12 would also remove its accused products from its sales channels and discontinue
 13 further sales.

14 66. Thus, Defendant's infringement of the '728 Patent is willful, deliberate,
 15 and flagrant, entitling Vivato to increased damages under 35 U.S.C. § 284 and to
 16 attorneys' fees and costs incurred in prosecuting this action under 35 U.S.C. § 285.

17 PRAYER FOR RELIEF

18 WHEREFORE, Vivato prays for the following relief:

19 (a) A judgment in favor of Vivato that Defendant has infringed and is
 20 infringing U.S. Patent Nos. 7,729,728 and 10,594,376;

21 (b) An award of damages to Vivato arising out of Defendant's infringement
 22 of U.S. Patent Nos. 7,729,728 and 10,594,376, together with prejudgment and post-
 23 judgment interest, in an amount according to proof;

24 (c) An award of an ongoing royalty for Defendant's post-judgment
 25 infringement in an amount according to proof;

26 (d) Declaring that Defendant's infringement of the '728 Patent is willful
 27 and that this is an exceptional case under 35 U.S.C. § 285, and awarding enhanced
 28 damages pursuant to 35 U.S.C. § 284 and attorneys' fees and costs in this action.

1 (e) Granting Vivato its costs and further relief as the Court may deem just
2 and proper.

3 **DEMAND FOR JURY TRIAL**

4 Vivato demands a trial by jury of any and all issues triable of right before a
5 jury.

6
7 DATED: June 16, 2021

Respectfully submitted,

8 **RUSS AUGUST & KABAT**

9
10
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RUSS, AUGUST & KABAT