RUSS AUGUST & KABAT
Marc A. Fenster, CA SBN 181067
mfenster@raklaw.com
Reza Mirzaie, CA SBN 246953
rmirzaie@raklaw.com
Philip X. Wang, CA SBN 262239
pwang@raklaw.com
Christian Conkle, CA SBN 306374
cconkle@raklaw.com
James N. Pickens, CA SBN 307474
jpickens@raklaw.com
Minna Y. Chan, CA SBN 305941
mchan@raklaw.com
12424 Wilshire Boulevard, 12th Floor
Los Angeles, California 90025
Tele: 310/826-7474
Fax: 310/826-6991

Attorneys for Plaintiff
XR COMMUNICATIONS, LLC,
dba VIVATO TECHNOLOGIES

UNITED STATES DISTRICT COURT

CENTRAL DISTRICT OF CALIFORNIA

XR COMMUNICATIONS, LLC, dba VIVATO TECHNOLOGIES, *Plaintiff*, *v.* D-LINK SYSTEMS, INC., *Defendant*.	Case No. 8:21-cv-01063 **COMPLAINT FOR PATENT INFRINGEMENT**

I. JURISDICTION AND VENUE

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

II. THE PARTIES

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

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

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

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

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

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

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

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

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

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

III. BACKGROUND OF THE TECHNOLOGY

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

24. The Accused Products satisfy all claim limitations of Claims 3, 4, 5, and 12 of the '728 Patent. The following paragraphs compare limitations of Claim 4 to an exemplary '728 Accused Product, the D-Link DAP-X2810[1] wireless access point.

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

26. Each of the Accused Products comprises a phased array antenna configured to selectively allow a receiving device to operatively associate with a beam downlink transmittable to the receiving device via a phased array antenna of an access point. For example, as with each Accused Product, the D-Link DAP-X2810 selectively allows a receiving device (*e.g.*, station, abbreviated "STA") to operatively associate (*e.g.*, connect) with a beam downlink transmittable to the receiving device (*e.g.*, SU-MIMO, DL MU-MIMO or UL MU-MIMO beamforming) via a phased array antenna of an access point (*e.g.,* the antenna array and supporting mechanisms of the D-Link DAP-X2810). *See, e.g.,* D-Link Nuclias

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

Connect AX1800 Wi-Fi 6 Access Point DAP-X2810, 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 https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf ("Wi-Fi 6 delivers greater network efficiency and lower latency, with nearly four times the capacity of previous Wi-Fi standards"; "MU-MIMO slices through congestion, reducing wait time for all users"; "2 x dual-band internal antennas"). *See, e.g.,* IEEE 802.11ax Standard, at 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, 27.3.5, 27.3.10.7, 27.3.10.8, 27.3.10.9, 27.3.15, including Tables 27-19, 27-20, 27-21, 27-24, 27-25, 27-26, 27-27, 27-28, 27-29, Annex G at G.5, Annex Z. See, *e.g.*, IEEE 802.11ax Standard, Section 27.3.1.1 ("The transmission within an RU in a PPDU may be single stream to one user, spatially multiplexed to one user (SU-MIMO), or spatially multiplexed to multiple users (MU-MIMO)."); Section 27.3.2.5 ("The number of users in the MU-MIMO group is indicated in the Number Of HE-SIG-B Symbols Or MU-MIMO Users field in HE-SIG-A. The allocated spatial streams for each user and the total number of spatial streams are indicated in the Spatial Configuration field of User field in HE-SIG-B containing the STA-ID of the designated MU-MIMO STA as defined in Table 27-29 (Spatial Configuration subfield encoding)…[i]f there is only one User field (see Table 27-27 (User field format for a non-MU-MIMO allocation)) for an RU in the HE-SIG-B content channel, then the number of spatial streams for the user in the RU is indicated by the NSTS field in the User field. If there is more than one User field (see Table 27-28 (User field for an MU-MIMO allocation)) for an RU in the HE-SIG-B content channel, then the number of allocated spatial streams for each user in the RU is indicated by the Spatial Configuration field of the User field in HE-SIG-B."); Section 27.3.2.6 ("UL MU transmissions are preceded by a Trigger frame or frame carrying a TRS Control subfield from the AP. The Trigger frame or frame carrying the TRS Control subfield indicates the parameters, such as the duration of the HE TB PPDU, RU allocation, target RSSI and MCS (see 9.3.1.22 (Trigger frame format), 9.2.4.6a.1 (TRS Control) and 26.5.3.3 (Non-AP STA behavior for UL MU operation)), required to transmit an HE TB PPDU"); Section 27.3.10.8 (HE-SIG-B) ("The HE-SIG-B field provides the OFDMA and DL MU-MIMO resource allocation information to allow the STAs to look up the corresponding resources to be used in the data portion of the frame."); Section 27.3.15 ("SU-MIMO and DL-MU-MIMO beamforming are techniques used by a STA with multiple antennas (the beamformer) to steer signals using knowledge of the channel to improve throughput. With SU-MIMO beamforming all space-time streams in the transmitted signal are intended for reception at a single STA in an RU. With DL MU-MIMO beamforming, disjoint subsets of the space-time streams are intended for reception at different STAs in an RU of size greater than or equal to 106-tones"); Section 27.3.10.8.5 (HE-SIG-B per user content) ("The User Specific field consists of multiple User fields. The User fields follow the Common field of HE-SIG-B. The RU Allocation field in the Common field and the position of the User field in the User Specific field together identify the RU used to transmit a STA's data…

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 …., 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,…, 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).

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

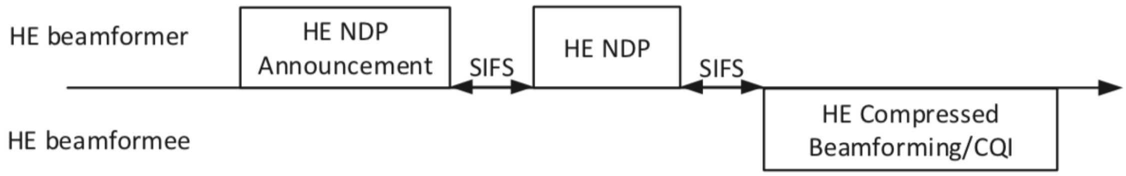

Figure 26-6—An example of the sounding protocol with a single HE beamformee

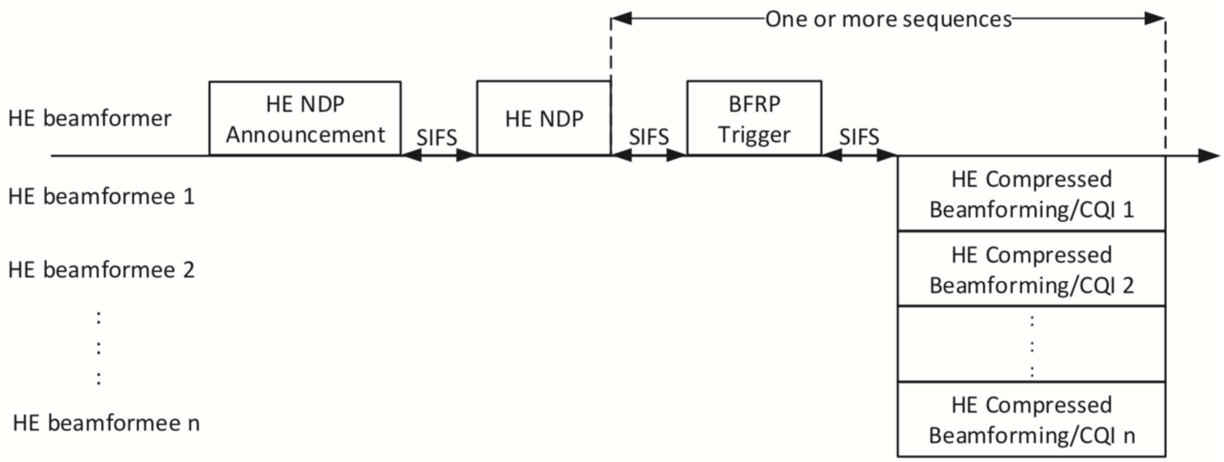

Figure 26-7—An example of the sounding protocol with more than one HE beamformee

; Section 26.7.3 ("An HE beamformee that receives an HE NDP Announcement frame from an HE beamformer with which it is associated and that contains the HE beamformee's MAC address in the RA field and also receives an HE sounding NDP a SIFS after the HE NDP Announcement frame shall transmit its HE compressed beamforming/CQI report a SIFS after the HE sounding NDP. The TXVECTOR parameter CH_BANDWIDTH for the PPDU containing the HE compressed beamforming/CQI report shall be set to indicate a bandwidth not wider than that indicated by the RXVECTOR parameter CH_BANDWIDTH of the HE sounding NDP. An HE beamformee that receives an HE NDP Announcement frame as part of an HE TB sounding sequence with a STA Info field addressed to it soliciting SU or MU feedback shall generate an HE compressed beamforming/CQI report using the feedback type, Ng and codebook size indicated in the STA Info field. If the HE beamformee then receives a BFRP Trigger frame with a User Info field addressed to it, the HE beamformee transmits an HE TB PPDU containing the HE compressed beamforming/CQI report following the rules defined in 26.5.3.3 (Non-AP STA behavior for UL MU operation)."); Section 26.5.3 (UL MU operation) ("UL MU operation allows an AP to solicit simultaneous immediate response frames from one or more non-AP HE STAs"); Section 27.3.10.10 (HE-LTF) ("The HE-LTF field provides a means for the receiver to estimate the MIMO channel between the set of constellation mapper outputs (or, if STBC is applied, the STBC encoder outputs) and the receive chains. In an HE SU PPDU and HE ER SU PPDU, the transmitter provides training for NSTS space-time streams (spatial mapper inputs) used for the transmission of the PSDU. In an HE MU PPDU, the transmitter provides training for NSTS,r,total space-time streams used for the transmission of the PSDU(s) in the r-th RU. In an HE TB PPDU, the transmitter of user u in the r-th RU provides training for NSTS,r,u space-time streams used for the transmission of the PSDU. For each tone in the r-th RU, the MIMO channel that can be estimated is an NRX x NSTS,r,total matrix. An HE transmission has a preamble that contains HE-LTF symbols, where the data tones of each HE-LTF symbol are multiplied by entries belonging to a matrix PHE-LTF, to enable channel estimation at the receiver…. In an HE SU PPDU, HE MU PPDU and HE ER SU PPDU, the combination of HE-LTF type and GI duration is indicated in HE-SIG-A field. In an HE TB PPDU, the combination of HE-LTF type and GI duration is indicated in the Trigger frame that triggers transmission of the PPDU. If an HE PPDU is an HE sounding NDP, the combinations of HE-LTF types and GI durations are listed in 27.3.18 (Transmit specification). If an HE PPDU is an HE TB feedback NDP, the combination of HE-LTF types and GI durations are listed in 27.3.4 (HE PPDU formats."); Section 27.3.15.1 (SU-MIMO and DL-MIMO beamforming) ("The DL MU-MIMO steering matrix Qk = [Qk,0, Qk,1,…,Qk,Nuser,r-1] can be detected by the beamformer using the beamforming feedback for subcarrier k from beamformee u, where u = 0,1,…Nuser,r -1. The feedback report format is described in 9.4.1.65 (HE Compressed Beamforming Report field) and 9.4.1.66 (HE MU Exclusive Beamforming Report field). The steering matrix that is computed (or updated) using new beamforming feedback from some or all of participating beamformees might replace the existing steering matrix Qk for the next DL MU-MIMO data transmission. For SU-MIMO beamforming, the steering matrix Qk can be determined from the beamforming feedback matrix Vk that is sent back to the beamformer by the beamformee using the compressed beamforming feedback matrix format as defined in 19.3.12.3.6 (Compressed beamforming feedback matrix). The feedback report format is described in 9.4.1.65 (HE Compressed Beamforming Report field.")

28.Each of the Accused Products is configured to determine from the uplink transmission if the receiving device should operatively associate with a different beam downlink transmittable via the phased array antenna. For example, the D-Link DAP-X2810 is configured to determine from information contained in the uplink transmission (*e.g.,* an uplink transmission received in response to a trigger frame soliciting an uplink transmission, including, *e.g.,* HE TB PPDU, *e.g.,* HE TB feedback NDP, further including, *e.g.,* an uplink transmission that includes information regarding an estimate of the channel state in, *e.g.,* an HE compressed beamforming/CQI report carried in one or more HE Compressed Beamforming/CQI frames) if the receiving device (*e.g.,* STA, or HE beamformee) that sent the uplink transmission should operatively associate with a different beam downlink transmittable via the phased array antenna. *See, e.g.,* D-Link Nuclias Connect AX1800 Wi-Fi 6 Access Point DAP-X2810, 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 https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf ("Wi-Fi 6 delivers greater network efficiency and lower latency, with nearly four times the capacity of previous Wi-Fi standards"; "MU-MIMO slices through congestion, reducing wait time for all users"; "2 x dual-band internal antennas"). *See, e.g.,* IEEE 802.11ax 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, 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, 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. See, *e.g.*, IEEE 802.11ax Standard at Section 26.7.1 ("Transmit beamforming and DL MU-MIMO require knowledge of the channel state to compute a steering matrix that is applied to the transmit signal to optimize reception at one or more receivers. HE STAs use the HE sounding protocol to determine the channel state information. The HE sounding protocol provides explicit feedback mechanisms, defined as HE non-trigger-based (non-TB) sounding and HE trigger-based (TB) sounding, where the HE beamformee measures the channel using a training signal (*i.e.*, an HE sounding NDP) transmitted by the HE beamformer and sends back a transformed estimate of the channel state. The HE beamformer uses this estimate to derive the steering matrix."); Section 27.3.15.1 (SU-MIMO and DL-MIMO beamforming) ("The DL MU-MIMO steering matrix Qk = [Qk,0, Qk,1,…,Qk,Nuser,r-1] can be detected by the beamformer using the beamforming feedback for subcarrier k from beamformee u, where u = 0,1,…Nuser,r -1. The feedback report format is described in 9.4.1.65 (HE Compressed Beamforming Report field) and 9.4.1.66 (HE MU Exclusive Beamforming Report field). The steering matrix that is computed (or updated) using new beamforming feedback from some or all of participating beamformees might replace the existing steering matrix Qk for the next DL MU-MIMO data transmission. For SU-MIMO beamforming, the steering matrix Qk can be determined from the beamforming feedback matrix Vk that is sent back to the beamformer by the beamformee using the compressed beamforming feedback matrix format as defined in 19.3.12.3.6 (Compressed beamforming feedback matrix). The feedback report format is described in 9.4.1.65 (HE Compressed Beamforming Report field."); Section 9.4.1.65 (HE Compressed Beamforming Report field) ("The HE Compressed Beamforming Report field carries the average SNR of each space-time stream and compressed beamforming feedback matrices V for use by a transmit beamformer to determine steering matrices Q, as described in 10.32.3 (Explicit feedback beamforming) and 19.3.12.3 (Explicit feedback beamforming)"); Section 9.1.4.66 (HE MU Exclusive Beamforming Report field) ("The HE MU Exclusive Beamforming Report field carries explicit feedback in the form of delta SNRs. The information in the HE Compressed Beamforming Report field and the HE MU Exclusive Beamforming Report field can be used by the transmit MU beamformer to determine the steering matrices Q, as described in 27.3.3.1 (DL MU-MIMO)"); Section 9.4.1.67 (HE CQI Report Field) ("The HE CQI Report field carries the per-RU average SNRs of each space-time stream, where each per-RU average SNR is the arithmetic mean of the SNR in decibels over a 26-tone RU for which the feedback is being requested."); Section 27.3.10.10 (HE-LTF) ("The HE-LTF field provides a means for the receiver to estimate the MIMO channel between the set of constellation mapper outputs (or, if STBC is applied, the STBC encoder outputs) and the receive chains. In an HE SU PPDU and HE ER SU PPDU, the transmitter provides training for NSTS space-time streams (spatial mapper inputs) used for the transmission of the PSDU. In an HE MU PPDU, the transmitter provides training for NSTS,r,total space-time streams used for the transmission of the PSDU(s) in the r-th RU. In an HE TB PPDU, the transmitter of user u in the r-th RU provides training for NSTS,r,u space-time streams used for the transmission of the PSDU. For each tone in the r-th RU, the MIMO channel that can be estimated is an NRX x NSTS,r,total matrix. An HE transmission has a preamble that contains HE-LTF symbols, where the data tones of each HE-LTF symbol are multiplied by entries belonging to a matrix PHE-LTF, to enable channel estimation at the receiver…. In an HE SU PPDU, HE MU PPDU and HE ER SU PPDU, the combination of HE-LTF type and GI duration is indicated in HE-SIG-A field. In an HE TB PPDU, the combination of HE-LTF type and GI duration is indicated in the Trigger frame that triggers transmission of the PPDU. If an HE PPDU is an HE sounding NDP, the combinations of HE-LTF types and GI durations are listed in 27.3.18 (Transmit specification). If an HE PPDU is an HE TB feedback NDP, the combination of HE-LTF types and GI durations are listed in 27.3.4 (HE PPDU formats.").

29.Each of the Accused Products is configured to allow the receiving device to operatively associate with the different beam downlink if determining that the receiving device should operatively associate with the different beam downlink. For example, as with each Accused Product, the D-Link DAP-X2810 is configured to allow the receiving device (*e.g.,* STA or HE beamformee) to operatively associate with a different beam downlink if determining that the receiving device should operatively associate with the different beam downlink. *See, e.g.,* IEEE 802.11ax 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, 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, 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. *See, e.g.,* IEEE 802.11ax Standard, Section 27.3.15.1 (SU-MIMO and DL-MIMO beamforming) ("The DL MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,N_{user,r}-1}]$ can be detected by the beamformer using the beamforming feedback for subcarrier k from beamformee u, where $u = 0,1,\ldots N_{user,r}$ -1. The feedback report format is described in 9.4.1.65 (HE Compressed Beamforming Report field) and 9.4.1.66 (HE MU Exclusive Beamforming Report field). The steering matrix that is computed (or updated) using new beamforming feedback from some or all of participating beamformees might replace the existing steering matrix Q_k for the next DL MU-MIMO data transmission. For SU-MIMO beamforming, the steering matrix Q_k can be determined from the beamforming feedback matrix V_k that is sent back to the beamformer by the beamformee using the compressed beamforming feedback matrix format as defined in 19.3.12.3.6 (Compressed beamforming feedback matrix). The feedback report format is described in 9.4.1.65 (HE Compressed Beamforming Report field."); Section 27.3.15.2 ("After receiving the angle information, $\phi(k,u)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer uses $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,N_{user,r}-1}]$ using $V_{k,u}$ and Delta $\Delta SNR_{k,u}$ ($0 \leq u \leq N_{user,r}-1$) in order to suppress crosstalk between participating beamformees. The method used by the beamformer to calculate the steering matrix Q_k is implementation specific."); Section 27.3.2.5 (Resource indication and User identification in an HE MU PPDU) ("The number of users in the MU-MIMO group is indicated in the Number Of HE-SIG-B Symbols Or MU-MIMO Users field in HE-SIG-A. The allocated spatial streams for each user and the total number of spatial streams are indicated in the Spatial Configuration field of User field in HE-SIG-B containing the STA-ID of the designated MU-MIMO STA as defined in Table 27-29 (Spatial Configuration subfield encoding)…[i]f there is only one User field (see Table 27-27 (User field format for a non-MU-MIMO allocation)) for an RU in the HE-SIG-B content channel, then the number of spatial streams for the user in the RU is indicated by the N_{STS} field in the User field. If there is more than one User field (see Table 27-28 (User field for an MU-MIMO allocation)) for an RU in the HE-SIG-B content channel, then the number of allocated spatial streams for each user in the RU is indicated by the Spatial Configuration field of the User field in HE-SIG-B."); Section 27.3.2.6 ("UL MU transmissions are preceded by a Trigger frame or frame carrying a TRS Control subfield from the AP. The Trigger frame or frame carrying the TRS Control subfield indicates the parameters, such as the duration of the HE TB PPDU, RU allocation, target RSSI and MCS (see 9.3.1.22 (Trigger frame format), 9.2.4.6a.1 (TRS Control) and 26.5.3.3 (Non-AP STA behavior for UL MU operation)), required to transmit an HE TB PPDU."); 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)."); Section 26.5.3.3.3 (TXVECTOR parameters for HE TB PPDU response to Trigger frame).

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

such as in response to a trigger frame soliciting an uplink transmission, including, *e.g.,* HE TB PPDUs, further including, *e.g.,* an uplink transmission that includes information regarding an estimate of the channel state in, *e.g.,* an HE compressed beamforming/CQI report carried in one or more HE Compressed Beamforming/CQI frames). See, *e.g.*, IEEE 802.11ax Standard, 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, 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, 37.3.3.2.2, - 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, 27.3.16, 27.3.17. See, *e.g.*, IEEE 802.11ax Standard, Section 26.7 ("Transmit beamforming and DL MU-MIMO require knowledge of the channel state to compute a steering matrix that is applied to the transmit signal to optimize reception at one or more receivers. HE STAs use the HE sounding protocol to determine the channel state information. The HE sounding protocol provides explicit feedback mechanisms, defined as HE non-trigger-based (non-TB) sounding and HE trigger-based (TB) sounding, where the HE beamformee measures the channel using a training signal (*i.e.*, an HE sounding NDP) transmitted by the HE beamformer and sends back a transformed estimate of the channel state. The HE beamformer uses this estimate to derive the steering matrix."); Section 27.3.2.5 ("HE-LTF symbols in the DL HE MU PPDU are used to measure the channel for the space-time streams intended for the STA and can also be used to measure the channel for the interfering space-time streams."); Section 27.3.4 (HE PPDU formats) ("Four HE PPDU formats are defined: HE SU PPDU, HE MU PPDU, HE ER SU PPDU, and HE TB PPDU. The HE sounding NDP is a variant of the HE SU PPDU and defined in 27.3.16 (HE sounding NDP). The HE TB feedback NDP is a variant of the HE TB PPDU and defined in 27.3.17 (HE TB feedback NDP)"); Section 27.3.10.10 (HE-LTF) ("The HT-LTF field provides a means for the receiver to estimate the MIMO channel between the set of constellation mapper outputs (or, if STBC is applied, the STBC encoder outputs) and the receive chains."); Section 26.5.3.3.3 (TXVECTOR parameters for HE TB

PPDU response to Trigger frame); Section 27.3.2.6 ("UL MU transmissions are preceded by a Trigger frame or frame carrying a TRS Control subfield from the AP. The Trigger frame or frame carrying the TRS Control subfield indicates the parameters, such as the duration of the HE TB PPDU, RU allocation, target RSSI and MCS (see 9.3.1.22 (Trigger frame format), 9.2.4.6a.1 (TRS Control) and 26.5.3.3 (Non-AP STA behavior for UL MU operation)), required to transmit an HE TB PPDU."); 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).") Section 27.2.2 (TXVECTOR and RXVECTOR parameters) (EXPANSION_MAT, CHAN_MAT, DELTA_SNR, SNR, CQI, STBC, GI_TYPE, RSSI, RSSI_LEGACY, NUM_STS, RU_ALLOCATION, BEAMFORMED, HE_LTF_TYPE, HE_LTF_MODE, NUM_HE_LTF, STARTING_STS_NUM, PREAMBLE_TYPE, TRIGGER_METHOD, BEAM_CHANGE, BSS_COLOR, UPLINK_FLAG, STA_ID_LIST, NDP_REPORT, FEEDBACK_STATUS, RU_TONE_SET_INDEX); Section 26.5.3.2.4 (Allowed settings of the Trigger frame fields and TRS Control subfield) ("An AP shall transmit an HE PPDU that carries a Trigger frame or frame that includes a TRS Control subfield with the TXVECTOR parameter BEAM_CHANGE set to 1."). Section 26.5.3.3 (Non-AP STA behavior for UL MU operation) ("UL MU operation allows an AP to solicit simultaneous immediate response frames from one or more non-AP STAs. A non-AP STA shall follow the rules in this subclause for the transmission of response frames in an HE TB PPDU unless the Trigger frame is an MU-RTS Trigger frame, in which case the response is a CTS frame sent in a non-HT PPDU (see 26.2.6 (MU-RTS Trigger/CTS frame exchange procedure))."); Section 26.11 (Setting TXVECTOR parameters for an HE

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

31. The Accused Products determine a current position of the receiving device relative to the phased array antenna from the uplink transmission received from the receiving device through the phased array antenna. For example, as with each Accused Product, the D-Link DAP-X2810 determines a current position of the receiving device (*e.g.,* STA or HE beamformee) relative to the phased array antenna from the uplink transmission received from the receiving device through the phased array antenna (*e.g.,* uplink transmission received from the STA such as in response to a trigger frame soliciting an uplink transmission, including, *e.g.,* HE TB PPDUs, further including, *e.g.,* an uplink transmission that includes information regarding an estimate of the channel state in, *e.g.,* an HE compressed beamforming/CQI report carried in one or more HE Compressed Beamforming/CQI frames). *See, e.g.,* D-Link Nuclias Connect AX1800 Wi-Fi 6 Access Point DAP-X2810, 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 https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf ("Wi-Fi 6 delivers greater

network efficiency and lower latency, with nearly four times the capacity of previous Wi-Fi standards"; "MU-MIMO slices through congestion, reducing wait time for all users"; "2 x dual-band internal antennas"). *See, e.g.,* IEEE 802.11ax Standard, 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, 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, -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, 27.3.16, 27.3.17, Table 27-1. *See, e.g.,* IEEE 802.11ax Standard, at Section 27.3.1.1 ("The transmission within an RU in a PPDU may be single stream to one user, spatially multiplexed to one user (SU-MIMO), or spatially multiplexed to multiple users (MU-MIMO)."); Section 27.3.10.10 (HE-LTF) ("The HT-LTF field provides a means for the receiver to estimate the MIMO channel between the set of constellation mapper outputs (or, if STBC is applied, the STBC encoder outputs) and the receive chains."); Section 27.3.15 (SU-MIMO and DL-MIMO beamforming); Section 27.3.15.1 ("SU-MIMO and DL-MU-MIMO beamforming are techniques used by a STA with multiple antennas (the beamformer) to steer signals using knowledge of the channel to improve throughput. With SU-MIMO beamforming all space-time streams in the transmitted signal are intended for reception at a single STA in an RU. With DL MU-MIMO beamforming, disjoint subsets of the space-time streams are intended for reception at different STAs in an RU of size greater than or equal to 106-tones."); Section 27.3.15.2 ("After receiving the angle information, $\phi(k,u)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer uses $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,N_{user,r}}\text{-}1]$ using $V_{k,u}$ and Delta $\Delta SNR_{k,u}$ $(0 \leq u \leq N_{user,r}-1)$ in order to suppress crosstalk between participating beamformees. The method used by the beamformer to calculate the steering matrix Q_k is implementation specific.").

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

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

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

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

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

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

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

38. The ’728 Patent is valid and enforceable.

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

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

RUSS, AUGUST & KABAT

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

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

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

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

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

44.The '376 Accused Products satisfy all claim limitations of numerous claims of the '376 Patent, including Claim 1. The following paragraphs compare limitations of Claim 1 to an exemplary '376 Accused Product, the D-Link DAP-X2810[2] wireless access point.

45.Each of the '376 Accused Products comprises a data-communications networking apparatus. For example, the D-Link DAP-X2810 is a data-communications networking apparatus. *See, e.g.,* D-Link Nuclias Connect AX1800 Wi-Fi 6 Access Point DAP-X2810, 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 https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf ("Wi-Fi 6 delivers greater network efficiency and lower latency, with nearly four times the capacity of previous Wi-Fi standards"; "MU-MIMO slices through congestion, reducing wait time for all users"; "2 x dual-band internal antennas").

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

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

X2810 has at least one processor (*e.g.,* one or more central processing units (CPUs), Wi-Fi processors, a baseband processor in the Wi-Fi 6 radio, as examples) for generating signals for transmission. *See, e.g.,* D-Link Nuclias Connect AX1800 Wi-Fi 6 Access Point DAP-X2810, 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 https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf ("Wi-Fi 6 delivers greater network efficiency and lower latency, with nearly four times the capacity of previous Wi-Fi standards"; "MU-MIMO slices through congestion, reducing wait time for all users"; "2 x dual-band internal antennas"). For a further example, as with each '376 Accused Product, the D-Link DAP-X2810 generates a probing signal for transmission (*e.g.,* a probing signal transmission that triggers or elicits a responsive transmission from each of a first client device and a second client device, such as NDP Announcement, HE sounding NDP, Beamforming Report trigger frames pursuant to High Efficiency (HE) channel sounding, including preamble training fields allowing an estimate of the channel for MU-MIMO) to at least a first client device and a second client device (*e.g.,* a first non-AP STA / HE beamformee and a second non-AP STA / HE beamformee). *See, e.g.,* 802.11ax Standard, Sections 9.3.1.19, 9.3.1.22, 9.3.1.22.3, 9.4.1.64, 9.4.1.65, 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. *See, e.g.,* Section 26.7 (HE sounding protocol) ("Transmit beamforming and DL MU-MIMO require knowledge of the channel state to compute a steering matrix that is applied to the transmit signal to optimize reception at one or more receivers. HE STAs use the HE sounding protocol to determine the channel state information. The HE sounding protocol provides explicit feedback mechanisms, defined as HE non-trigger-based (non-TB) sounding and HE trigger-based (TB) sounding, where the HE beamformee measures the channel using a training signal (*i.e.*, an HE sounding NDP) transmitted by the HE beamformer and sends back a transformed estimate of the channel state. The HE beamformer uses this estimate to derive the steering matrix. The HE beamformee returns an estimate of the channel state in an HE compressed beamforming/CQI report carried in one or more HE Compressed Beamforming/CQI frames."); Section 26.7.3, Figures 26-6 and 26-7

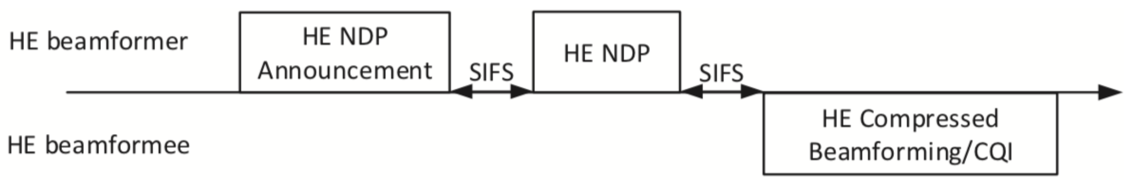

Figure 26-6—An example of the sounding protocol with a single HE beamformee

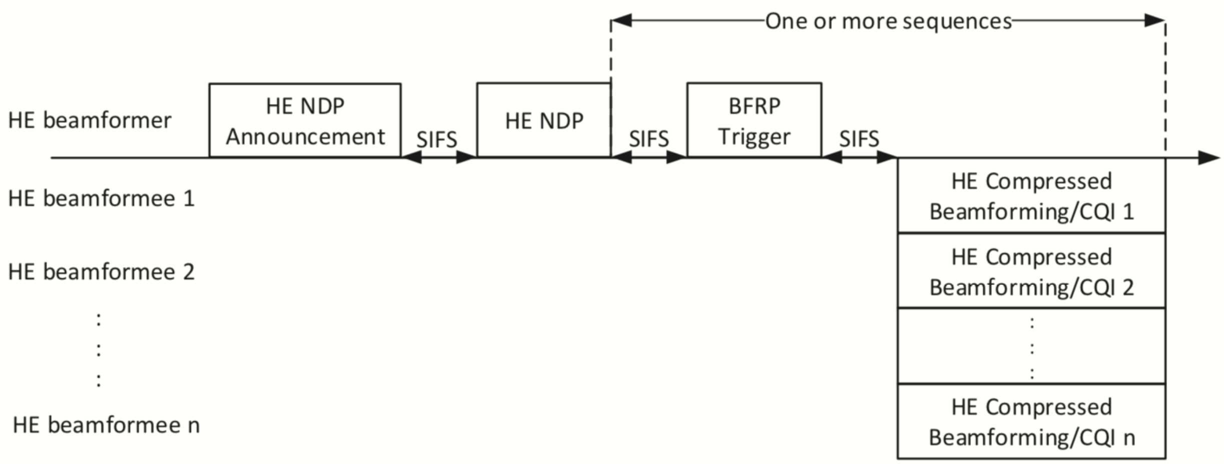

Figure 26-7—An example of the sounding protocol with more than one HE beamformee

; Section 26.7.3 ("An HE beamformee that receives an HE NDP Announcement frame from an HE beamformer with which it is associated and that contains the HE beamformee's MAC address in the RA field and also receives an HE sounding NDP a SIFS after the HE NDP Announcement frame shall transmit its HE compressed beamforming/CQI report a SIFS after the HE sounding NDP. The TXVECTOR parameter CH_BANDWIDTH for the PPDU containing the HE compressed beamforming/CQI report shall be set to indicate a bandwidth not wider than that indicated by the RXVECTOR parameter CH_BANDWIDTH of the HE sounding NDP. An HE beamformee that receives an HE NDP Announcement frame as part of an HE TB sounding sequence with a STA Info field addressed to it soliciting SU or MU feedback shall generate an HE compressed beamforming/CQI report using the feedback type, *Ng* and codebook size indicated in the STA Info field. If the HE beamformee then receives a BFRP Trigger frame with a User Info field addressed to it, the HE beamformee transmits an HE TB PPDU containing the HE compressed beamforming/CQI report following the rules defined in 26.5.3.3 (Non-AP STA behavior for UL MU operation)."); Section 26.5.3 (UL MU operation) ("UL MU operation allows an AP to solicit simultaneous immediate response frames from one or more non-AP HE STAs"); Section 27.3.10.10 (HE-LTF) ("The HE-LTF field provides a means for the receiver to estimate the MIMO channel between the set of constellation mapper outputs (or, if STBC is applied, the STBC encoder outputs) and the receive chains. In an HE SU PPDU and HE ER SU PPDU, the transmitter provides training for N_{STS} space-time streams (spatial mapper inputs) used for the transmission of the PSDU. In an HE MU PPDU, the transmitter provides training for $N_{STS,r,total}$ space-time streams used for the transmission of the PSDU(s) in the *r*-th RU. In an HE TB PPDU, the transmitter of user *u* in the *r*-th RU provides training for $N_{STS,r,u}$ space-time streams used for the transmission of the PSDU. For each tone in the *r*-th RU, the MIMO channel that can be estimated is an N_{RX} x $N_{STS,r,total}$ matrix. An HE transmission has a preamble that contains HE-LTF symbols, where the data tones of each HE-LTF symbol are multiplied by entries belonging to a matrix $P_{HE\text{-}LTF}$, to enable channel estimation at the receiver…. In an HE SU PPDU, HE MU PPDU and HE ER SU PPDU, the combination of HE-LTF type and GI duration is indicated in HE-SIG-A field. In an HE TB PPDU, the combination of HE-LTF type and GI duration is indicated in the Trigger frame that triggers transmission of the PPDU. If an HE PPDU is an HE sounding NDP, the combinations of HE-LTF types and GI durations are listed in 27.3.18 (Transmit specification). If an HE PPDU is an

HE TB feedback NDP, the combination of HE-LTF types and GI durations are listed in 27.3.4 (HE PPDU formats."); Section 27.3.15.1 (SU-MIMO and DL-MIMO beamforming) ("The DL MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,N_{user,r}-1}]$ can be detected by the beamformer using the beamforming feedback for subcarrier k from beamformee u, where $u = 0,1,\ldots N_{user,r}$ -1. The feedback report format is described in 9.4.1.65 (HE Compressed Beamforming Report field) and 9.4.1.66 (HE MU Exclusive Beamforming Report field). The steering matrix that is computed (or updated) using new beamforming feedback from some or all of participating beamformees might replace the existing steering matrix Q_k for the next DL MU-MIMO data transmission. For SU-MIMO beamforming, the steering matrix Q_k can be determined from the beamforming feedback matrix V_k that is sent back to the beamformer by the beamformee using the compressed beamforming feedback matrix format as defined in 19.3.12.3.6 (Compressed beamforming feedback matrix). The feedback report format is described in 9.4.1.65 (HE Compressed Beamforming Report field."). Section 9.4.1.65 (HE Compressed Beamforming Report field) ("The HE Compressed Beamforming Report field carries the average SNR of each space-time stream and compressed beamforming feedback matrices V for use by a transmit beamformer to determine steering matrices Q, as described in 10.32.3 (Explicit feedback beamforming) and 19.3.12.3 (Explicit feedback beamforming)"); Section 9.1.4.66 (HE MU Exclusive Beamforming Report field) ("The HE MU Exclusive Beamforming Report field carries explicit feedback in the form of delta SNRs. The information in the HE Compressed Beamforming Report field and the HE MU Exclusive Beamforming Report field can be used by the transmit MU beamformer to determine the steering matrices Q, as described in 27.3.3.1 (DL MU-MIMO)"); Section 9.4.1.67 (HE CQI Report Field) ("The HE CQI Report field carries the per-RU average SNRs of each space-time stream, where each per-RU average SNR is the arithmetic mean of the SNR in decibels over a 26-tone RU for which the feedback is being requested."). For a further example, as with each '376 Accused Product, the D-Link DAP-X2810 generates a probing signal for transmission (*e.g.,* a probing signal transmission that triggers or elicits a responsive transmission from each of a first client device and a second client device, such as NDP Announcement pursuant to Very High Throughput (VHT) channel sounding, including preamble training fields allowing an estimate of the channel for MU-MIMO) to at least a first client device and a second client device (*e.g.,* a first non-AP STA / VHT beamformee and a second non-AP STA / VHT beamformee). See, *e.g.*, 802.11ac Standard Clause 9.31.5.2 ("A VHT beamformer shall initiate a sounding feedback sequence by transmitting a VHT NDP Announcement frame followed by a VHT NDP after a SIFS. The VHT beamformer shall include in the VHT NDP Announcement frame one STA Info field for each VHT beamformee that is expected to prepare VHT Compressed Beamforming feedback and shall identify the VHT beamformee by including the VHT beamformee's AID in the AID subfield of the STA Info field. The VHT NDP Announcement frame shall include at least one STA Info field."); *id.* ("A non-AP VHT beamformee that receives a VHT NDP Announcement frame… shall transmit its VHT Compressed Beamforming feedback a SIFS after receiving a Beamforming Report Poll with RA matching its MAC address and a non-bandwidth signaling TA obtained from the TA field matching the MAC address of the VHT beamformer."); *id.* Clause 8.5.23.2 (defining format and subfields within the VHT Compressed Beamforming frame); *id.* Clause 8.4.1.48 (including Tables 8-53(d)-(h)) ("Each SNR value per tone in stream i (before being averaged) corresponds to the SNR associated with the column i of the beamforming feedback matrix V determined at the beamformee"); *id.* Clause 8.4.1.49 (including

Table 8-53i – MU Exclusive Beamforming Report information); *id.* Clauses 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:

> Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in 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 the form of angles using the method described in 20.3.12.3.6. The angles, $\phi(k,\upsilon)$ 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.
>
> The beamformee shall generate the beamforming feedback matrices with the number of rows (Nr) equal to the N_{STS} of the NDP.
>
> After receiving the angle information, $\phi(k,u)$ 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 matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,N_{user}-1}]$ using $V_{k,u}$ and $SNR_{k,u}$ ($0 \le u \le N_{user} - 1$) in order to suppress crosstalk between participating beamformees. The method used by the beamformer to calculate the steering matrix Q_k is implementation specific.

47. Each of the '376 Accused Products comprises a processor configured to generate a first data stream for transmission to the first client device and generate a second data stream for transmission to the second client device. For example, as with each Accused Product, the D-Link DAP-X2810 has at least one processor and Wi-Fi 6 radio functionality (*e.g.,* the CPU(s) and/or Wi-Fi processors and/or baseband processor(s) in the Wi-Fi 6 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.,* D-Link Nuclias Connect AX1800 Wi-Fi 6 Access Point DAP-X2810, 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

https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf ("Wi-Fi 6 delivers greater network efficiency and lower latency, with nearly four times the capacity of previous Wi-Fi standards"; "MU-MIMO slices through congestion, reducing wait time for all users"; "2 x dual-band internal antennas"). *See, e.g.,* IEEE 802.11ax Standard, at 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, 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, 27-21, 27-24, 27-25, 27-26, 27-27, 27-28, 27-29, Figures 27-19, 27-20, and other transmitter block diagrams for MU-MIMO transmission. *See, e.g.,* Section 27.1.1 ("The HE PHY extends the maximum number of users supported for DL MU-MIMO transmissions up to 8 users per resource unit (RU) and provides support for DL and UL orthogonal frequency division multiple access (OFDMA) as well as for UL MU-MIMO. Both DL and UL MU-MIMO transmissions are supported on portions of the PPDU bandwidth (on resource units greater than or equal to 106 tones). In an MU-MIMO resource unit, there is support for up to 8 users with up to 4 space-time streams per user with the total not exceeding 8 space-time streams"); Section 27.3.1.1 ("DL MU transmission allows an AP to simultaneously transmit information to more than one non-AP STA. For a DL MU transmission, the AP uses the HE MU PPDU format and employs either DL OFDMA, DL MU-MIMO, or a mixture of both."); Section 27.3.10.8.1 ("The HE-SIG-B field provides the OFDMA and DL MU-MIMO resource allocation information to allow the STAs to look up the corresponding resources to be used in the data portion of the frame."); Section 27.3.2.5 ("If there is more than one User field (see Table 27-28 (User field for an MU-MIMO allocation)) for an RU in the HE-SIG-B content channel, then the number of allocated spatial streams for each user in the RU is indicated by the Spatial Configuration field of the User field in HE-SIG-B…In each HE-SIG-B content channel, the User fields are first ordered in the order of RUs (from lower frequency to higher frequency) as described by the RU Allocation field if the HE-SIG-B contains the Common field. If an RU has multiple User fields in an HE-SIG-B content channel, the User fields of the RU are ordered in the order of spatial stream index, from lower to higher spatial stream, as indicated in the Spatial Configuration field. The STA-ID field in each User field indicates the intended recipient user of the corresponding spatial streams and the RU."); *See, e.g.,* IEEE 802.11ax Standard, Section 27.3.5 (Transmitter block diagram), at, *e.g.,* Figure 27-19:

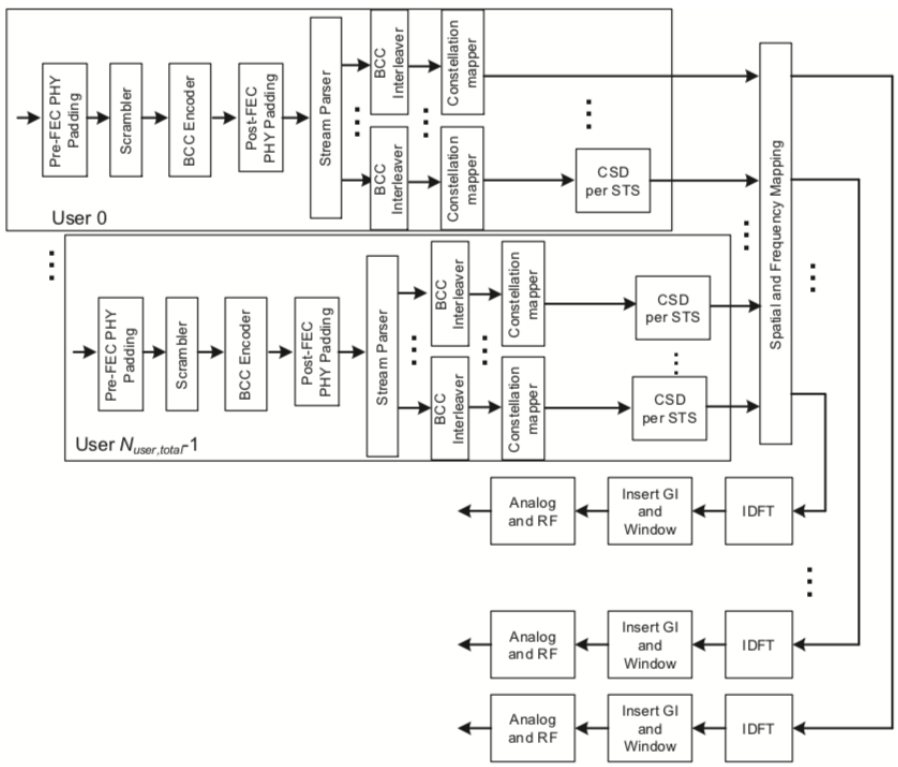

Figure 27-19—Transmitter block diagram for the Data field of an HE DL MU-MIMO transmission in a 106-, 242-, 484- or 996-tone RU with BCC encoding

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

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

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

49.Each of the '376 Accused Products comprises a transceiver operatively coupled to the processor and configured to: transmit the probing signal to at least the first client device and the second client device via a smart antenna; wherein the smart antenna is operatively coupled to the transceiver and comprises a first antenna element and a second antenna element. For example, as with each '376 Accused Product, the D-Link DAP-X2810 has a Wi-Fi 6 radio with a transceiver operatively coupled to the processor (*e.g.,* the Wi-Fi 6 radio generates signals for transmission and processes received signals with, *e.g.,* the CPU, Wi-Fi processors, and/or baseband processor in the Wi-Fi 6 radio, and the radio comprises a transceiver that transmits and receives signals via a smart antenna); and, as with each '376 Accused Product, the D-Link DAP-X2810 has a Wi-Fi 6 radio transceiver operatively coupled to the processor and to a smart antenna, wherein the smart antenna is operatively coupled to the Wi-Fi 6 radio and comprises a first antenna element and a second antenna element. *See, e.g.,* D-Link Nuclias Connect AX1800 Wi-Fi 6 Access Point DAP-X2810, 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 https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf ("Wi-Fi 6 delivers greater network efficiency and lower latency, with nearly four times the capacity of previous Wi-Fi standards"; "MU-MIMO slices through congestion, reducing wait time for all users"; "2 x dual-band internal antennas"). For a further example, as with each '376 Accused Product, the D-Link DAP-X2810 transmits the probing signal (*e.g.,* a probing signal transmission that triggers or elicits a responsive transmission from each of a first client device and a second client device, such as NDP Announcement, HE sounding NDP, Beamforming Report trigger frames pursuant to High Efficiency (HE) channel sounding, including preamble training fields allowing an estimate of the channel for MU-MIMO) to at least the first client device and the second client device (*e.g.,* the first non-AP STA and the second non-AP STA) via the smart antenna. *See, e.g.,* 802.11ax Standard, Sections 9.3.1.19, 9.3.1.22, 9.3.1.22.3, 9.4.1.64, 9.4.1.65, 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. *See, e.g.,* Section 26.7.5 (HE sounding NDP transmission) (setting forth TXVECTOR parameters for HE sounding NDP); Section 27.3.10.10 (HE-LTF) ("The HE-LTF field provides a means for the receiver to estimate the MIMO channel between the set of constellation mapper outputs (or, if STBC is applied, the STBC encoder outputs) and the receive chains. In an HE SU PPDU and HE ER SU PPDU, the transmitter provides training for N_{STS} space-time streams (spatial mapper inputs) used for the transmission of the PSDU. In an HE MU PPDU, the transmitter provides training for $N_{STS,r,total}$ space-time streams used for the transmission of the PSDU(s) in the r-th RU. In an HE TB PPDU, the transmitter of user u in the r-th RU provides training for $N_{STS,r,u}$ space-time streams used for the transmission of the PSDU. For each tone in the r-th RU, the MIMO channel that can be estimated is an N_{RX} x $N_{STS,r,total}$ matrix. An HE transmission has a preamble that contains HE-LTF symbols, where the data tones of each HE-LTF symbol are multiplied by entries belonging to a matrix $P_{\text{HE-LTF}}$, to enable channel estimation at the receiver…. In an HE SU PPDU, HE MU PPDU and HE ER SU PPDU, the combination of HE-LTF type and GI duration is indicated in HE-SIG-A field. In an HE TB PPDU, the combination of HE-LTF type and GI duration is indicated in the Trigger frame that triggers transmission of the PPDU. If an HE PPDU is an HE sounding NDP, the combinations of HE-LTF types and GI durations are listed in 27.3.18 (Transmit specification). If an HE PPDU is an HE TB feedback NDP, the combination of HE-LTF types and GI durations are listed in 27.3.4 (HE PPDU formats.”). *See, e.g.,* Section 26.7.3, Figure 26-7

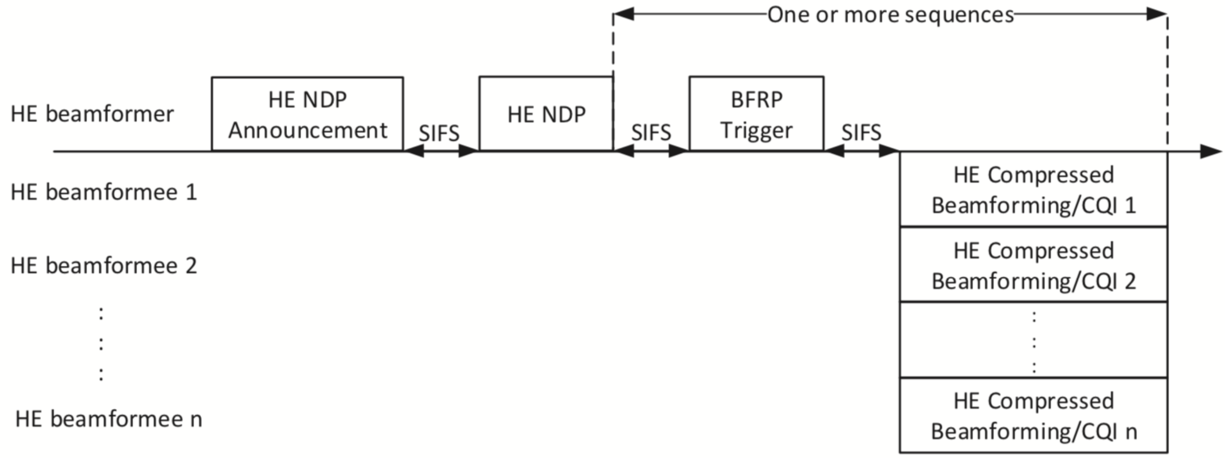

Figure 26-7—An example of the sounding protocol with more than one HE beamformee

; Section 9.4.1.65 (HE Compressed Beamforming Report field) (“The HE Compressed Beamforming Report field carries the average SNR of each space-time stream and compressed beamforming feedback matrices *V* for use by a transmit beamformer to determine steering matrices *Q*, as described in 10.32.3 (Explicit feedback beamforming) and 19.3.12.3 (Explicit feedback beamforming)”); Section 9.1.4.66 (HE MU Exclusive Beamforming Report field) (“The HE MU Exclusive Beamforming Report field carries explicit feedback in the form of delta SNRs. The information in the HE Compressed Beamforming Report field and the HE MU Exclusive Beamforming Report field can be used by the transmit MU beamformer to determine the steering matrices *Q*, as described in 27.3.3.1 (DL MU-MIMO)”); Section 9.4.1.67 (HE CQI Report Field) (“The HE CQI Report field carries the per-RU average SNRs of each space-time stream, where each per-RU average SNR is the arithmetic mean of the SNR in decibels over a 26-tone RU for which the feedback is being requested.”). *See, e.g.,* 802.11ac Standard Clause 9.31.5.2 (“A VHT beamformer shall initiate a sounding feedback sequence by transmitting a VHT NDP Announcement frame followed by a VHT NDP after a SIFS. The VHT beamformer shall include in the VHT NDP Announcement frame one STA Info field for each VHT beamformee that is expected to prepare VHT Compressed Beamforming feedback and shall identify the VHT beamformee by including the VHT beamformee's AID in the AID subfield of the STA Info field. The VHT NDP Announcement frame shall include at least one STA Info field."); *id.* ("A non-AP VHT beamformee that receives a VHT NDP Announcement frame… shall transmit its VHT Compressed Beamforming feedback a SIFS after receiving a Beamforming Report Poll with RA matching its MAC address and a non-bandwidth signaling TA obtained from the TA field matching the MAC address of the VHT beamformer."); *id.* Clause 8.5.23.2 (defining format and subfields within the VHT Compressed Beamforming frame); *id.* Clause 8.4.1.48 (including Tables 8-53(d)-(h)) ("Each SNR value per tone in stream i (before being averaged) corresponds to the SNR associated with the column i of the beamforming feedback matrix V determined at the beamformee"); *id.* Clause 8.4.1.49 (including Table 8-53i – MU Exclusive Beamforming Report information); *id.* Clauses 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.

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

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

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

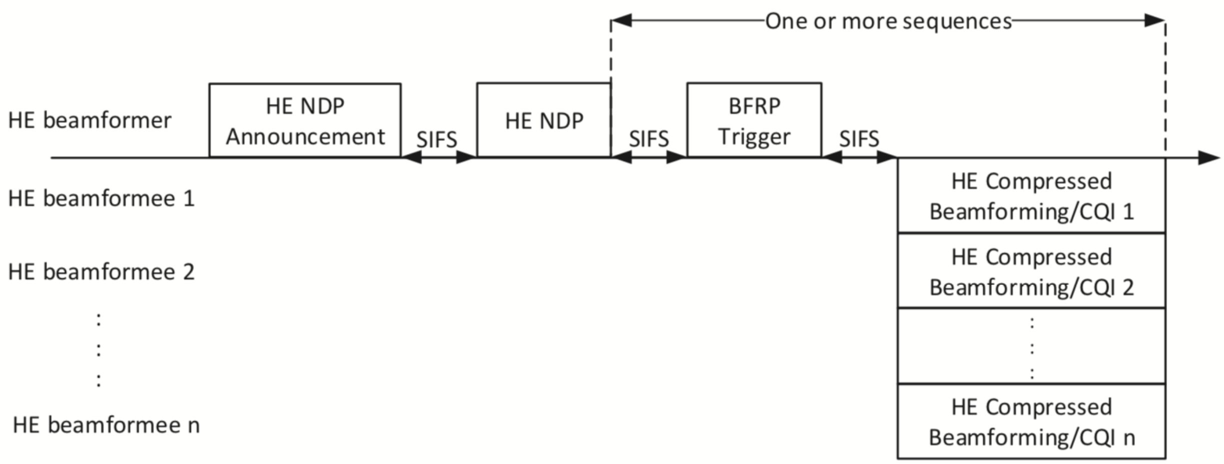

Figure 26-7—An example of the sounding protocol with more than one HE beamformee

51.For a further example, as with each '376 Accused Product, the D-Link DAP-X2810 comprises one or more of the processor, the transceiver, or the smart antenna further configured to receive channel state information and estimates of the channel state and MU MIMO-related feedback information from each of the first non-AP STA and the second non-AP STA pursuant to MU-MIMO sounding procedures. This feedback information, carried in one or more compressed beamforming frames, is in response to the transmission of the probing signal (*e.g.,* a probing signal transmission that triggers or elicits a responsive transmission from each of a first client device and a second client device, such as NDP Announcement pursuant to Very High Throughput (VHT) channel sounding, including preamble training fields allowing an estimate of the channel for MU-MIMO). See, *e.g.*, 802.11ac Standard Clause 9.31.5.2 ("A VHT beamformer shall initiate a sounding feedback sequence by transmitting a VHT NDP Announcement frame followed by a VHT NDP after a SIFS. The VHT beamformer shall include in the VHT NDP Announcement frame one STA Info field for each VHT beamformee that is expected to prepare VHT Compressed Beamforming feedback and shall identify the VHT beamformee by including the VHT beamformee's AID in the AID subfield of the STA Info field. The VHT NDP Announcement frame shall include at least one STA Info field."); *id.* ("A non-AP VHT beamformee that receives a VHT NDP Announcement frame… shall transmit its VHT Compressed Beamforming feedback a SIFS after receiving a Beamforming Report Poll with RA matching its MAC address and a non-bandwidth signaling TA obtained from the TA field matching the MAC address of the VHT beamformer."); *id.* Clause 8.5.23.2 (defining format and subfields within the VHT Compressed Beamforming frame); *id.* Clause 8.4.1.48 (including Tables 8-53(d)-(h)) ("Each SNR value per tone in stream i (before being averaged) corresponds to the SNR associated with the column i of the beamforming feedback matrix V determined at the beamformee"); *id.* Clause 8.4.1.49 (including Table 8-53i – MU Exclusive Beamforming Report information); *id.* Clauses 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:

Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in 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 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.

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

After receiving the angle information, $\phi(k,u)$ 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 matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,N_{user}-1}]$ using $V_{k,u}$ and $SNR_{k,u}$ $(0 \le u \le N_{user} - 1)$ in order to suppress crosstalk between participating beamformees. The method used by the beamformer to calculate the steering matrix Q_k is implementation specific.

52.Each of the ’376 Accused Products comprises a data-communications networking apparatus wherein one or more of the processor, the transceiver, or the smart antenna is further configured to: determine where to place transmission peaks and transmission nulls within one or more spatially distributed patterns of electromagnetic signals based in part on the first and the second feedback information. For example, as with each ’376 Accused Product, the D-Link DAP-X2810 comprises one or more of the processor, the transceiver, or the smart antenna further configured to determine where to place transmission peaks and transmission nulls within one or more spatially distributed patterns of electromagnetic signals based in part on the first and the second feedback information, including, *e.g.,* where it determines where to place transmission peaks and transmission nulls through a 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.

See, e.g., Section 9.4.1.65 (HE Compressed Beamforming Report field) ("The HE Compressed Beamforming Report field carries the average SNR of each space-time stream and compressed beamforming feedback matrices *V* for use by a transmit beamformer to determine steering matrices *Q*, as described in 10.32.3 (Explicit feedback beamforming) and 19.3.12.3 (Explicit feedback beamforming)"); Section 9.1.4.66 (HE MU Exclusive Beamforming Report field) ("The HE MU Exclusive Beamforming Report field carries explicit feedback in the form of delta SNRs. The information in the HE Compressed Beamforming Report field and the HE MU Exclusive Beamforming Report field can be used by the transmit MU beamformer to determine the steering matrices *Q*, as described in 27.3.3.1 (DL MU-MIMO)"); Section 9.4.1.67 (HE CQI Report Field) ("The HE CQI Report field carries the per-RU average SNRs of each space-time stream, where each per-RU average SNR is the arithmetic mean of the SNR in decibels over a 26-tone RU for which the feedback is being requested."); Section 27.3.15.1 ("SU-MIMO and DL-MU-MIMO beamforming are techniques used by a STA with multiple antennas (the beamformer) to steer signals using knowledge of the channel to improve throughput. With SU-MIMO beamforming all space-time streams in the transmitted signal are intended for reception at a single STA in an RU. With DL MU-MIMO beamforming, disjoint subsets of the space-time streams are intended for reception at different STAs in an RU of size greater than or equal to 106-tones…The DL MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,N_{user,r}-1}]$ can be detected by the beamformer using the beamforming feedback for subcarrier *k* from beamformee *u*, where $u = 0,1,\ldots N_{user,r}-1$. The feedback report format is described in 9.4.1.65 (HE Compressed Beamforming Report field) and 9.4.1.66 (HE MU Exclusive Beamforming Report field). The steering matrix that is computed (or updated) using new beamforming feedback from some or all of participating beamformees might replace the existing steering matrix Q_k for the next DL MU-MIMO data transmission."); Section 27.3.15.2 ("Upon receipt of an HE sounding NDP, the beamformee computes a set of matrices for feedback to the beamformer as described in 21.3.11.2 (Beamforming Feedback Matrix *V*). The eligible beamformees shall remove the space-time stream CSD in Table 21-11 (Cyclic shift values for the VHT modulated fields of a PPDU) 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* in RU *r* shall be compressed in the form of angles using the method described in 19.3.12.3.6 (Compressed beamforming feedback matrix). The angles $\phi(k,u)$ and $\psi(k,u)$, are quantized according to Table 9-68 (Quantization of angles)…. The beamformee shall generate the beamforming feedback matrices with the number of rows (*Nr*) equal to the N_{STS} of the HE sounding NDP. After receiving the angle information, $\phi(k,u)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer uses $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,N_{user,r}}\text{-}1]$ using $V_{k,u}$ and Delta $\Delta SNR_{k,u}$ ($0 \leq u \leq N_{user,r}$-1) in order to suppress crosstalk between participating beamformees. The method used by the beamformer to calculate the steering matrix Q_k is implementation specific."). 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 20.3.12.3.6; 802.11ac Standard Clauses 8.4.1.24, 9.31.5.1, 9.31.5.2; *id.* Clause 22.3.11.1:

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

, Clause 22.3.11.2:

> Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in 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 the form of angles using the method described in 20.3.12.3.6. The angles, $\phi(k,\upsilon)$ 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.
>
> The beamformee shall generate the beamforming feedback matrices with the number of rows (Nr) equal to the N_{STS} of the NDP.
>
> After receiving the angle information, $\phi(k,u)$ 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 matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,N_{user}-1}]$ using $V_{k,u}$ and $SNR_{k,u}$ ($0 \le u \le N_{user} - 1$) in order to suppress crosstalk between participating beamformees. The method used by the beamformer to calculate the steering matrix Q_k is implementation specific.

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

DAP-X2810 comprises one or more of the processor, the transceiver, or the smart antenna further configured to transmit the first data stream to the first client device (*e.g.,* the first non-AP STA) via the one or more spatially distributed patterns of electromagnetic signals (*e.g.,* transmission of data to the first non-AP STA pursuant to HE MU-MIMO beamforming where a beamforming steering matrix is applied); and transmit the second data stream to the second client device (*e.g.,* the second non-AP STA) via the one or more spatially distributed patterns of electromagnetic signals (*e.g.,* transmission of data to the second non-AP STA pursuant to HE MU-MIMO beamforming where a beamforming steering matrix is applied); wherein transmission of the first data stream and transmission of at least part of the second data stream occur at the same time (*e.g.,* simultaneous HE DL MU-MIMO transmissions); and wherein the one or more spatially distributed patterns of electromagnetic signals are configured to exhibit a first transmission peak at a location of the first client device and a second transmission peak at a location of the second client device (*e.g.,* through HE MU-MIMO beamforming, radio energy is directed at each of the first client device and the second client device to form a transmission peak at the location of each device, and including, *e.g.,* where the beamforming steering matrix is applied, a first space-time stream ("STS") intended for reception at the first client device and a second STS intended for reception at the second client device is representative of a first transmission peak being placed at the location of the first client device and a second transmission peak being placed at the location of second client device). *See, e.g.,* D-Link Nuclias Connect AX1800 Wi-Fi 6 Access Point DAP-X2810, 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 https://www.dlink.com/-/media/global-pdfs/global-datasheets/dap/dapx2810a1datasheetv100ww.pdf ("Wi-Fi 6 delivers greater network efficiency and lower latency, with nearly four times the capacity of previous Wi-Fi standards"; "MU-MIMO slices through congestion, reducing wait time for all users"; "2 x dual-band internal antennas"). *See, e.g.,* IEEE 802.11ax Standard, Section 27.3.15.1 ("SU-MIMO and DL-MU-MIMO beamforming are techniques used by a STA with multiple antennas (the beamformer) to steer signals using knowledge of the channel to improve throughput. With SU-MIMO beamforming all space-time streams in the transmitted signal are intended for reception at a single STA in an RU. With DL MU-MIMO beamforming, disjoint subsets of the space-time streams are intended for reception at different STAs in an RU of size greater than or equal to 106-tones…The DL MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,N_{user,r}-1}]$ can be detected by the beamformer using the beamforming feedback for subcarrier k from beamformee u, where $u = 0,1,\ldots N_{user,r}$ -1. The feedback report format is described in 9.4.1.65 (HE Compressed Beamforming Report field) and 9.4.1.66 (HE MU Exclusive Beamforming Report field). The steering matrix that is computed (or updated) using new beamforming feedback from some or all of participating beamformees might replace the existing steering matrix Q_k for the next DL MU-MIMO data transmission."); Section 27.3.15.2 ("The beamformee shall generate the beamforming feedback matrices with the number of rows (Nr) equal to the N_{STS} of the HE sounding NDP. After receiving the angle information, $\phi(k,u)$ and $\psi(k,u)$, the beamformer reconstructs $V_{k,u}$ using Equation (19-79). For SU-MIMO beamforming, the beamformer uses $V_{k,0}$ matrix to determine the steering matrix Q_k. For DL MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,N_{user,r}}-1]$ using $V_{k,u}$ and Delta $\Delta SNR_{k,u}$ ($0 \leq u \leq N_{user,r}$-1) in order to suppress crosstalk between participating beamformees. The method used by the beamformer to calculate the steering matrix Q_k is implementation specific."); Section 27.1.1 ("The HE PHY extends the maximum

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

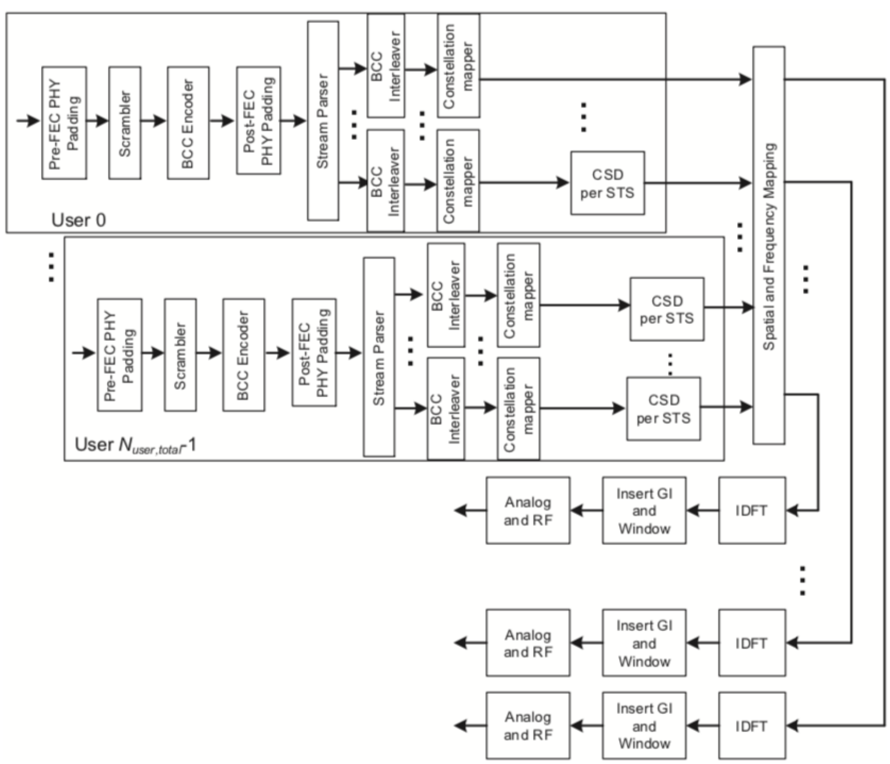

Figure 27-19—Transmitter block diagram for the Data field of an HE DL MU-MIMO transmission in a 106-, 242-, 484- or 996-tone RU with BCC encoding

; Section 9.4.1.65 (HE Compressed Beamforming Report field) ("The HE Compressed Beamforming Report field carries the average SNR of each space-time stream and compressed beamforming feedback matrices *V* for use by a transmit beamformer to determine steering matrices *Q*, as described in 10.32.3 (Explicit feedback beamforming) and 19.3.12.3 (Explicit feedback beamforming)"); Section 9.1.4.66 (HE MU Exclusive Beamforming Report field) ("The HE MU Exclusive Beamforming Report field carries explicit feedback in the form of delta SNRs. The information in the HE Compressed Beamforming Report field and the HE MU Exclusive Beamforming Report field can be used by the transmit MU beamformer to determine the steering matrices *Q*, as described in 27.3.3.1 (DL MU-MIMO)"); Section 9.4.1.67 (HE CQI Report Field) ("The HE CQI Report field carries the per-RU average SNRs of each space-time stream, where each per-RU average SNR is the arithmetic mean of the SNR in decibels over a 26-tone RU for which the feedback is being requested."). See, *e.g.*, 802.11ac Standard Clause 9.31.5.1 ("Transmit 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 20.3.12.3.6; 802.11ac Standard Clauses 8.4.1.24, 9.31.5.1, 9.31.5.2; *id.* Clause 22.3.11.1, 22.3.11.2:

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

Upon receipt of a VHT NDP sounding PPDU, the beamformee shall remove the space-time stream CSD in 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 the form of angles using the method described in 20.3.12.3.6. The angles, $\phi(k,\upsilon)$ 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.

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

After receiving the angle information, $\phi(k,u)$ 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 matrix Q_k. For DL-MU-MIMO beamforming, the beamformer may calculate a steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,N_{user}-1}]$ using $V_{k,u}$ and $SNR_{k,u}$ $(0 \le u \le N_{user} - 1)$ in order to suppress crosstalk between participating beamformees. The method used by the beamformer to calculate the steering matrix Q_k is implementation specific.

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

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

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

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

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

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

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

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

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

VI. WILLFUL INFRINGEMENT

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

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

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

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

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

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

PRAYER FOR RELIEF

WHEREFORE, Vivato prays for the following relief:

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

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

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

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

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

DEMAND FOR JURY TRIAL

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

DATED: June 16, 2021

Respectfully submitted,

RUSS AUGUST & KABAT

By: */s/ Reza Mirzaie*
Reza Mirzaie
Marc A. Fenster
Philip X. Wang
Christian Conkle
James N. Pickens
Minna Y. Chan

Attorneys for Plaintiff
XR COMMUNICATIONS, LLC,
dba VIVATO TECHNOLOGIES