UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF TEXAS
WACO DIVISION

XR COMMUNICATIONS, LLC, dba VIVATO TECHNOLOGIES, Plaintiff, v. ASUSTEK COMPUTER INC. Defendant.	Case No. **JURY TRIAL DEMANDED**

COMPLAINT FOR PATENT INFRINGEMENT AGAINST
ASUSTEK COMPUTER INC.

This is an action for patent infringement arising under the Patent Laws of the United States of America, 35 U.S.C. § 1 *et seq.*, in which Plaintiff XR Communications LLC d/b/a Vivato Technologies ("Plaintiff" or "Vivato") makes the following allegations against Defendant ASUSTeK Computer Inc. ("Defendant"):

INTRODUCTION

1. 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"), 10,594,376 (the "'376 Patent"), and 10,715,235 (the "'235 Patent") (collectively, the "Asserted Patents").

2. 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.

3. 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.

4. 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.

5. 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.

6. 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 successive limitations and roadblocks directed wireless communication technology..

7. 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 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.

8. Moving from omnidirectional networks to modern networks, has required an additional series 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, heterogeneous, transmitters and receivers.

9. 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 the 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 Defendants' accused products.

PARTIES

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

11. 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.

12. 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.

13. 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.

14. 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.

15. 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.

16. Defendant ASUSTeK Computer Inc. (“ASUSTeK”) is a publicly-owned corporation organized under the laws of Taiwan, with its principal place of business at No. 15, Li-Teh Rd., Beitou District, Taipei City 112, Taiwan. ASUSTeK does substantial business on an ongoing basis in the United States, including in this State and in this District. On information and belief, ASUSTeK causes and controls the sale, offer for sale, and distribution of its products in the State of Texas and in this District.

JURISDICTION AND VENUE

17. This action arises under the patent laws of the United States, Title 35 of the United States Code § 1, *et seq*, including 35 U.S.C. §§ 271, 281, 283, 284, and 285. This Court has original subject matter jurisdiction pursuant to 28 U.S.C. §§ 1331 and 1338(a).

18. This Court has personal jurisdiction over Defendant in this action because Defendant has committed acts within this District giving rise to this action, and has established minimum contacts with this forum such that the exercise of jurisdiction over Defendant would not offend traditional notions of fair play and substantial justice. Defendant, directly and through subsidiaries or intermediaries, has committed and continue to commit acts of infringement in this District by, among other things, importing, offering to sell, and selling products that infringe the

asserted patents, and inducing others to infringe the asserted patents in this District. Defendant is directly and through intermediaries making, using, selling, offering for sale, distributing, advertising, promoting, and otherwise commercializing its infringing products in this District. Defendant regularly conducts and solicits business in, engages in other persistent courses of conduct in, and/or derives substantial revenue from goods and services provided to the residents of this District and the State of Texas.

19. Venue is proper in this District. Venue is proper as to a foreign defendant in any district. 28 U.S.C. § 1391(c)(3); *In re HTC Corp.*, 889 F.3d 1349 (Fed. Cir. 2018). Defendant is a foreign corporation organized under the laws of Taiwan, with a principal place of business in Taiwan. Accordingly, venue is proper in this District over Defendant.

COUNT I

INFRINGEMENT OF U.S. 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. 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. Defendant's ASUS RT-AX Series and GT-AX Series of products, including the ASUS RT-AX50, ASUS RT-AX80, and ASUS RT-AX90 Series of products, including for example the ASUS RT-AX55, ASUS RT-AX56U, ASUS RT-AX58U, ASUS RT-AX68U, ASUS RT-AX86U, ASUS RT-AX88U, ASUS RT-AX89U, ASUS RT-AX92U, ASUS RT-AX1800, ASUS RT-AX3000, ASUS RT-AX6000, ASUS RT-AX11000, ASUS ROG Rapture GT-AX11000 Triband Wi-Fi 6, GT-AXE11000, ASUS AiMesh AX6100 WiFi System, CM-AX6000, RP-AX56, ZenWiFi AX6600 XT8, ZenWiFi AX Mini XD4N, ZenWiFi AX Mini XD4R, PCE-AX3000, PCE-AX58BT) (collectively the "'728 Accused Products"). Defendant is liable for infringement of the '728 Patent pursuant to 35 U.S.C. § 271(a).

23. 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 ASUS RT-AX3000.

24. Each of the '728 Accused Products perform a method for use in a wireless communication system. For example, as with each '728 Accused Product, the ASUS RT-AX3000 is used for wireless communications in an IEEE 802.11ax (Wi-Fi 6) wireless network. *See, e.g.,* ASUS RT-AX3000 Product Specification,[1] which explains that ASUS RT-AX3000 includes "IEEE 802.11ax" Network Standard support with advertised data rates of up to 574 Mbps (2.4 GHz) and up to 2402 Mbps (5 GHz). *See, e.g.,* ASUS RT-AX3000 Product Overview,[2] which provides: "RT-AX3000 is a 2x2 dual-band Wi-Fi router that provides 160 MHz bandwidth and

[1] ASUS RT-AX3000 Product Specifications are available on Defendant's website at https://www.asus.com/ca-en/networking-iot-servers/wifi-6/all-series/rt-ax3000/techspec/ (formerly at http://www.asus.com/ca-en/Networking/RT-AX3000/specifications/).
[2] ASUS RT-AX3000 Product Overview is available on Defendant's website at https://www.asus.com/us/Networking/RT-AX3000/ or https://www.asus.com/ca-en/networking-iot-servers/wifi-6/all-series/rt-ax3000/.

1024-QAM for dramatically faster wireless connections…[i]n most cases, your RT-AX3000 can deliver smooth, reliable Wi-Fi to every part of your home."

25. The '728 Accused Products 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. The ASUS RT-AX3000 is an access point for use in an IEEE 802.11ax wireless network. *See, e.g.,* ASUS RT-AX3000 Product Overview, which provides: "RT-AX3000 is a 2x2 dual-band Wi-Fi router that provides 160 MHz bandwidth and 1024-QAM for dramatically faster wireless connections…[i]n most cases, your RT-AX3000 can deliver smooth, reliable Wi-Fi to every part of your home." Further, the ASUS RT-AX3000 is an access point with at least one phased array antenna. *See, e.g.,* ASUS RT-AX3000 Product Specification, which explains for ASUS RT-AX3000, Antenna includes "External antenna x 4," Transmit/Receive includes "2.4 GHz (2x2), 5 GHz (2x2)," Wi-Fi Technology includes "Beamforming: standard-based and universal," Features include "MU-MIMO" and "Beamforming"; *see also* ASUS RT-AX3000 Product Overview:

Further, the ASUS RT-AX3000 uses and includes an access point with a phased array antenna and a Wi-Fi 6 radio that performs beamforming. *See, e.g.,* ASUS RT-AX3000 Product Specification, which explains for ASUS RT-AX3000, Antenna includes "External antenna x 4," Transmit/Receive includes "2.4 GHz 2x2, 5 GHz 2x2," Wi-Fi Technology includes "Beamforming: standard-based and universal," Features include "MU-MIMO" and "Beamforming". *See, e.g.,* IEEE 802.11ax Standard[3] at Section 27.3.5 (Transmitter block diagram). Further, the Accused Products, including the ASUS RT-AX3000, selectively allow 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. *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

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[3] A reference to a Section of the IEEE 802.11ax Standard operates as an incorporation by reference of the same or corresponding Section in any Draft or Final version of the IEEE 802.11ax Standard.

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 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 MCSn, 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 MCSn, 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.			

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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).").

26. The ’728 Accused Products receive an uplink transmission from the receiving device through the phased array antenna. For example, as with each ’728 Accused Product, the Wi-Fi radio in ASUS RT-AX3000 is operatively coupled to the phased array antenna and allows ASUS RT-AX3000 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:

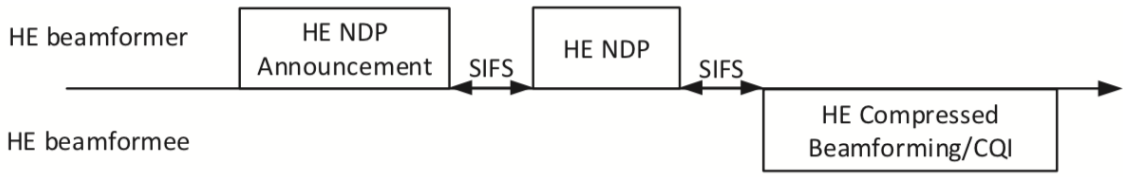

Figure 26-6—An example of the sounding protocol with a single HE beamformee

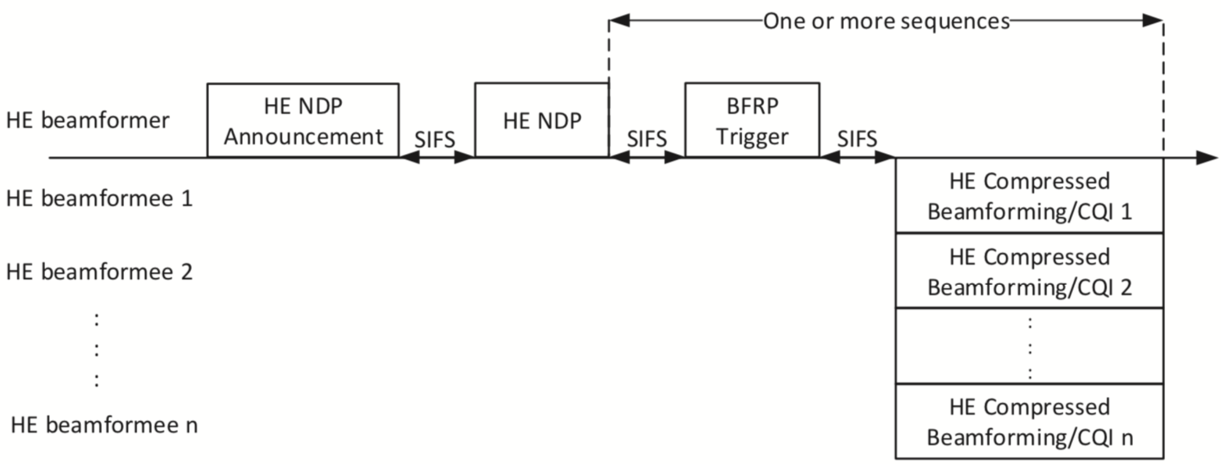

Figure 26-7—An example of the sounding protocol with more than one HE beamformee

; 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 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."); Section 27.3.15.1 (SU-MIMO and DL-MIMO beamforming) ("The DL MU-MIMO steering matrix $Q_k = [Q_{k,0},\ Q_{k,1}, \ldots, Q_{k,Nuser,r\text{-}1}]$ can be detected by the beamformer using the beamforming feedback for subcarrier k from beamformee u, where u = 0,1,…$N_{user,r}$ -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.").

27. The '728 Accused Products 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, as with each '728 Accused Product, the ASUS RT-AX3000 determines based on information from 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 a client device (*e.g.,* a STA, or HE beamformee) should operatively associate with a different beam downlink transmittable via the phased array antenna. *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 $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,Nuser,r\text{-}1}]$ 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."); 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.").

28. The '728 Accused Products allow the receiving device to operatively associate with

a different beam downlink if determining that the receiving device should operatively associate with the different beam downlink. For example, as with each ’728 Accused Product, the ASUS RT-AX3000 allows 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 $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,Nuser,r-1}]$ 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 $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,Nuser,r}\text{-}1]$ using $V_{k,u}$ and Delta $\Delta SNR_{k,u}$ $(0 \leq u \leq N_{user,r}\text{-}1)$ in order to suppress crosstalk between participating beamformees. The method used by the beamformer to calculate the steering matrix Q_k is implementation specific."); 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).

29. The ’728 Accused Products actively probe the receiving device by generating a signal to initiate that the phased array antenna transmit 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 ’728 Accused Product, the ASUS RT-AX3000 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.").

30. The ’728 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 ’728 Accused Product, the ASUS RT-AX3000 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.,* 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 $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,Nuser,r}\text{-}1]$ 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.").

31. Defendant also has been and is now knowingly and intentionally inducing infringement of numerous claims, including claims 3, 4, 5, and 12 of the '728 Patent in violation of 35 U.S.C. § 271(b). Through the filing and service of this Complaint, Defendant has had knowledge of the '728 Patent and the infringing nature of the '728 Accused Products. Defendant also had knowledge of Vivato's '728 Patent by at least the citation of the application that led to the '728 Patent, during the prosecution of Defendant's U.S. Patent Application No. 12/138,449, "Method for setting smart antenna and system thereof." On December 22, 2010, during prosecution of Defendant's U.S. Patent Application No. 12/138,449, the USPTO examiner cited U.S. Patent Application Publication No. 2006/0238400A1 to Brennan, which is the application that led to Vivato's '728 Patent. Vivato's '728 Patent had already issued on June 1, 2010. Accordingly, a reasonable inference is that Defendant had knowledge of the '728 Patent and its issued claims by at least as early as December 22, 2010. Further, Defendant also had knowledge of Vivato's '728 Patent by at least the filing of the Complaint on April 19, 2017 and waiver of service of said complaint by Defendant on May 24, 2017 in the United States District Court for the Central District of California, Case No. 2:17-cv-2948-AG(JCGx).

32. Despite this knowledge of the '728 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 '728 Accused Products in ways that directly infringe the '728 Patent. For example, Defendant's website provided, and continues to provide, instructions for using the '728 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 '728 Accused Products, despite its knowledge of the '728 Patent, thereby specifically intending for and inducing its customers to infringe the '728 Patent through the customers' normal and customary use of the '728 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 '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.

33. Defendant also contributorily infringes by making, using, selling, offering to sell, and/or importing the '728 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.

34. By making, using, offering for sale, selling and/or importing into the United States the '728 Accused Products, Defendant has injured Vivato and is liable for infringement of the '728 Patent pursuant to 35 U.S.C. § 271.

35. 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.

36. Vivato's '728 Patent is valid and enforceable.

37. Vivato has complied with 35 U.S.C. 287 and it does not preclude the recovery of pre-suit damages at least because Vivato is only asserting method claims from the '728 Patent.

38. As a result of Defendant's infringement of the '728 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.

39. 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.

COUNT II

INFRINGEMENT OF U.S. PATENT NO. 10,594,376

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

41. 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.

42. 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 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. Defendant's ASUS RT-AX Series and GT-AX Series of products, including the ASUS RT-AX50, ASUS RT-AX80, and ASUS RT-AX90 Series of products, including for example the ASUS RT-AX55, ASUS RT-AX56U, ASUS RT-AX58U, ASUS RT-AX68U, ASUS RT-AX86U, ASUS RT-AX88U, ASUS RT-AX89U, ASUS RT-AX92U, ASUS RT-AX1800, ASUS RT-AX3000, ASUS RT-AX6000, ASUS RT-AX11000, ASUS ROG Rapture GT-AX11000 Triband Wi-Fi 6, GT-AXE11000, ASUS AiMesh AX6100 WiFi System, CM-AX6000, RP-AX56, ZenWiFi AX6600 XT8, ZenWiFi AX Mini XD4N, ZenWiFi AX Mini XD4R) and access points and routers supporting MU-MIMO utilizing the IEEE 802.11ac-2013 standard (e.g., Defendant's RT-ACRH13 AC1300 Dual-Band Gigabit Wi-Fi Router, RT-AC87U Dual-band 4x4 AC2400 Wifi 4-Port Gigabit Router with AiProtection Powered by Trend Micro, RT-AC88U AC3100 Dual-Band Wi-Fi Gigabit Router, RT-AC3100 Dual-Band 4x4 AC3100 Wifi 4-Port Gigabit Gaming Router with AiProtection Powered by Trend Micro, RT-AC3100 AC3100 Dual-Band Wi-Fi Router with Double Gaming Boost and MU-MIMO, RT-AC5300 Tri-Band 4x4 AC5300 Wi-Fi 4-Port Gigabit Gaming Router With AiProtection Powered by Trend Micro, RT-AC5300 AC5300 Tri-Band Wi-Fi Gigabit Router – For Gamers, ROG Rapture GT-AC5300 Tri-Band Gaming Router, BRT-AC828 AC2600 Dual-WAN VPN Wi-Fi Router, CM-32 AC2600 DOCSIS 3.0 Cable Modem Router, CM-32 AC2600 ASUS CM-32 Cable Modem Wifi Router, RT-AC86U AC2900 Dual-Band Gigabit Wi-Fi Router with MU-MIMO, RT-AC58U AC1300 Dual-Band Wi-Fi Router with MU-MIMO and Parental Controls, PCE-AX3000, PCE-AX58BT, and EA-AC87 5 GHz Wireless-AC 1800 Media Bridge/ Access Point) (collectively the "'376 Accused Products"). Defendant is liable for infringement of the '376 Patent pursuant to 35 U.S.C.

§ 271(a).

43. 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 ASUS RT-AX3000.

44. Each of the ’376 Accused Products comprises a data-communications networking apparatus. For example, as with each ’376 Accused Product, the ASUS RT-AX3000 is an apparatus for communication data on an IEEE 802.11ax / Wi-Fi 6 data communications network. *See, e.g.,* ASUS RT-AX3000 Product Specification, which explains that ASUS RT-AX3000 includes support for the “IEEE 802.11ax” Network Standard, with advertised IEEE 802.11ax data rates of up to 574 Mbps (2.4 GHz) and up to 2402 Mbps (5 GHz). *See, e.g.,* ASUS RT-AX3000 Product Overview, which provides: “RT-AX3000 is a 2x2 dual-band Wi-Fi router that provides 160 MHz bandwidth and 1024-QAM for dramatically faster wireless connections…[i]n most cases, your RT-AX3000 can deliver smooth, reliable Wi-Fi to every part of your home.”

45. 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 ASUS RT-AX3000 has at least one processor (*e.g.,* a 1.5 Ghz tri-core processor, a baseband processor in the Wi-Fi 6 radio) for generating signals for transmission. *See, e.g.,* ASUS RT-AX3000 Product Specification, which explains for ASUS RT-AX3000, Network Standard includes “IEEE 802.11ax,” Antenna includes “External antenna x 4,” Transmit/Receive includes “2.4 GHz 2x2, 5 GHz 2x2,” Processor includes “1.5 GHz tri-core processor,” Wi-Fi Technology includes “Beamforming: standard-based and universal,” Features include “MU-MIMO” and “Explicit Beamforming.” For a further example, as with each Accused Product, the ASUS RT-AX3000 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.,* ASUS.com WiFi 6 web page, available online as of April 2021 at https://www.asus.com/content/WiFi6/#Learnmore-C/ ("With a revolutionary combination of OFDMA, MU-MIMO and BSS coloring technology, WiFi 6 technology provides up to 4X greater network capacity to lower the latency in traffic-dense environments"; "The new WiFi 6 standard is designed to address such issues. With the promise to usher in a new era of WiFi. WiFi 6 builds upon the existing structure of its predecessors, and also seeks to hold certified partners to an enhanced set of standards that includes faster speed, larger capacity, wider coverage, and better battery efficiency. The first thing to note is that the underlying WiFi technology works using radio signals. To send a WiFi transmission, devices have to modulate the frequency signal on a specific radio channel, which will then be received by the recipient device in the form of binary code. Known as quadrature amplitude modulation (QAM), the process involves the modulation of radio waves in different ways to convey digital data, where the router's performance is determined by the scale of binary code being sent out."; "Because WiFi 6 allows multiple users to connect to the network all at once, there's a need to ensure that the timing for data transmissions remains as precise as possible across the board, too. To achieve a larger network capacity, interference between simultaneous users has to be minimized, and WiFi 6 manages to make this work through synchronizing the trigger frame broadcast of access points. A trigger frame is, in simpler terms, a new framework adopted by WiFi 6 to allocate RUs and set transmission timings for each client, such that upstream transmissions can be coordinated. As such, devices will be assigned to a specific individual transmit timing, the syncing of which brings about better bandwidth. With WiFi 6 also comes more sophisticated beamforming capabilities as well. In contrast to the traditional way of broadcasting WiFi signals in all directions, beamforming focuses on projecting them in a particular direction, such that the signal is stronger and more concentrated. What this translates to is a longer range that results in better reception for devices, as well as fewer dead zones for increased coverage.”). *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:

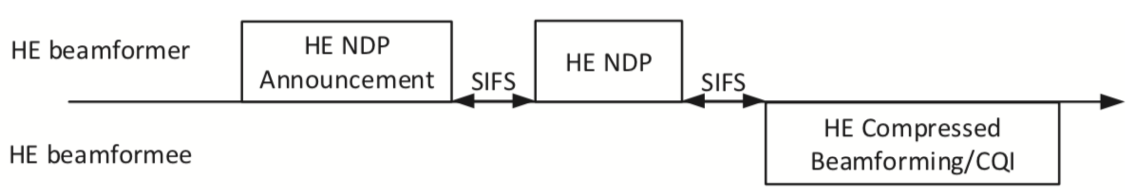

Figure 26-6—An example of the sounding protocol with a single HE beamformee

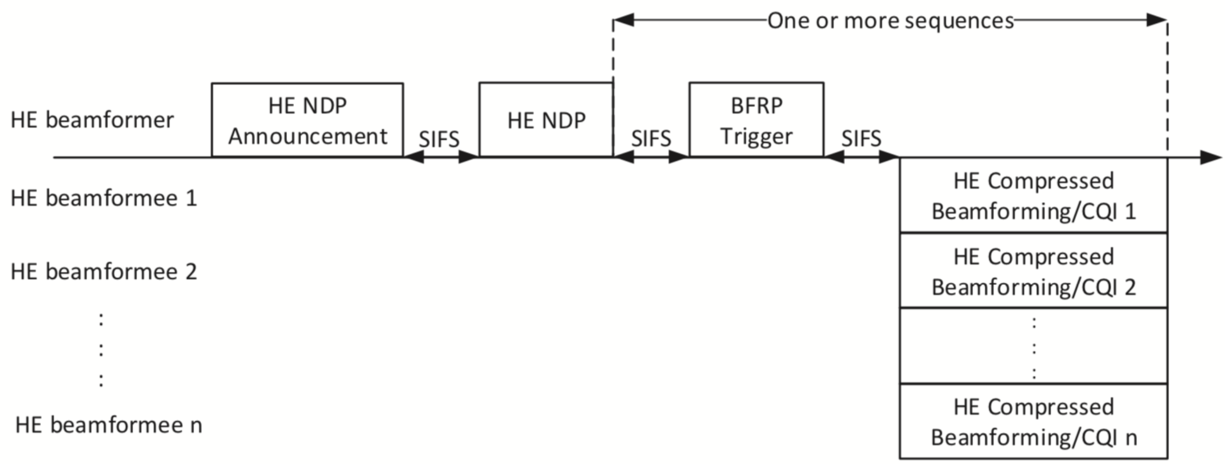

Figure 26-7—An example of the sounding protocol with more than one HE beamformee

; 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 $P_{\text{HE-LTF}}$, 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."); Section 27.3.15.1 (SU-MIMO and DL-MIMO beamforming) ("The DL MU-MIMO steering matrix $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,Nuser,r\text{-}1}]$ 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 Accused Product, the ASUS RT-AX3000 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.

46. 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 '376 Accused Product, the ASUS RT-AX3000 has at least one processor and Wi-Fi 6 radio functionality (*e.g.,* the 1.5GHz CPU 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.,* ASUS WiFi 6, available at https://www.asus.com/content/WiFi6/#Learnmore-C/ ("With a revolutionary combination of OFDMA, MU-MIMO and BSS coloring technology, WiFi 6 technology provides up to 4X greater network capacity to lower the latency in traffic-dense environments"; "Because WiFi 6 allows multiple users to connect to the network all at once, there's a need to ensure that the timing for data transmissions remains as precise as possible across the board, too. To achieve a larger network capacity, interference between simultaneous users has to be minimized, and WiFi 6 manages to make this work through synchronizing the trigger frame broadcast of access points. A trigger frame is, in simpler terms, a new framework adopted by WiFi 6 to allocate RUs and set transmission timings for each client, such that upstream transmissions can be coordinated. As such, devices will be assigned to a specific individual transmit timing, the syncing of which brings about better bandwidth. With WiFi 6 also comes more sophisticated beamforming capabilities as well. In contrast to the traditional way of broadcasting WiFi signals in all directions, beamforming focuses on projecting them in a particular direction, such that the signal is stronger and more concentrated. What this translates to is a longer range that results in better reception for devices, as well as fewer dead zones for increased coverage."). *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:

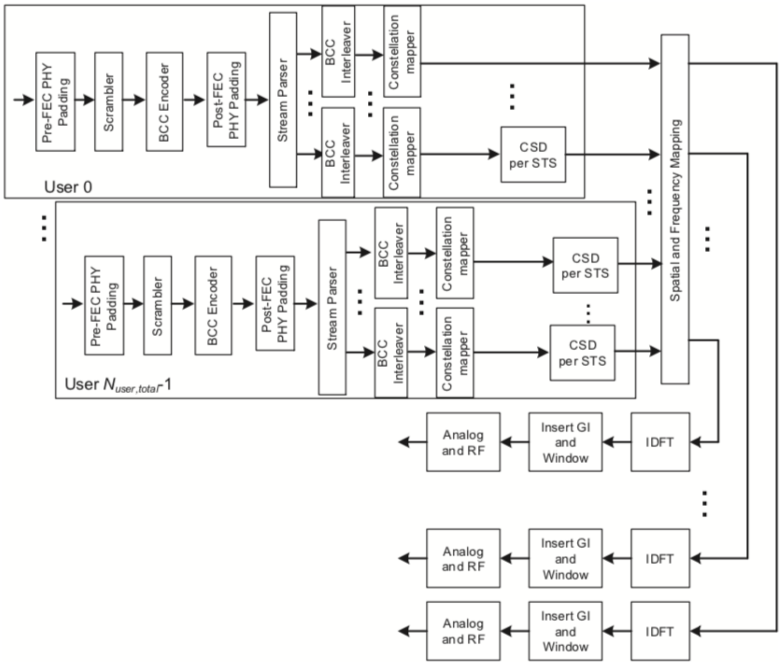

Figure 27-19—Transmitter block diagram for the Data field of an HE DL MU-MIMO transmission in a 106-, 242-, 484- or 996-tone RU with BCC encoding

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.

For a further example, as with each ’376 Accused Product, the ASUS RT-AX3000 has at least one processor and Wi-Fi radio functionality (*e.g.,* the 1.5GHz 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.

47. 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 ASUS RT-AX3000 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 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 Accused Product, the ASUS RT-AX3000 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.,* ASUS RT-AX3000 Product Specification, which explains for ASUS RT-AX3000, Network Standard includes "IEEE 802.11ax," Antenna includes "External antenna x 4," Transmit/Receive includes "2.4 GHz 2x2, 5 GHz 2x2," Processor includes "1.5 GHz tri-core processor," Wi-Fi Technology includes "Beamforming: standard-based and universal," Features include "MU-MIMO" and "Beamforming." *See, e.g.,* ASUS RT-AX3000 Product Overview:

For a further example, as with each '376 Accused Product, the ASUS RT-AX3000 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:

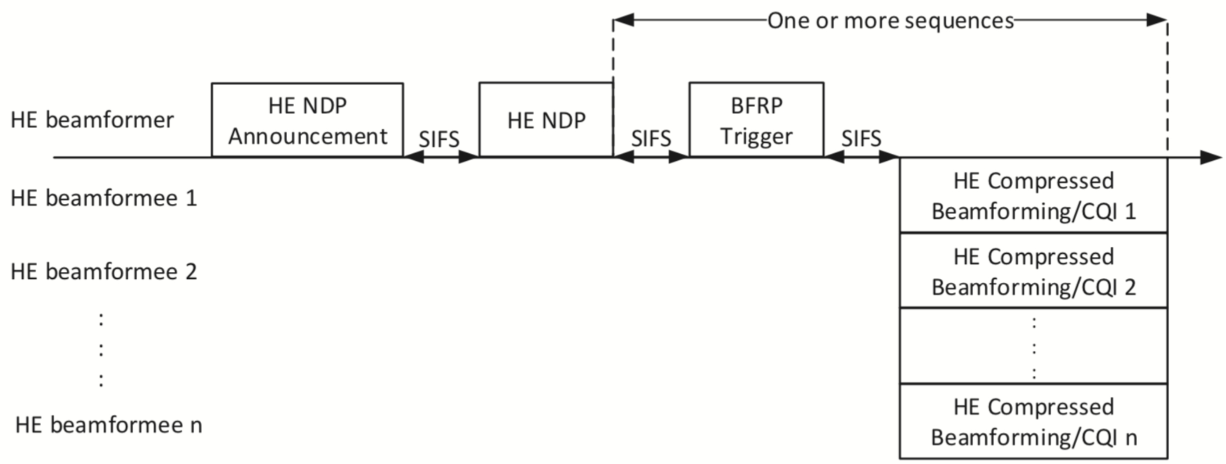

Figure 26-7—An example of the sounding protocol with more than one HE beamformee

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.

48. 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 ASUS RT-AX3000 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.,* ASUS RT-AX3000 Product Specification, which explains for ASUS RT-AX3000, Network Standard includes "IEEE 802.11ax," Antenna includes "External antenna x 4," Transmit/Receive includes "2.4 GHz 2x2, 5 GHz 2x2," Processor includes "1.5 GHz tri-core processor," Wi-Fi Technology includes "Beamforming: standard-based and universal," Features include "MU-MIMO" and "Explicit Beamforming." *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:

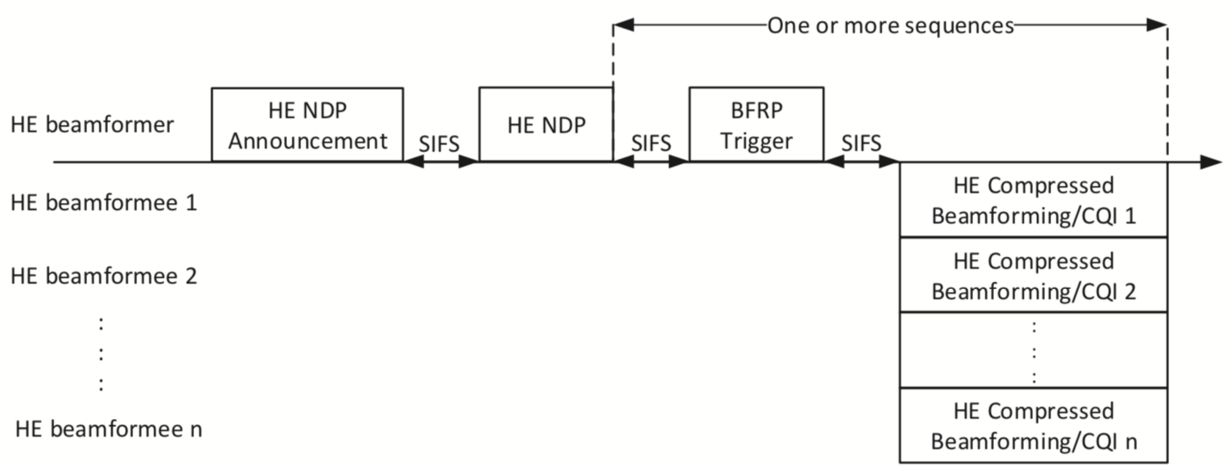

Figure 26-7—An example of the sounding protocol with more than one HE beamformee

For a further example, as with each Accused Product, the ASUS RT-AX3000 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, $\phi(k,\upsilon)$ 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.

49. 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 ASUS RT-AX3000 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. *See, e.g.,* ASUS RT-AX3000 Product Specification, which explains for ASUS RT-AX3000, Network Standard includes “IEEE 802.11ax,” Antenna includes “External antenna x 4,”

Transmit/Receive includes "2.4 GHz 2x2, 5 GHz 2x2," Processor includes "1.5 GHz tri-core processor," Wi-Fi Technology includes "Beamforming: standard-based and universal," Features include "MU-MIMO" and "Explicit Beamforming." *See, e.g.,* ASUS WiFi 6, available at https://www.asus.com/content/WiFi6/#Learnmore-C/ ("With a revolutionary combination of OFDMA, MU-MIMO and BSS coloring technology, WiFi 6 technology provides up to 4X greater network capacity to lower the latency in traffic-dense environments"; "With WiFi 6 also comes more sophisticated beamforming capabilities as well. In contrast to the traditional way of broadcasting WiFi signals in all directions, beamforming focuses on projecting them in a particular direction, such that the signal is stronger and more concentrated. What this translates to is a longer range that results in better reception for devices, as well as fewer dead zones for increased coverage."). *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 $Q_k = [Q_{k,0}, Q_{k,1}, \ldots, Q_{k,Nuser,r\text{-}1}]$ 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).

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.

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: 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 ASUS RT-AX3000 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.,* ASUS RT-AX3000 Product Specification, which explains for ASUS RT-AX3000, Network Standard includes "IEEE 802.11ax," Antenna includes "External antenna x 4," Transmit/Receive includes "2.4 GHz 2x2, 5 GHz 2x2," Processor includes "1.5 GHz tri-core processor," Wi-Fi Technology includes "Beamforming: standard-based and universal," Features include "MU-MIMO" and "Explicit Beamforming." *See, e.g.,* ASUS WiFi 6, available at https://www.asus.com/content/WiFi6/#Learnmore-C/ ("With a revolutionary combination of OFDMA, MU-MIMO and BSS coloring technology, WiFi 6 technology provides up to 4X greater network capacity to lower the latency in traffic-dense environments"; "With WiFi 6 also comes more sophisticated beamforming capabilities as well. In contrast to the traditional way of broadcasting WiFi signals in all directions, beamforming focuses on projecting them in a particular direction, such that the signal is stronger and more concentrated. What this translates to is a longer range that results in better reception for devices, as well as fewer dead zones for increased coverage."). *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 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:

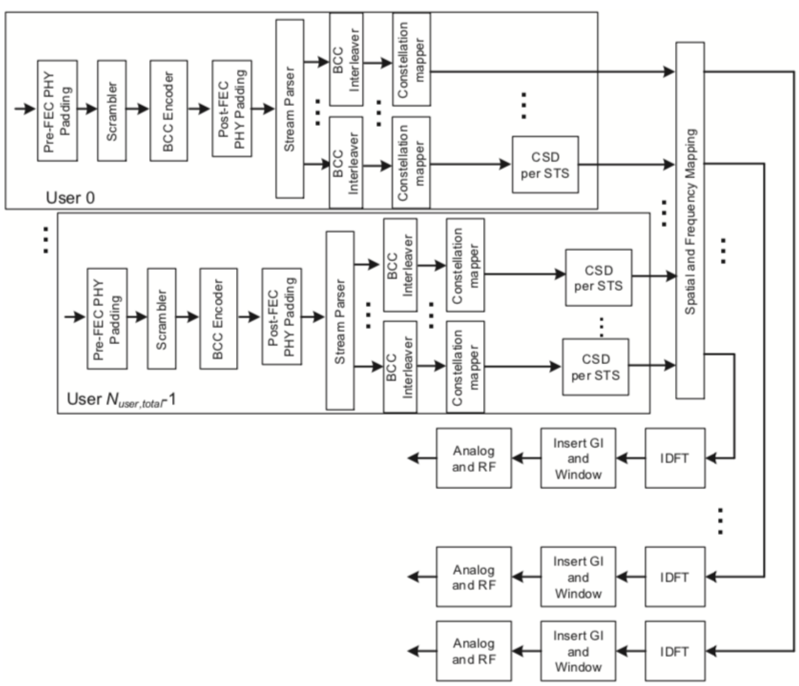

Figure 27-19—Transmitter block diagram for the Data field of an HE DL MU-MIMO transmission in a 106-, 242-, 484- or 996-tone RU with BCC encoding

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

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).

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.

51. 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). Through the filing and service of this Complaint, Defendant has had knowledge of the ’376 Patent and the infringing nature of the Accused Products.

52. Despite this knowledge of the ’376 Patent, Defendant has been and still 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.

53. Defendant also contributorily infringes by making, using, selling, offering to sell, and/or importing the ’376 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.

54. 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 ’231 Patent pursuant to 35 U.S.C. § 271.

55. 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.

56. Vivato’s ’376 Patent is valid and enforceable.

57. 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.

58. 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.

COUNT III

INFRINGEMENT OF U.S. PATENT NO. 10,715,235

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

60. On July 14, 2020, United States Patent No. 10,715,235 duly and legally issued for inventions entitled "Directed Wireless Communication." Vivato owns the '235 Patent and holds the right to sue and recover damages for infringement thereof. A copy of the '235 Patent is attached hereto as Exhibit C.

61. Defendants have directly infringed and continue to directly infringe numerous claims of the '235 Patent, including at least claim 8, by manufacturing, using, selling, offering to sell, and/or importing into the United States certain Wi-Fi products supporting MU-MIMO technologies (e.g., Defendant's Zenfone 8, ROG Phone 5, ROG Phone 3, ROG Defendant's ProArt StudioBook Series including ProArt StudioBook 15 H500 with Dual-Band 2x2 Wi-Fi 6, StudioBook 17 H700, ProArt StudioBook Pro 15 W500, ProArt StudioBook Pro 17 W700, ProArt StudioBook Pro X W730, ProArt StudioBook One W590, ASUS VivoBook S13 S333*, Defendant's Zenbook Series including ASUS ZenBook 14 UX434, ZenBook 15 UX534, ZenBook Duo UX481FL, ZenBook Duo UX481FA, ZenBook Pro Duo UX581, ZenBook Pro 15 UX535,

ZenBook Pro Duo 15 OLED UX582, ZenBook Pro 15 OLED UX535, VivoBook Series including VivoBook S15 S532, VivoBook S15 M513, VivoBook S13 S333, VivoBook S14 M435, VivoBook S15 S533, VivoBook S13 S333, VivoBook S14 433, VivoBook S15 S533, VivoBook S15 XS532, VivoBook 14 K413, VivoBook 15 K513, VivoBook 14 X412, VivoBook 15 M513, VivoBook 14 M413 AMD Ryzen 5000 Series, VivoBook 17 M712, VivoBook 17 X17, VivoBook Flip 14 TP412, VivoBook Flip 14 TM420 AMD Ryzen, VivoBook Flip 14 TM420, VivoBook Flip 14 TP470, ASUS Chromebook Series including ASUS Chromebook Flip CX5, ASUS Chromebook Flip C436 2-in-1 Laptop, Chromebook Flip C436FA, Chromebook CP713, Chromebook C871, Chromebook CP713, Chromebook Flip CB715, Chromebook CB714, Chromebook Flip C434TA, ASUS W202, ASUS V161, ROG Huracan G21CX, ROG Strix Series including ROG Strix G35CZ-XB982, ROG Strix G35CZ-XH988, ROG Strix G35CZ-XS991, ROG Strix GA15DH-BS762, ROG Strix GA15DH-DS757, ROG Strix GA15DH-ES557, ROG Strix GA35DX-XS99X, ROG Strix GL12CX-DH781, ROG Strix GL12CX-XB781, ROG Strix GL12CX-XB981, ROG Strix GL12CP-DS751, ROG Strix GL12CP-DS751, ROG Strix GL10CX-DS551, ROG Strix GL10CX-DS751, ROG Strix GL10DH-MH772, ROG Strix GL10DH-MH772, ROG Strix GL10DH-NH764, ROG Strix GL10DH-PH762, ROG Strix GLDH-PH552, ROG Strix GL10DH-NH764) (collectively, "'235 Accused Products). Defendant is liable for infringement of the '235 Patent pursuant to 35 U.S.C. § 271(a).

62. The '235 Accused Products satisfy all claim limitations of numerous claims of the '235 Patent, including Claim 8. The following paragraphs compare limitations of Claim 8 to an exemplary '235 Accused Product, Zenfone 8. *See, e.g.,* Zenfone 8 Data Sheet.[4]

[4] ASUS Zenfone 8 Data Sheet including "Tech Specs" available at https://www.asus.com/us/Mobile/Phones/ZenFone/Zenfone-8/techspec/.

63. Each ’235 Accused Product performs a method for use in a wireless communications system, the method comprising receiving a first signal transmission from a remote station via a first antenna element of an antenna and a second signal transmission from the remote station via a second antenna element of the antenna simultaneously, wherein the first signal transmission and the second signal transmission comprise electromagnetic signals comprising one or more transmission peaks and one or more transmission nulls. For example, as with each ’235 Accused Product, the Zenfone 8 receives a first signal transmission from a remote station, such as a Wi-Fi Access Point, via a first antenna element of an antenna and a second signal transmission from the remote station via a second antenna element of the antenna simultaneously, such as when the Zenfone 8 receives first and second signals with its first and second antenna elements that contain training fields of a null data packet used for MU-MIMO sounding and channel estimation procedures. *See, e.g.,* Zenfone 8 Data Sheet (“Wireless Technology” includes “Integrated WiFi 6/6E* (802.11 aa/b/g/n/ac/ax, 2x2 MIMO) Supports tri-band 2.4 GHz / 5 GHz / 6 GHz WiFi, Bluetooth® 5.2 (EDR + A2DP) supports LDAC, Qualcomm® aptX™, aptX™ HD, aptX™ Adaptive AAC, WiFi Direct, NFC”, “Processor” includes “2.84 GHz Qualcomm® Snapdragon™ 888 5G Mobile Platform with 5nm, 64-bit Octa-core Processor, Qualcomm® Adreno™ 660”). *See, e.g.,* IEEE 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."); *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. 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).

; *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 $SNR_{k,u}$ $(0 \leq u \leq N_{user} - 1)$ in order to suppress crosstalk between participating beamformees. The method used by the beamformer to calculate the steering matrix Q_k is implementation specific.

64. Each ’235 Accused Product performs a method for use in a wireless communications system, the method comprising determining first signal information for the first signal transmission and determining second signal information for the second signal transmission, wherein the second signal information is different than the first signal information. For example, as with each ’235 Accused Product, the Zenfone 8 determines different signal information for the first signal transmission than it does for the second signal transmission, by using the training fields of a null data packet for MU-MIMO sounding and channel estimation to determine the parameters in the beamforming feedback matrix. *See, e.g.,* Zenfone 8 Data Sheet (“Wireless Technology” includes “Integrated WiFi 6/6E* (802.11 aa/b/g/n/ac/ax, 2x2 MIMO) Supports tri-band 2.4 GHz / 5 GHz / 6 GHz WiFi, Bluetooth® 5.2 (EDR + A2DP) supports LDAC, Qualcomm® aptX™,

aptX™ HD, aptX™ Adaptive AAC, WiFi Direct, NFC", "Processor" includes "2.84 GHz Qualcomm® Snapdragon™ 888 5G Mobile Platform with 5nm, 64-bit Octa-core Processor, Qualcomm® Adreno™ 660").. *See, e.g.,* IEEE 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."); *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. 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).

; *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.

65. Each '235 Accused Product performs a method for use in a wireless communications system, the method comprising determining a set of weighting values based on the first signal information and the second signal information, wherein the set of weighting values is configured to be used by the remote station to construct one or more beam-formed transmission

signals, and transmitting to the remote station a third signal comprising content based on the set of weighting values. For example, as with each ’235 Accused Product, the Zenfone 8 determines a set of weighting values based on the first signal information and the second signal information, wherein the set of weighting values is configured to be used by the remote station to construct one or more beam-formed transmission signals, and transmits to the remote station a third signal comprising content based on the set of weighting values, by determining the parameters of the beamforming feedback matrix, which include weighting values configured to be used by the remote station (*e.g.,* a Wi-Fi access point) to construct one or more beamformed transmission signals, and transmitting to the remote station (*e.g.,* a Wi-Fi access point) a signal that includes the beamforming feedback matrix. *See, e.g.,* Zenfone 8 Data Sheet (“Wireless Technology” includes “Integrated WiFi 6/6E* (802.11 aa/b/g/n/ac/ax, 2x2 MIMO) Supports tri-band 2.4 GHz / 5 GHz / 6 GHz WiFi, Bluetooth® 5.2 (EDR + A2DP) supports LDAC, Qualcomm® aptX™, aptX™ HD, aptX™ Adaptive AAC, WiFi Direct, NFC”, “Processor” includes “2.84 GHz Qualcomm® Snapdragon™ 888 5G Mobile Platform with 5nm, 64-bit Octa-core Processor, Qualcomm® Adreno™ 660”). *See, e.g.,* IEEE 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.”); *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. 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).

; *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.

66. Defendant also has been and is now knowingly and intentionally inducing infringement of at least claim 1 of the ’235 Patent in violation of 35 U.S.C. § 271(b). Through at least the filing and service of this Complaint, Defendant has had knowledge of the ’235 Patent and the infringing nature of the ’235 Accused Products.

67. Despite this knowledge of the ’235 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 ’235 Accused Products in ways that directly infringe the ’235 Patent. For example, Defendant’s websites provided, and continues to provide, instructions for using the ’235 Accused Products on wireless communications systems, to utilize their 802.11ac beamforming and/or 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 ’235 Accused Products, despite its knowledge of the ’235 Patent, thereby specifically intending for and inducing its customers to infringe the ’235 Patent through the customers’ normal and customary use of the ’235 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 '235 Patent in the United States because Defendant had knowledge of the '235 Patent and actively induced others (*e.g.,* its customers) to directly infringe the '235 Patent.

68. Defendant also contributorily infringes under 35 U.S.C. § 271(c) by making, using, selling, offering to sell, and/or importing the '235 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.

69. By making, using, offering for sale, selling and/or importing into the United States the '235 Accused Products, Defendant has injured Vivato and is liable for infringement of the '235 Patent pursuant to 35 U.S.C. § 271.

70. Defendant also infringes numerous additional claims of the '235 Patent, including but not limited to Claim 12, for example, directly and through inducing infringement, for similar reasons as explained above with respect to Claim 1.

71. Vivato's '235 Patent is valid and enforceable.

72. Vivato has complied with 35 U.S.C. § 287 and it does not preclude the recovery of pre-suit damages at least because there are no unmarked patented articles subject to a duty to mark.

73. As a result of Defendant's infringement of the '235 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.

74. 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 '235 Patent, and, specifically, enjoining further manufacture, use, sale, importation, and/or offers for sale that come within the scope of the patent claims

WILLFUL INFRINGEMENT

75. Defendant had knowledge of Vivato's '728 Patent by at least the citation of the application that led to the '728 Patent, during the prosecution of Defendant's U.S. Patent Application No. 12/138,449 ("'449 Application"), titled "Method for setting smart antenna and system thereof." U.S. Patent Application Publication No. 2008/0309555A1 ("'555 Publication"), attached hereto as Exhibit D, is the publication of Defendant's '449 Application. Defendant's '449 Application concerns "a method for setting a smart antenna," where "[t]he pattern of the smart antenna is set to be the optimal antenna configuration dynamically to improve the communication quality and reduce the multi-path fading or interference caused by other communication equipment" in order to "maintain a high transmission rate." ('449 Application ¶ 0006). Like the '449 Application, the '728 Patent teaches the use of smart antennas and methods of controlling smart antennas to improve communication quality and transmission rates. The Accused Products also use smart antennas and employ software and/or hardware that controls smart antennas to improve communication quality and transmission rates.

76. On December 22, 2010, during prosecution of Defendant's '449 Application, the USPTO examiner cited U.S. Patent Application Publication No. 2006/0238400A1 to Brennan, which is the application that led to Vivato's '728 Patent. Vivato's '728 Patent, however, had already issued on June 1, 2010. Accordingly, a reasonable inference is that Defendant had knowledge of the '728 Patent, and its issued claims, by at least as early as December 22, 2010.

77. Further, by at least the filing of the Complaint in the United States District Court for the Central District of California, on April 19, 2017, and the waiver of service of the original Complaint on May 24, 2017, Defendant had knowledge of the ’728 Patent.

78. Despite Defendant’s knowledge of Vivato’s ’728 Patent, 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 of the ’728 Patent occurred, and continues to occur, with knowledge of Defendant’s infringement and/or with willful blindness to its infringement.

79. Defendant’s infringement was, and continues to be, willful, deliberate, and flagrant. Upon information and belief, Defendant’s employees, contractors, agents, and attorneys responsible for the procurement and management of Defendant’s ’449 Application informed Defendant’s employees, contractors, and agents responsible for the research, development, and manufacturing of its Accused Products about the ’728 Patent and its relevance to the research, development, and manufacturing of the Accused Products. Further, upon information and belief, Defendant’s employees, contractors, agents, and attorneys responsible for the procurement and management of Defendant’s ’449 Application collaborated with Defendant’s employees, contractors, and agents responsible for the research, development, and manufacturing of its Accused Products and as a result, Defendant deliberately and flagrantly copied and incorporated into its Accused Products the invention claimed in the ’728 Patent. Upon information and belief, it is Defendant’s regular practice for its employees, contractors, and agents responsible for the research, development, and manufacturing of its products to collaborate with Defendant’s employees, contractors, agents, and attorneys responsible for the procurement and management of

Defendant's patent portfolio during the development process of Defendant's products.

80. Defendant sold, and continues to sell, its Accused Products (*e.g.,* Wi-Fi 6 / IEEE 802.11ax Access Points such as the ASUS RT-AX3000) to customers despite its knowledge of Vivato's Asserted Patents, such as on Amazon.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.

81. 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 RT-AX3000 on Amazon.com. 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.

82. 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 respectfully requests that this Court enter:

a. A judgment in favor of Vivato that Defendant has infringed, either literally and/or under the doctrine of equivalents, the '728 Patent, the '376 Patent, and the '235 Patent;

b. A permanent injunction prohibiting Defendant from further acts of infringement of the '728 Patent, the '376 Patent, and the '235 Patent;

c. A judgment and order requiring Defendant to pay Vivato its damages, costs, expenses, and pre-judgment and post-judgment interest for Defendant's infringement of the '728 Patent, the '376 Patent, and the '235 Patent;

d. A judgment and order requiring Defendant to provide an accounting and to pay supplemental damages to Vivato, including without limitation, pre-judgment and post-judgment interest and an award of an ongoing royalty for Defendant's post-judgment infringement in an amount according to proof;

e. A judgment and order finding that this is an exceptional case within the meaning of 35 U.S.C. § 285 and awarding to Vivato its reasonable attorneys' fees and costs against Defendant, and enhanced damages pursuant to 35 U.S.C. § 284; and

f. Any and all other relief as the Court may deem appropriate and just under the circumstances.

DEMAND FOR JURY TRIAL

Vivato, under Rule 38 of the Federal Rules of Civil Procedure, requests a trial by jury of any issues so triable by right.

Dated: June 16, 2021

Respectfully submitted,

/s/ Reza Mirzaie

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