

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Juhyung Son, et al. Attorney Docket No. 39843-0195IP1
U.S. Patent No.: 11,159,210
Issue Date: October 26, 2021
Appl. Serial No.: 16/731,031
Filing Date: December 31, 2019
Title: WIRELESS COMMUNICATION METHOD AND WIRELESS
COMMUNICATION TERMINAL FOR SIGNALING MULTI-
USER PACKET

DECLARATION OF CHRISTOPHER J. HANSEN

I declare that all statements made herein on my own knowledge are true and that all statements made on information and belief are believed to be true, and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable under Section 1001 of Title 18 of the United States Code.

Date: April 30, 2025

By: 
Christopher J. Hansen

Table of Contents

I.	ASSIGNMENT.....	4
II.	QUALIFICATIONS AND BACKGROUND INFORMATION.....	4
III.	OVERVIEW OF CONCLUSIONS FORMED	9
IV.	LEVEL OF ORDINARY SKILL IN THE ART.....	9
V.	LEGAL STANDARDS	10
	A. Terminology.....	10
	B. Legal Standards.....	11
	C. Anticipation.....	11
	D. Obviousness	12
VI.	MATERIALS CONSIDERED	16
VII.	BACKGROUND OF THE TECHNOLOGY.....	20
	A. Acronyms	20
	B. Wi-Fi Standards	21
VIII.	OVERVIEW OF THE PRIOR ART	25
	A. Overview of 802.11ax_D1.0.....	25
	1. The Specification Framework	27
	2. 802.11ax_D0.1.....	28
	3. 802.11ax_D0.2.....	31
	4. 802.11ax_D0.3 & 802.11ax_D0.4.....	32
	5. 802.11ax_D0.5.....	32
	B. Bharadwaj	33
	C. Sun	35
IX.	THE '210 PATENT.....	38
	A. The Prior Art Teaches the '210 Patent Claims	38
	B. Prosecution History.....	41
X.	MANNER IN WHICH THE PRIOR ART REFERENCES RENDER THE '210 CLAIMS UNPATENTABLE	46
	A. Ground 1A: 802.11ax_D1.0 Renders Claims 6-9 Obvious	46
	1. Claim 6.....	46
	2. Claim 7.....	64
	3. Claim 8.....	65
	4. Claim 9.....	67

B. [GROUND 1B] – 802.11ax_D1.0 and Bharadwaj Render Claims 1-5	
Obvious	68
1. The Predictable Combination of 802.11ax_D1.0 and Bharadwaj..	68
2. Reasons to Combine	69
3. Analysis – Claim 1.....	71
4. Claim 2.....	75
5. Claim 3.....	75
6. Claim 4.....	76
7. Claim 5.....	76
C. [GROUND 2] – Bharadwaj and Sun Render Claims 1-9 Obvious	77
1. The Predictable Combination of Bharadwaj and Sun	77
2. Reasons to Combine	78
3. Analysis – Claim 1.....	81
4. Claim 2.....	90
5. Claim 3.....	91
6. Claim 4.....	93
7. Claim 5.....	94
8. Claim 6.....	95
9. Claim 7.....	96
10. Claim 9.....	97
XI. CONCLUSION.....	97

I. ASSIGNMENT

1. I have been retained on behalf of Samsung Electronics Co., Ltd. (“Samsung”) to offer technical opinions related to 11,159,210 (“the ’210 Patent”) (SAMSUNG-1001). I understand that Samsung is requesting that the Patent Trial and Appeal Board (“PTAB” or “Board”) to institute an *inter partes* review (“IPR”) proceeding of the ’210 Patent.

2. I have been asked to provide my independent analysis of the ’210 Patent based on the prior art publications cited in this declaration.

3. I am not and never have been, an employee of Samsung. I received no compensation for this declaration beyond my normal hourly compensation based on my time actually spent analyzing the ’210 Patent, the prior art publications cited below, and issues related thereto, and I will not receive any added compensation based on the outcome of any IPR or other proceeding involving the ’210 Patent.

II. QUALIFICATIONS AND BACKGROUND INFORMATION

4. I am over the age of 18 and am competent to write this declaration. I have personal knowledge, or have developed knowledge of these technologies based upon education, training, or experience, of the matters set forth herein.

5. My qualifications are summarized here and explained in more detail in my curriculum vitae, which is attached as Appendix A to this report. Appendix

A also includes a list of my publications and the cases in which I have testified at deposition, hearing, or trial within the past four years.

6. I received a B.S. in electrical engineering from Rensselaer Polytechnic Institute in 1987. I received an M.S. in electrical engineering from University of Massachusetts, Amherst in 1989. I received a Ph.D. in electrical engineering from University of California, Los Angeles in 1997.

7. I have over 25 years of experience working with wireless communications and IEEE standards and over 15 years of experience working in 802.11 WLAN chipsets and cellular base-station systems development.

8. A copy of my curriculum vitae listing my full employment history is included as Appendix A. I will briefly summarize aspects of my experience below.

9. From 1989 through 1992, my work focused on radio frequency (RF) and microwave systems and circuit development for radar systems and cellular (mobile) radio. This work included the development of feed-forward amplifiers used in commercial base station equipment.

10. From 1997 through 1999, I was employed by two Silicon Valley startup companies developing advanced digital communications technology for asymmetrical digital subscriber line (ADSL) and high bit-rate digital subscriber line (HDSL2) systems.

11. From 2000 through 2012, I was employed by Broadcom Corporation,

where I served as system engineer for the IEEE 802.11a/b/g wireless local area network chipsets including analysis of radio and baseband DSP architectures for the physical layer design, and then project manager and lead system engineer for Broadcom's proposal to the IEEE 802.11m task group. My responsibilities focused on technology developments and contributions to a number of the IEEE 802.11 standards, and in particular the IEEE 802.11n standard which incorporated a MIMO-OFDM physical layer and enhanced MAC layer for higher throughput wireless networks. My work covered many topics including preamble design, advanced channel coding, channel estimation, and multiple antenna beamforming.

12. From June 2012 through July 2013, I was employed at Apple Inc., where I served as senior wireless system architect for analysis of the IEEE.11 wireless networks for iOS products.

13. From August 2013 to present, I have worked as a self-employed consultant while continuing to participate in the IEEE.

14. I am currently President of Covariant Corporation, which is a consulting firm that provides expertise on the IEEE 802.11 standards and product development.

15. I am named inventor on more than 125 issued patents, including many standard essential patents for the IEEE 802.11 standards. A listing of my patents is included in my curriculum vitae, which I have included as an appendix to this

declaration. I am also an author on 7 peer-reviewed technical papers, including recent research work on methods for more reliable Wi-Fi networks.

16. I have been a member of the Institute of Electrical and Electronics Engineers (“IEEE”) since 1989. I became a senior member of the IEEE in 2011. I began participating in the IEEE’s standards-setting process in January 2000.

17. During my 12 years working for Broadcom, I was one of Broadcom’s lead representatives in the IEEE 802.11 standards-setting process. Specifically, I took on a number of significant roles during the development of the IEEE 802.11h, IEEE 802.11n, and the IEEE 802.11ad amendment. For IEEE 802.11n, these roles included making multiple technical contributions and attending all meetings of the study group responsible for defining the scope of the standard and all meetings of the task group responsible for writing the standard.

18. I was significantly involved in the development of IEEE 802.11n as part of my duties at Broadcom. I attended all meetings of the High Throughput Study Group, which was responsible for defining the scope of IEEE 802.11n, and all meetings of the Task Group for 802.11n (TGn), which was responsible for writing the IEEE 802.11n specifications.

19. I was largely responsible for defining the Medium Access Controller (MAC) portion and the physical layer (PHY) of Broadcom’s IEEE 802.11n contributions as well as technical simulations that were used to justify the design

choices used in those contributions.

20. My curriculum vitae, included as an appendix to this declaration, includes a list of publications on which I am a named author. It contains further details regarding my experience, education, publications, and other qualifications to render an expert opinion in connection with this proceeding.

21. In writing this Declaration, I have considered the following: my own knowledge and experience, including my work experience in the fields of wireless networking, digital communications, and communications standards; my experience with developing and implementing the 802.11 standard; my experience in training other engineers in these subjects; and my experience in working with others involved in these fields.

22. I have no financial interest in the outcome of this proceeding. I am being compensated for my work as an expert on an hourly basis. My compensation is not dependent on the outcome of these proceedings or the content of my opinions.

23. My opinions, as explained below, are based on my education, experience, and expertise in the fields relating to the '210 Patent. Unless otherwise stated, my testimony below refers to the knowledge of one of ordinary skill in the art as of the earliest possible priority date. Any figures that appear within this document have been prepared with the assistance of Counsel and reflect my

understanding of the '210 Patent and the prior art discussed below.

III. OVERVIEW OF CONCLUSIONS FORMED

24. This declaration explains the conclusions that I have formed based on my analysis of all of the considered materials and my personal experience. To summarize those conclusions, based upon my knowledge and experience and my review of the prior art references listed above, I believe that:

25. Ground 1A: 802.11ax_D1.0 renders claims 6-9 obvious.

26. Ground 1B: 802.11ax_D1.0 in view of Bharadwaj render claims 1-5 obvious.

27. Ground 2: Bharadwaj in view of Sun render claims 1-9 obvious.

28. In support of these conclusions, I provide an overview of the references in Sections VII-VIII and more detailed comments regarding the obviousness of claims 1-9 (“the Challenged Claims”) of the '210 Patent in Section X.

IV. LEVEL OF ORDINARY SKILL IN THE ART

29. For purposes of this IPR, my opinion is that a person of ordinary skill in the art (“POSITA”) would have had a Bachelor’s degree in electrical engineering, computer engineering, computer science, or a related field, and at least 3 years of experience in the research, design or development of wireless communication devices, systems, and/or networks, or the equivalent, as of the

Critical Date. Increased educational experience can make up for less work experience, and vice versa.

30. Further, all positions in this declaration are from the vantage point of a POSITA as of January 9, 2017.

31. Based on my experiences, I believe that I have a good understanding of the capabilities of a POSITA. Indeed, I have trained, participated in standards and industry organizations, and mentored many such persons over the course of my career. Based on my knowledge, skill, and experience, I have an understanding of the capabilities of a POSITA. For example, from my industry experience, I am familiar with what a POSITA would have known and found predictable in the art. Furthermore, I possess those capabilities myself.

V. LEGAL STANDARDS

A. Terminology

32. I have been informed by Counsel and understand that the best indicator of claim meaning is its usage in the context of the patent specification as understood by one of ordinary skill. I further understand that the words of the claims should be given their plain meaning unless that meaning is inconsistent with the patent specification or the patent's history of examination before the Patent Office. Counsel has also informed me, and I understand, that the words of the claims should be interpreted as they would have been interpreted by one of

ordinary skill at the time of the invention was made (not today). The '210 Patent was filed December 31, 2019, and claims priority to KR 10-2017-0003147 filed January 9, 2017, which I refer to as the "Critical Date" in this proceeding. Because I do not know at what date the invention as claimed was made, if ever, I have used the Critical Date of the '210 Patent as the point in time for claim interpretation purposes. My opinion does not change if the invention date is earlier.

B. Legal Standards

33. I have been informed by Counsel and understand that documents and materials that qualify as prior art can render a patent claim unpatentable as being anticipated or obvious.

34. I am informed by Counsel and understand that all prior art references are to be examined from the viewpoint of a person of ordinary skill in the art at the time of the invention, and that this viewpoint prevents one from using his or her own insight or hindsight in deciding whether a claim is anticipated or rendered obvious.

C. Anticipation

35. I understand that patents or printed publications that qualify as prior art can be used to invalidate a patent claim as either anticipated or as obvious.

36. I understand that, once the claims of a patent have been properly construed, the second step in determining anticipation of a patent claim requires a

comparison of the properly construed claim language to the prior art on a limitation-by-limitation basis.

37. I understand that a prior art reference “anticipates” an asserted claim, and thus renders the claim invalid, if all limitations of the claim are disclosed in that prior art reference, either explicitly or inherently (i.e., necessarily present).

D. Obviousness

38. I understand that even if a patent is not anticipated, it is still invalid if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious to a POSITA at the time the invention..

39. I have been informed by Counsel and understand that a claim is unpatentable for obviousness and that obviousness may be based upon a combination of references. I am informed by Counsel and understand that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. However, I am informed by Counsel and understand that a patent claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.

40. I am informed by Counsel and understand that when a patented invention is a combination of known elements, a court determines whether there

was an apparent reason to combine the known elements in the fashion claimed by the patent at issue by considering the teachings of prior art references, the effects of demands known to people working in the field or present in the marketplace, and the background knowledge possessed by a person having ordinary skill in the art.

41. I am informed by Counsel and understand that a patent claim composed of several limitations is not proved obvious merely by demonstrating that each of its limitations was independently known in the prior art. I am informed by Counsel and understand that identifying a reason that those elements would be combined can be important because inventions in many instances rely upon building blocks long since uncovered, and claimed discoveries will be combinations of what, in some sense, is already known. I am informed by Counsel and understand that it is improper to use hindsight in an obviousness analysis, and that a patent's claims should not be used as a "roadmap."

42. I am informed by Counsel and understand that an obviousness inquiry requires consideration of the following factors: (1) the scope and content of the prior art, (2) the differences between the prior art and the claims, (3) the level of ordinary skill in the art, and (4) any so called "secondary considerations" of non-obviousness, which include: (i) "long felt need" for the claimed invention, (ii) commercial success attributable to the claimed invention, (iii) unexpected results

of the claimed invention, and (iv) “copying” of the claimed invention by others.

43. I have been informed by Counsel and understand that an obviousness evaluation can be based on a single reference or a combination of multiple prior art references. I understand that the prior art references themselves may provide a suggestion, motivation, or reason to combine, but that the nexus linking two or more prior art references is sometimes simple common sense. I have been informed by Counsel and understand that obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that a motivation to combine references may be supplied by the direction of the marketplace.

44. I have been informed by Counsel and understand that if a technique has been used to improve one device, and a person of ordinary skill at the time of invention would have recognized that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.

45. I have been informed by Counsel and understand that practical and common sense considerations should guide a proper obviousness analysis, because familiar items may have obvious uses beyond their primary purposes. I have been informed by Counsel and understand that a person of ordinary skill looking to overcome a problem will often be able to fit together the teachings of multiple

prior art references. I have been informed by Counsel and understand that obviousness analysis therefore takes into account the inferences and creative steps that a person of ordinary skill would have employed at the time of invention.

46. I have been informed by Counsel and understand that a proper obviousness analysis focuses on what was known or obvious to a person of ordinary skill at the time of invention, not just the patentee. Accordingly, I understand that any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

47. I have been informed by Counsel and understand that a claim can be obvious in light of a single reference, without the need to combine references, if the elements of the claim that are not found explicitly or inherently in the reference can be supplied by the common sense of one of skill in the art.

48. In sum, my understanding is that prior art teachings are properly combined where one of ordinary skill having the understanding and knowledge reflected in the prior art and motivated by the general problem facing the inventor, would have been led to make the combination of elements recited in the claims. Under this analysis, the prior art references themselves, or any need or problem known in the field of endeavor at the time of the invention, can provide a reason for combining the elements of multiple prior art references in the claimed manner.

49. I have been informed by Counsel and understand that in an *inter partes* review, “the petitioner shall have the burden of proving a proposition of unpatentability,” including a proposition of obviousness, “by a preponderance of the evidence.” 35 U.S.C. §316(e).

VI. MATERIALS CONSIDERED

50. My analysis and conclusions set forth in this declaration are based on my educational background and experiences in the field (see Section II). Based on my knowledge and experience, I believe that I am considered to be an expert in the field. Also, based on my knowledge and experience, I understand and know of the capabilities of persons of ordinary skill in the field around the Priority Date, and I trained, participated in organizations, and worked closely with many such persons in the field during that time frame.

51. As part of my independent analysis for this declaration, I have considered the following: the background knowledge/technologies that were commonly known to persons of ordinary skill in this art during the time before the Priority Date; my own knowledge and experiences gained from my work experience in the field of the '210 Patent and related disciplines, including work I performed reviewing and voting on the 802.11ax standard as it was developed; and my experience in working with others involved in this field and related disciplines.

52. I have reviewed the '210 Patent (SAMSUNG-1001), and relevant

excerpts of the prosecution history (SAMSUNG-1002) of the '210 Patent. Among various documents and publications, I have also reviewed the following references:

Exhibit No.	Reference
SAMSUNG-1004	IEEE P802.11ax/D1.0 Draft Standard for Information technology– Telecommunications and information exchange between systems Local and metropolitan area networks– Specific requirements. Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications. Amendment 6: Enhancements for High Efficiency WLAN (November 2016) (“802.11ax_D1.0”)
SAMSUNG-1005	IEEE P802.11ax/D0.5 Draft Standard for Information technology– Telecommunications and information exchange between systems Local and metropolitan area networks– Specific requirements. Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications. Amendment 6: Enhancements for High Efficiency WLAN (September 2016) (“802.11ax_D0.5”)
SAMSUNG-1006	IEEE P802.11ax/D0.4 Draft Standard for Information technology– Telecommunications and information exchange between systems Local and metropolitan area networks– Specific requirements. Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications. Amendment 6: Enhancements for High Efficiency WLAN (August 2016) (“802.11ax_D0.4”)
SAMSUNG-1007	IEEE P802.11ax/D0.3 Draft Standard for Information technology– Telecommunications and information exchange between systems Local and metropolitan area networks– Specific requirements. Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications. Amendment 6: Enhancements for High Efficiency WLAN (August 2016) (“802.11ax_D0.3”)
SAMSUNG-1008	IEEE P802.11ax/D0.2 Draft Standard for Information technology– Telecommunications and information exchange

Exhibit No.	Reference
	between systems Local and metropolitan area networks— Specific requirements. Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications. Amendment 6: Enhancements for high efficiency in frequency bands between 1GHz and 6 GHz (June 2016) (“802.11ax_D0.2”)
SAMSUNG-1009	IEEE P802.11ax/D0.1 Draft Standard for Information technology– Telecommunications and information exchange between systems Local and metropolitan area networks— Specific requirements. Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications. Amendment 6: Enhancements for high efficiency in frequency bands between 1GHz and 6 GHz (March 2016) (“802.11ax_D0.1”)
SAMSUNG-1010	IEEE 802.11-15/132r17 Specification Framework for TGax, May 25, 2016 (“Stacey”)
SAMSUNG-1011	IEEE 802.11-16/0928r2 Proposed resolutions to comments on clause 26.3.9.8 (July 2016) (“Josiam Proposal”)
SAMSUNG-1012	IEEE 802.11-16/0915r2 Bit field finalization of HE-SIG-A in HE PPDU formats (July 2016) (“Verma Proposal”)
SAMSUNG-1013	U.S. Pat. Pub. 2017/0181130 to Bharadwaj et al., filed on Dec. 21, 2016 (“Bharadwaj”)
SAMSUNG-1015	U.S. Pat. Pub. 2016/0204912 to Sun, et al., filed January 8, 2016 (“Sun”)
SAMSUNG-1017	Extended European Search Report
SAMSUNG-1018	IEEE802.11ax_D0.5 (Partial) (“802.11ax_D0.5_IDS”)
SAMSUNG-1019	U.S. Provisional Application No. 62/270,562, filed on Dec. 21, 2015 (“Bharadwaj Provisional 1”)
SAMSUNG-1020	U.S. Provisional Application No. 62/299,554, filed on Feb. 24, 2016 (“Bharadwaj Provisional 2”)
SAMSUNG-1021	U.S. Provisional Application No. 62/328,602, filed on Apr. 27, 2016 (“Bharadwaj Provisional 3”)
SAMSUNG-1022	U.S. Provisional Application No. 62/344,374, filed on Jun.

Exhibit No.	Reference
	1, 2016 (“Bharadwaj Provisional 4”)
SAMSUNG-1023	U.S. Provisional Application No. 62/365,329, filed on Jul. 21, 2016 (“Bharadwaj Provisional 5”)
SAMSUNG-1024	Complaint, <i>Wilus Institute of Standards and Technology Inc., v. Samsung Electronics Co., LTD., et al.</i> , 2-24-cv-00746 (EDTX) filed September 11, 2024
SAMSUNG-1025	Exhibit D (Infringement Chart for ’210 Patent), <i>Wilus Institute of Standards and Technology Inc., v. Samsung Electronics Co., LTD., et al.</i> , 2-24-cv-00746 (EDTX) filed September 11, 2024
SAMSUNG-1027	U.S. Pat. Pub. 2016/0380664 to Braun et al., filed on August 18, 2015, published on December 29, 2016 (“Braun”)
SAMSUNG-1028	IEEE 802.11 Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications, Amendment 4: Enhancements for Very High Throughput of Operation in Bands below 6 GHz (“802.11ac-2013”)
SAMSUNG-1029	Kim et al., IEEE 802.11-15/0821r2, HE-SIG-B Structure, 2015-07-11
SAMSUNG-1030	Josiam, et al., IEEE 802.11-15/1066r0, HE-SIG-B Contents, 2015-09-13
SAMSUNG-1031	Josiam, et al., IEEE 802.11-15/1315/r1, HE-SIG-B Mapping and Compression, 2015-11-09
SAMSUNG-1032	Liu et al., IEEE 802.11-15/1335r2, HE-SIG-B Contents, 2015-11-09
SAMSUNG-1033	Noh et al., IEEE 802.11-16/0040r0, Issues with Compressed SIG-B Mode, 2016-01-18
SAMSUNG-1034	Josiam, et al., IEEE 802.11-15/0349r1, HE-SIG-B Compression Mode, 2016-03-14
SAMSUNG-1035	Stacey, Comments on TGax, 2017-01-09
SAMSUNG-1036	Lim et al., IEEE 802.11-17/0299r0, Comment Resolutions on Clause 28.3.10.8.1, 2017-03-08

53. Counsel (Fish & Richardson) has informed me that I should consider these materials through the lens of one of ordinary skill in the art related to the '210 Patent at the time of the earliest possible priority date of the '210 Patent, and I have done so during my review of these materials. I have been informed by Counsel to use the date of January 9, 2017 as the Priority Date.

54. My analysis and conclusions set forth in this declaration are based on the perspective of a POSITA.

VII. BACKGROUND OF THE TECHNOLOGY

A. Acronyms

55. It may be helpful to define certain terms and acronyms that I use throughout this declaration:

Acronym	Definition
AID	Association Identifier
AP	Access Point
HE	High Efficiency
MCS	Modulation and Coding Scheme
MIMO	Multiple-input Multiple-output
MU	Multi-User
NSTS	Number of Spatial Streams (or Number of Space Time Streams)

PHY	Physical Layer
PPDU	PHY Protocol Data Unit
RB	Resource Block
RU	Resource Unit
SCF	Spatial Configuration Field
SIG-A	Signaling field A
SIG-B	Signaling field B
SU	Single User
STA	Station
STA-ID	Station Identifier
TGax	Task Group for 802.11ax
TxBF	Transmit Beam Forming
WLAN	Wireless Local Area Network

B. Wi-Fi Standards

56. Wi-Fi technology employs protocols defined by the IEEE 802.11 family of standards. These standards describe the signaling necessary for data transmission between devices that are produced by different vendors. The original 802.11 standard was published in 1997, but the standard has been updated multiple times through amendments and maintenance by the IEEE 802.11 working group to

add or refine functionality. For example, in 2016, the IEEE working group devised a new version of the standard that added functionality for supporting high-efficiency (HE) multi-user (MU) multiple-input multiple-output (MIMO) (HE MU-MIMO). *E.g.*, Framework, §3.2.

57. The primary mechanism for driving higher efficiency was the use of simultaneous transmissions on both the downlink and the uplink.¹ Simultaneous transmission requires partitioning the radio channel by frequency into sub-channels, called resource units (RUs), or by spatial streams using MU-MIMO. MU-MIMO takes advantage of the fact that modern Wi-Fi APs use multiple antennas to transmit to multiple stations at the same time. Multiple antennas facilitate multiple simultaneous transmission paths called spatial streams. With MU-MIMO, the access point can partition its spatial streams among multiple client devices.

58. Early versions of MU-MIMO used the entire channel bandwidth—this configuration is often referred to as full bandwidth MU-MIMO. *E.g.*, 802.11ac-2013, §22.3.11. Developments to the 802.11 standard that began in 2016 enhanced

¹ The downlink (or DL) refers to the communication path from the access point (AP) to the station (STA or client device); the uplink (or UL) refers to the communication path from the station to the AP.

MU-MIMO to allow its use on either full bandwidth or one or more narrower RUs. *E.g.*, 802.11ax_D0.1, 172. To facilitate this enhancement, updates to the standard also introduced new signaling techniques that are incorporated into each packet preamble.

59. IEEE 802.11 uses the term physical layer (PHY) protocol data unit (PPDU) to describe the packet that is transmitted from one station to another. The High Efficiency Multi-user (HE MU) PPDU is typically used by an AP to send data to multiple client stations simultaneously, but may also be used to send data to one client. *E.g.*, 802.11ax_D1.0, 239.

60. PPDU include a preamble and a payload. Fields in the PPDU preamble are used by a receiver for synchronization, wireless channel estimation, and determination of the type and format of the PPDU. The receiver uses this information to demodulate and decode the portions of the PPDU for which it is the intended recipient. The preamble of the HE MU PPDU consists of signaling fields HE-SIG-A and HE-SIG-B.² *See, e.g.*, 802.11ax_D1.0, 298, 312. (The “HE-SIG-A field carries information required to interpret HE PPDU”; and the HE-SIG-B includes one or more User Block fields for one or two stations to “decode their payloads.”)

² HE-SIG-B is also referred to as the content channel.

61. The HE-SIG-A field carries information including the PPDU bandwidth (20, 40, 80, or 160 MHz), BSS Color (a identifier for the particular Basic Service Set, or cell, where the transmitter is located), and TXOP duration (a measure of the time the wireless channel will be in use). *E.g.*, 802.11ax_D1.0, §28.3.10.7. The HE-SIG-B field is only used in an HE MU PPDU and signals the general layout of the channel in terms of number and type of RUs as well as the assignment of RUs and spatial streams to individual users.

62. The HE-SIG-B can contain multiple parts, including a Common field and a User Specific field. The Common field is used to indicate the arrangement of RUs for the PPDU. For example, a 20 MHz HE MU PPDU can be divided into 2 to 9 smaller RUs with different combinations of sizes. The transmitter signals the particular format with an allocation value that corresponds to Table 27-25 in IEEE 802.11ax.

63. For Full Bandwidth mode of operation (i.e., when only one RU is to be used in the PPDU), the common field is not needed since there is no arrangement of smaller RUs. In this case, the HE-SIG-B only contains the User Specific field. Full Bandwidth is signaled using the “HE-SIG-B Compression bit” being set to 1 in the HE-SIG-A field, and when Full Bandwidth is indicated, the common field is not included in the HE-SIG-B. When operating in Full Bandwidth MU-MIMO mode, an entire channel is employed for transmission to

multiple devices using different allocations of spatial streams.

64. The HE-SIG-B always contains a User Specific field, which consists of one or more User fields or User Block fields. Each A User Block field can include one or more user fields that contains detailed information for one particular station. SAMSUNG-1004, 312. This includes addressing information (STA-ID), MCS (modulation and coding set) information, and details of the user's spatial allocation. *Id.*, 312, 320-324.

VIII. OVERVIEW OF THE PRIOR ART

A. Overview of 802.11ax_D1.0

65. In January 2016, the 802.11ax Task Group 802.11ax (TGax) opened the framework for the development of the 802.11ax standard, which was an amendment to the previous version of the wireless networking standard. Framework (SAMSUNG-1010), *passim*. Through October 2016, TGax received contributions from voting members, conducted meetings to discuss proposed amendments, and published iterations of the 802.11ax drafts. Every two months, the task group would release a working draft of the new amendment (these are 802.11ax_D0.1 through 802.11ax_D0.5). *E.g.*, 802.11ax_D0.5-802.11ax_D0.5. The various iterations and updates culminated in the 802.11ax_D1.0 version, which is the first draft that the TGax considered to be “technically complete” (i.e., ready for voting on by the larger working group). 802.11ax_D1.0 was publicly

available at least as early as December 1, 2016 to the 802.11 working group for its first letter ballot. The timeline of the dates for the various documents I discuss below are as follows:

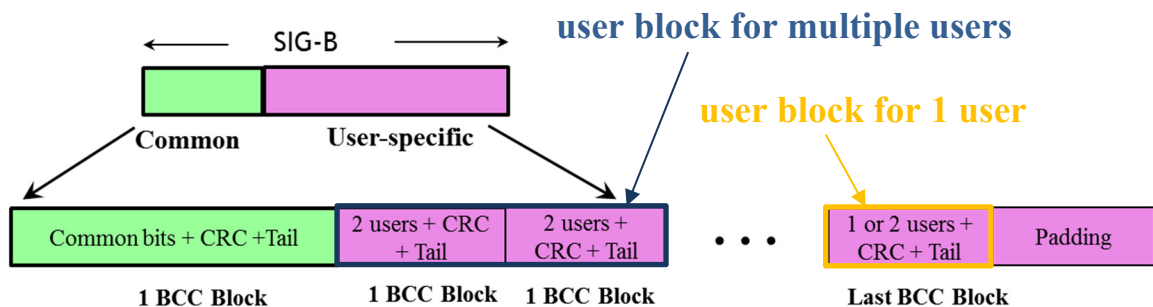
Document	Date
Robert Stacey, Specification Framework for TGax, IEEE 802.11-15/0132r15, SAMSUNG-1010	January 2016
802.11ax_D0.1, SAMSUNG-1009	March 2016
802.11ax_D0.2, SAMSUNG-1008	June 2016
802.11ax_D0.3, SAMSUNG-1007	August 15, 2016
802.11ax_D0.4, SAMSUNG-1006	August 30, 2016
802.11ax_D0.5, SAMSUNG-1005	October 2016
802.11ax_D1.0, SAMSUNG-1004	December 1, 2016

The letter ballot process is used to correct errors and improve the overall quality of the draft amendment. Each working group member is expected to read the draft and vote “yes” or “no” on whether the draft is ready to move forward to the next stage of approval. If a person votes no, he or she is required to make one or more letter ballot comments on the particular portions of the draft that need to be changed. The letter ballot comments are collected together and the task group reviews them and develops solutions. Once, every comment is addressed, the

editor produces a new draft. This process is repeated over several cycles until the number of “no” votes is very small and the task group agrees that no further changes to the draft are needed.

1. The Specification Framework

66. The Specification Framework for TGax (“the Framework”) was a reference document maintained by the 802.11ax editor to keep track of 802.11ax task group motions and their corresponding technical contributions. The Framework helped both the editor and the entire task group keep track of the features that would be incorporated into the 802.11ax drafts. The Framework included many of the features claimed by the Challenged Claims. For example, the Framework introduced the HE MU PPDU format, and HE-SIG-A and HE-SIG-B fields (Framework, 3, 7-17). Also, the Framework included the feature that HE-SIG-B user blocks can support one or more stations, as shown in Figure 5 below:



Framework, Figure 5 (annotated)

67. The Framework describes the common field which includes Resource Unit (RU) allocation. It also describes the user specific field which contains the

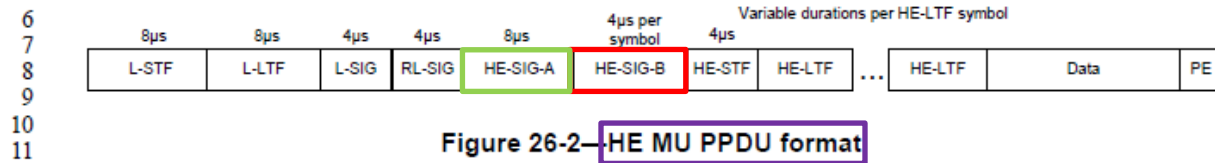
per user dedicated information, “where **one** or multiple of those **sub-fields** are for each designated receiving STA.” Framework, 12-13 (emphasis added).

68. The Framework also included the HE-SIG-A SIGB Compression Mode field to indicate full BW MU-MIMO. Framework, Table 2. When SIGB compression mode is enabled, the bits indicating the number of symbols are repurposed to indicate the number of MU-MIMO users. *Id.*

69. And, importantly, the Framework describes the two different HE-SIG-B user field formats for SU allocations versus MU allocations. Framework, 13-15. Specifically, the Framework describes that the HE-SIG-B user specific field format for SU allocations includes the number of spatial streams (NSTS) field and transmit beamforming (TxBF) field; and the HE-SIG-B user specific field format for MU allocation includes spatial configuration fields (SCF). Framework, 13-15. Likewise, the Framework describes the Spatial Configuration subfield encoding. Framework, Table 5.

2. 802.11ax_D0.1

70. The draft 802.11ax_D0.1, dated March 2016, included the **HE MU PPDU** format for supporting MU-MIMO that included the **HE-SIG-A** and **HE-SIG-B** fields. 802.11ax_D0.1, 92-93. The **HE MU PPDU** with **HE-SIG-B** field is shown below:



802.11ax_D0.1, Figure 26-2 (annotated)

71. Note that 802.11ax_D0.1 describes that the “**HE-SIG-B** field is present only in the **HE MU PPDU**.” 802.11ax_D0.1, 93. Thus, discussions of the **HE-SIG-B** field, and any subfield, fall in the context of **HE MU PPDU**s, including the fields for supporting SU allocations.

72. 802.11ax_D0.1 described that the Common Block field contains information regarding the resource unit allocation such as the RU arrangement in frequency domain, the RUs allocated for MU-MIMO and the number of users in MU-MIMO allocations. 802.11ax_D0.1, 129, 132. 802.11ax_D0.1 also describes the HE-SIG-B to consist of “multiple User Block fields.” *Id.*, 129. “Each User Block field contains information for two STAs to decode their payloads.” *Id.* As described in 802.11ax_D0.1, the “contents of the user field differ based on whether the field addresses a single-STA ... or a STA in a MU-MIMO allocation.” *Id.*, 135; *see also*, SAMSUNG-1030 & SAMSUNG-1032 for contribution document. Some of these differences are shown in Tables 26-19 and 26-20, reproduced below:

Table 26-19—Fields of the HE-SIG-B user field for a SU allocation

Bit	Field	Number of bits	Description
TBD	STA-ID	11	The STA identifier that addresses a STA – reference to MAC section(?). For RUs that carry a broadcast allocation: For single BSS AP, the STAID for Broadcast will be 0; For Multiple BSS AP, the STAID for Broadcast to a specific BSS will follow the group addressed AID assignment in the TIM according to the existing Multi-BSSID TIM operation; For Multiple BSS AP, the STAID for Broadcast to all BSS of the AP will have a special STAID value reserved.
TBD	NSTS	3	Number of spatial streams
TBD	Tx Beam-forming	1	Use of transmit beamforming
TBD	MCS	4	Modulation and Coding Scheme
TBD	DCM	1	Indication for use of dual carrier modulation
TBD	Coding	1	Indication for use of LDPC

Table 26-20—Fields of the HE-SIG-B user field for a MU-MIMO allocation

Bit	Field	Number of bits	Description
TBD	STA-ID	11	The STA identifier that addresses an STA – reference to MAC section(?)
TBD	Spatial Configuration	4	Indication for the number of spatial streams for a STA in a MU-MIMO allocation. See Table 26-21 (Spatial Configuration subfield encoding).
TBD	MCS	4	Modulation and Coding Scheme
TBD	DCM	1	Use of dual carrier modulation
TBD	Coding	1	Use of LDPC

802.11ax_D0.1, Tables 26-19 & 26-20 (annotated)

73. Table 26-19 included the **Number of Spatial Streams (NSTS) field**, whereas Table 26-20 included the **Spatial Configuration Field (SCF)**. *Id.* Thus, as early as March 2016, the 802.11 draft already contemplated 1) using the **HE MU PDU** for the single-STA (SU or non-MU-MIMO) use-case and 2) that the format for the user-specific field in the HE-SIG-B was different for the single-STA use-case (SU or non-MU-MIMO) versus the MU-MIMO use-case. Note that the use of the term “SU” in Table 26-19 is understood to imply the non-MU-MIMO

allocation when the number of users is 1 because the table represents the format of the user field of a HE-SIG-B, which is only in a HE MU PPDU. *E.g.*, 802.11ax_D0.1, 93.

74. Likewise, the 802.11ax_D0.1 draft described using the SIG-B (or SIGB) compression field in HE-SIG-A to indicate that there would be no need for RU signaling in the common field of the HE-SIG-B. 802.11ax_D0.1, 173. Instead, when the SIGB compression field was set to 1, the “number of STAs in the MU-MIMO group is indicated” in a field “in HE-SIG-A.” *Id.*

3. 802.11ax_D0.2

75. 802.11ax_D0.2 clarified that the SIGB compression field in HE-SIG-A being set to 1 indicates full bandwidth, and in that case, the HE-SIG-B did not include a common field. 802.11ax_D0.2, 177; *see also* SAMSUNG-1031 for contribution document. 802.11ax_D0.2 also expressly clarified that the number of STAs in the MU-MIMO group is indicated in the Number Of HE-SIG-B Symbols Or MU-MIMO Users field in HE-SIG-A. 802.11ax_D0.2, 177 (*cf.* Framework, Table 5 showing NSTS mapping); *see also* SAMSUNG-1033 & SAMSUNG-1034 for contribution document. Table 26-16—**HE-SIG-A** field of an **HE MU PPDU** included the SIGB Compression field for indicating full bandwidth and a field for indicating the number of MU-MIMO users when operating in full bandwidth is shown below:

Table 26-16—Fields in the HE-SIG-A for an HE MU PPDU

Two Parts of HE-SIG-A	Bit	Field	Number of bits	Description
...				
	TBD	Number Of HE-SIG-B Symbols Or MU-MIMO Users	4	<p>If the SIGB Compression field is 0, indicates the number of OFDM symbols in the HE-SIG-B field minus 1.(#821)</p> <p>If the SIGB Compression field is 1, indicates the number of MU-MIMO users.(#296)</p>
	TBD	SIGB Compression	1	<p>Set to 1 for full BW MU-MIMO. Set to 0 otherwise.</p>

802.11ax_D0.2, Table 26-16 (annotated).

76. In addition, Table 26-19 was clarified to refer to non-MU-MIMO, linking the SU scenario to the term “non-MU-MIMO.” *Id.*, 138.

4. 802.11ax_D0.3 & 802.11ax_D0.4

77. 802.11ax_D0.3 clarified that the HE-SIG-B field consisted of “one or more” User Block fields, indicating updated support for the single STA use case.

802.11ax_D0.3, 177; *see also* SAMSUNG-1036 for contribution document.

802.11ax_D0.4 did not add anything pertinent to the challenged claims.

5. 802.11ax_D0.5

78. By the time 802.11ax_D0.5 was released, the Specification included the following:

- the HE MU PPDU including the HE-SIG-B structure to include one or more User Blocks. 802.11ax_D0.5, 215, 254;
- the description and bitmapping in HE-SIG-A for SIGB compression set to 1 to

indicate full bandwidth. *Id.*, 212-213, Table 26-17;

- the description and bitmapping in **HE-SIG-A** for the Number of MU-MIMO Users indicated when in full bandwidth, which was mapped to the same field as the Number of HE-SIG-B Symbols. *Id.*, Table 26-17;
- the common field being absent from the **HE-SIG-B** structure when in full bandwidth, meaning that in full bandwidth, no RU allocation signal was included in the **HE-SIG-B**. *Id.*, 212-213, 254; and
- the formats for the user-specific fields of the **HE-SIG-B** are identified based on the number of MU-MIMO users, where the **non-MU-MIMO** format includes **NSTS**, while the format for **MU-MIMO** includes the **SCF**. *Id.*, 262-266, Tables 26-22–26-24.

79. 802.11ax_D1.0 describes all of the features of the HE MU-PPDU described above, and included other refinements that placed the draft in a condition for consideration by the working group in a letter ballot. 802.11ax_D1.0 renders the Challenged Claims unpatentable as obvious.

B. Bharadwaj

80. Bharadwaj describes preamble designs for HE MU PPDU for supporting MU-MIMO operations. *E.g.*, Bharadwaj, ¶[0065]. Bharadwaj describes stations (STAs 110) and access points (APs 105), shown in FIG. 1, for communicating according to the 802.11 (e.g., 802.11ax) baseband protocol

including physical (PHY) and medium access control (MAC) layers. *Id.*, [0064].

FIG. 1, depicting an HE-WLAN, is reproduced below:

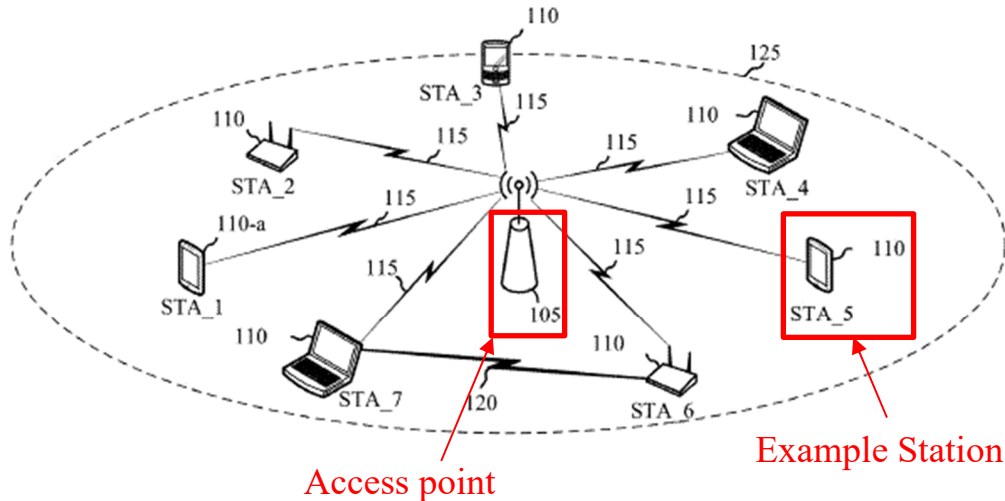


FIG. 1

Bharadwaj, FIG. 1 (annotated)

81. The AP 105 can support MU-MIMO and can transmit to multiple stations 110 simultaneously, or to one station. *E.g., id.*, ¶[0097]. The stations 110 can be “mobile handsets, tablet computers, personal digital assistants (PDAs), other handheld devices, netbooks, notebook computers, tablet computers, laptops, desktop computers, ... etc.” *Id.*, ¶[0093]. The stations include a processor, such as a hardware processor, such as a central processing unit (CPU), micro-controller, or application-specific integrated circuit (ASIC), and a transceiver 1320, to facilitate bi-directional communications. *Id.*, ¶[0150], [0152]. Antenna(s) are communicatively coupled with the transceiver(s). *Id.*, ¶[0149]. “The processor

1305 processes information received through the transceiver(s)” *Id.*, ¶[0150].

82. Bharadwaj describes that high-efficiency wireless local area networks (HE-WLAN) preambles “enables an AP to simultaneously transmit to multiple stations (e.g., MU-MIMO).” *Id.*, ¶¶[0064], [0069], [0097]. HE-WLAN preambles can include HE WLAN signaling fields, such as HE-SIG-A and HE-SIG-B fields, for providing user fields with user-specific information. *Id.*, ¶¶[0093], [0097], [0117], [0125].

83. For example, the station can decode the HE-SIG-B content channels to distinguish between single-user and MU-MIMO allocations. *Id.*, ¶[0128]. In addition, the HE-SIG-A field can be used to indicate compression mode and another field can be used to indicate the number of MU-MIMO users. *E.g., id.*, ¶[0129], FIG. 18B (Fields in HE-SIG-A for HE MU PPDU), FIGS. 21A-C. In one specific example, a “user field for an MU-MIMO allocation, e.g. in a HE-SIG-B field, may include a spatial configuration subfield” *Id.*, ¶[0093].

C. Sun

84. Sun is directed to generating a physical layer (PHY) data unit for downlink signaling in a wireless network, such as those compliant with 802.11ax. Sun, ¶¶[0011]-[0012], [0031], Abstract. Sun describes that the PHY data unit includes HE-SIG-A and HE-SIG-B fields and supports MU-MIMO transmissions. *E.g.*, Sun, ¶¶[0043], [0049], FIGS. 2-5. Sun describes that the HE-SIG-B structure

includes a common portion and one or more user blocks corresponding to one or more users. *E.g.*, Sun, ¶¶[0072]-[0073], FIGS. 13A-B. The HE-SIG-B structure, including the one or more user blocks, is shown below:

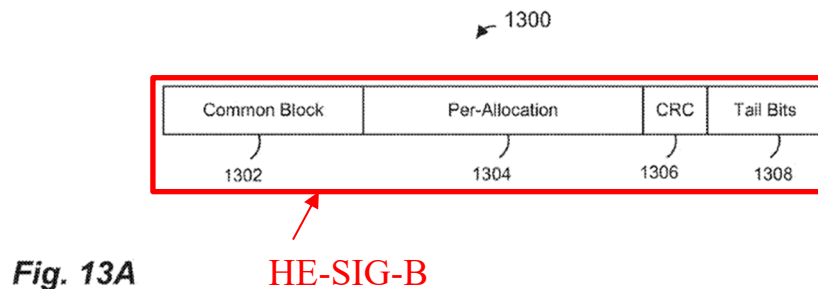


Fig. 13A

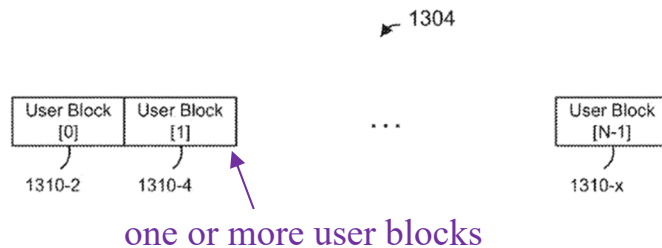


Fig. 13B

Sun, FIGS. 13A-B (annotated)

Sun provides examples of the user block formats for single user and MU-MIMO allocations. Sun, [0082]-[0087], FIGS. 13A-B, 16A-D.

85. According to Sun, “each of the user blocks 1310 of FIG. 13B corresponds to one of the user blocks 1600, 1650” of FIGS. 16A-B, respectively.

Sun, ¶[0082]. “FIGS. 16A and 16B are block diagrams of user blocks 1600, 1650³ that correspond to an MU-MIMO resource unit and an SU resource unit, respectively. Sun’s MU-MIMO and single-user formats are shown in FIGS. 16A-B, below:

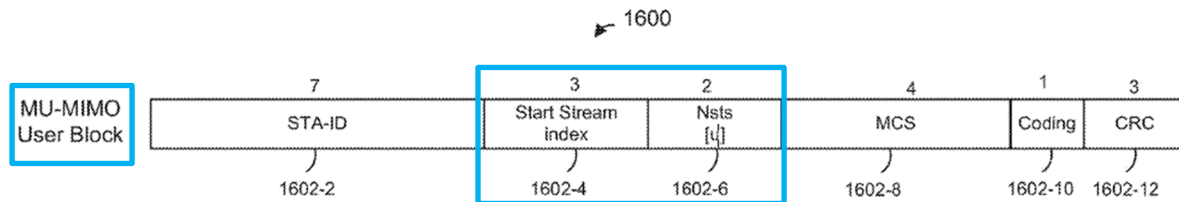
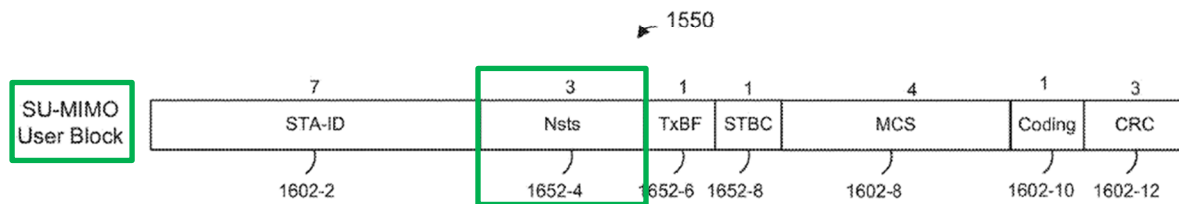


Fig. 16A

MU-MIMO format includes subfields for spatial configuration



single-user format includes NSTS subfield

Fig. 16B

Sun, FIGS. 16A-B (annotated)

86. The MU-MIMO format include subfields for spatial configuration, including “a start stream index 1604-4” and “a number of space time streams

³ The text of Sun recites that FIG. 16B shows “the SU user block 1650,” Sun, ¶[0084]. FIG. 16B has a typographical error, mislabeling FIG. 16B as user block 1550.

corresponding to the user (Nsts[u]) subfield 1602-6.” Sun, ¶[0083]. “The start stream index 1602 includes an indication of a first spatial stream, e.g., of eight possible spatial streams or of four possible spatial streams, allocated to the client station 2 indicated by the STA-ID subfield 1602.” *Id.* “The Nsts[u] subfield 1602-6 indicates a number of spatial streams allocated to the client station 25 indicated by the STA-ID subfield 1602.” *Id.*

87. FIG. 16B illustrates an example single-user user block, which differs from the MU-MIMO user block in that “bits used for the start stream index subfield 1602-4 and bits used for the Nsts[u] subfield 1602-6 in the MU-MIMO user block 1600 are used for Nsts subfield 1652-4, a transmit beamforming (TxBF) subfield 1652-6 and space time block coding (STBC) subfield 1652-8.” *Id.*, ¶[0084].

IX. THE '210 PATENT

A. The Prior Art Teaches the '210 Patent Claims

88. Viewed against the backdrop of this prior art, the '210 Patent purports to claim “a wireless communication method and a wireless communication terminal for signaling a multi-user packet” that uses an HE MU PPDU with an HE-SIG-B user field with formats identified based on the number of MU-MIMO users. '210 Patent, Abstract, cl.1. Like 802.11ax_D1.0 and Bharadwaj+Sun, claim 1 recites identifying the format of the user specific field of the HE-SIG-B based on

the number of MU-MIMO users indicated by a HE-SIG-A subfield when in full bandwidth. As discussed herein, and as stated by the examiner during prosecution, this feature was described in 802.11 as early as the 802.11ax_D0.5 draft. *E.g.*, '210 Patent, cl.1; '210 Patent File History, 112; 802.11ax_D0.5, §§26.3.3.7.4, 26.3.10.8.1; 802.11ax_D1.0, §§28.3.3.8.3, 28.3.10.8.1–28.3.10.8.1.5; Bharadwaj, ¶[0093]; Sun, ¶¶[0082]–[0084]. The formats described by the '210 Patent were also known, as early as the Framework, where the single-user case included the number of spatial streams and transmission beam forming, while the multi-user format included a spatial configuration field. *E.g.*, '210 Patent, 20:33-21:54 (describing two formats shown in FIGS. 13(d)-1–2); Framework, 12; 802.11ax_D0.1, 135-136; 802.11_D1.0, 320-324; Bharadwaj, ¶¶[0093], [0157]; Sun, ¶¶[0082]–[0084].

89. The '210 Patent illustrates user fields in FIGS. 13(d)-1–(d)-2, which are reproduced below:

non-MU-MIMO

Field	RR	Descriptions
AID	11	STA ID
NSTS	3	# of Spatial Streams
TxBF	1	TxBF on/off
MCS	4	
DCM	1	
Coding	1	BCC/LDPC
Total	21	

NSTS

(d)-1

MU-MIMO

Field	RR	Descriptions
AID	11	STA ID
SCF	4	Spatial Conf. Fields
MCS	4	
DCM	1	
Coding	1	BCC/LDPC
Total	21	

SCF

(d)-2

'210 Patent, FIGS. 13(d)1-(d)2

90. The '210 Patent describes that when “one user is allocated to one resource unit (i.e., **non-MU-MIMO allocation**), the user field includes the **NSTS** field. When a plurality of users are allocated to one resource unit (i.e., **MU-MIMO allocation**), the user field includes a **spatial configuration field**. These formats are the same as what are described in 802.11ax_D1.0 and in Bharadwaj and Sun. Indeed, even FIG. 13(e) showing the SCF encoding is the same as 802.11ax_D1.0, Table 28-24 and Bharadwaj, FIG. 7.

91. The 210 Patent refers to FIG. 13(d)-1 as the user field for an OFDMA transmission, and, by contrast, refers to FIG. 13(d)-2 as the user field for MU-MIMO transmission. But the differences between FIG. 13(d)-1 and FIG. 13(d)-2 are the same differences that exist between the user formats described in, e.g.,

802.11ax_D1.0 Tables 28-22 (non-MU-MIMO) and 28-23 (MU-MIMO). Thus, a POSITA would have understood that, for the purposes of the '210 Patent, a user field for an OFDMA transmission has the same format as a user field for a non-MU-MIMO allocation, as taught by 802.11ax_D1.0.

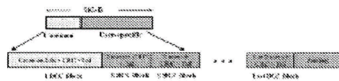
B. Prosecution History

92. During prosecution, the Applicant submitted an IDS that included, among other things, 802.11ax_D0.5_IDS, which was cited in the Extended European Search Report. '210 Patent File History, 123; EESR, 23-25. The examiner applied 802.11ax_D0.5_IDS in a final rejection, in combination with other references, to show that when in full bandwidth, the format of the user fields of the HE-SIG-B is identified based on a number of MU-MIMO users indicated by a subfield of the HE-SIG-A. '210 Patent File History, 108-113 (citing 802.11ax_D0.5_IDS, §26.3.3.7.4). Despite rejecting the independent claims with 802.11ax_D0.5_IDS, the examiner erroneously allowed dependent claims 23-25 and 29-31. *Id.*, 118. The Applicant amended independent claims 21 and 27 to include the wherein clauses in claims 23 and 29, respectively.

93. As described herein, the features of claims 23 and 29 were also included in 802.11ax_D0.5_IDS. A quick mapping between each wherein clause and 802.11ax_D0.5 is shown in Table 1 below:

94. Table 1: Comparison of claim 23 wherein clauses with

802.11ax_D0.5

Claim 23 Limitation	802.11ax_D0.5																								
wherein when the number of MU-MIMO users indicates two or more users, the user specific field of the HE-SIG-B includes user fields for MU-MIMO allocation, and	<p>26.3.10.8.1 Encoding and modulation</p> <p>The HE-SIG-B field is separately encoded on each 20 MHz band. The encoding structure in one such 20 MHz band is shown in HE-SIG-B field encoding structure in each 20 MHz. It consists of a Common Block field followed by a User Specific field which together are referred to as the HE-SIG-B content channel(#2020).</p>  <p>Figure 26-20—HE-SIG-B field encoding structure in each 20 MHz</p> <p>The User Specific field of a HE-SIG-B content channel(#2020) consists of one or more(#2022) User Block fields. Each User Block field is made up of two user fields that contain(#2020) information for two STAs to decode their payloads. The last User Block field may contain information for one or two STAs depending on whether the number of users indicated by the RU allocation signaling is odd and depending on the signaling of the center 26-tone RU(#302). See HE-SIG-B per-user content for a description of the contents of the User Block field.</p> <p>When the SIGB Compression field in the HE-SIG-A field of an HE MU PPDU is set to 1 (indicating full bandwidth MU-MIMO transmission), the Common Block field is not present and the content channel consists of only the User Specific field.(#2543)</p> <p>26.3.10.8.5 HE-SIG-B per-user content</p> <p>The user-specific field consists of multiple user fields.</p> <p>The contents of the user field differ based on whether the field addresses a single-STA in an RU or a STA in an(#2817) MU-MIMO allocation in an RU. Irrespective of whether the allocation is for a STA in an(#196) SU or an MU-MIMO allocation, the size of the user field is the same.</p> <p>The HE-SIG-B user field for an STA in MU-MIMO allocation contain the subfields shown in Fields of the HE-SIG-B user field for an.</p> <p>Table 26-23—Fields of the HE-SIG-B user field for an(#2817) MU-MIMO allocation(#2037)</p> <table><tr><th>Bit</th><th>Field</th><th>Number of bits</th><th>Description</th></tr><tr><td>B0-B10</td><td>STA-ID</td><td>11</td><td>The STA-ID refers to the AID described in 9.4.1.8 (AID field). The 11 LSBs of the AID field are used to address STAs in this field.(#1003)</td></tr><tr><td>B11-B14</td><td>Spatial Configuration</td><td>4</td><td>Indication for the number of spatial streams for a STA in an(#2817) MU-MIMO allocation. See Spatial Configuration subfield encoding .</td></tr><tr><td>B15-B18</td><td>MCS</td><td>4</td><td>Modulation and coding scheme. Set to n for MCS_n, where n = 0, 1, 2,.....11 Values 12 to 15 are reserved</td></tr><tr><td>B19</td><td>DCM</td><td>1</td><td>Indicates whether or not dual carrier modulation is used. Set to 1 to indicate that the payload of the HE MU PPDU is modulated with dual carrier modulation for the MCS. Set to 0 indicates that the payload of the PPDU is not modulated with dual carrier modulation for the MCS.</td></tr><tr><td>B20</td><td>Coding</td><td>1</td><td>Indicates whether BCC or LDPC is used. Set to 0 for BCC Set to 1 for LDPC</td></tr></table> <p>NOTE—Integer fields are transmitted in unsigned binary format, LSB first, where the LSB is in the lowest numbered bit position.(#1010)</p>	Bit	Field	Number of bits	Description	B0-B10	STA-ID	11	The STA-ID refers to the AID described in 9.4.1.8 (AID field). The 11 LSBs of the AID field are used to address STAs in this field.(#1003)	B11-B14	Spatial Configuration	4	Indication for the number of spatial streams for a STA in an(#2817) MU-MIMO allocation. See Spatial Configuration subfield encoding .	B15-B18	MCS	4	Modulation and coding scheme. Set to n for MCS _n , where n = 0, 1, 2,.....11 Values 12 to 15 are reserved	B19	DCM	1	Indicates whether or not dual carrier modulation is used. Set to 1 to indicate that the payload of the HE MU PPDU is modulated with dual carrier modulation for the MCS. Set to 0 indicates that the payload of the PPDU is not modulated with dual carrier modulation for the MCS.	B20	Coding	1	Indicates whether BCC or LDPC is used. Set to 0 for BCC Set to 1 for LDPC
Bit	Field	Number of bits	Description																						
B0-B10	STA-ID	11	The STA-ID refers to the AID described in 9.4.1.8 (AID field). The 11 LSBs of the AID field are used to address STAs in this field.(#1003)																						
B11-B14	Spatial Configuration	4	Indication for the number of spatial streams for a STA in an(#2817) MU-MIMO allocation. See Spatial Configuration subfield encoding .																						
B15-B18	MCS	4	Modulation and coding scheme. Set to n for MCS _n , where n = 0, 1, 2,.....11 Values 12 to 15 are reserved																						
B19	DCM	1	Indicates whether or not dual carrier modulation is used. Set to 1 to indicate that the payload of the HE MU PPDU is modulated with dual carrier modulation for the MCS. Set to 0 indicates that the payload of the PPDU is not modulated with dual carrier modulation for the MCS.																						
B20	Coding	1	Indicates whether BCC or LDPC is used. Set to 0 for BCC Set to 1 for LDPC																						

wherein when the number of MU-MIMO users indicates a single user, the user specific field of the HE-SIG-B includes one user field for non-MU-MIMO allocation

26.3.10.8.1 Encoding and modulation

The HE-SIG-B field is separately encoded on each 20 MHz band. The encoding structure in one such 20 MHz band is shown in HE-SIG-B field encoding structure in each 20 MHz. It consists of a Common Block field followed by a User Specific field which together are referred to as the HE-SIG-B content channel(#2020).

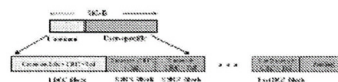


Figure 26-20—HE-SIG-B field encoding structure in each 20 MHz

The User Specific field of a HE-SIG-B content channel(#2020) consists of one or more(#2022) User Block fields. Each User Block field is made up of two user fields that contain(#2020) information for two STAs to decode their payloads. The last User Block field may contain information for one or two STAs depending on whether the number of users indicated by the RU allocation signaling is odd and depending on the signaling of the center 26-tone RU(#302). See HE-SIG-B per-user content for a description of the contents of the User Block field.

When the SIGB Compression field in the HE-SIG-A field of an HE MU PPDU is set to 1 (indicating full bandwidth MU-MIMO transmission), the Common Block field is not present and the content channel consists of only the User Specific field.(#2543)

The contents of the user field differ based on whether the field addresses a single-STA in an RU or a STA in an (#2817) MU-MIMO allocation in an RU. Irrespective of whether the allocation is for a STA in an (#196) SU or an MU-MIMO allocation, the size of the user field is the same.

The contents of the user field differ based on whether the field addresses a single-STA in an RU or a STA in an (n2817) MU-MIMO allocation in an RU. Irrespective of whether the allocation is for a STA in an (n96) SU or an MU-MIMO allocation, the size of the user field is the same.

The HE-SIG-B user field for an (n916) SU allocation contains the subfields shown in Fields of the HE-SIG-B user field for an

Table 26-22—Fields of the HE-SIG-B user field for an(#916) non-MU-MIMO(#1101) allocation(#2037)

Bit	Field	Number of bits	Description
B0-B10	STA-ID	11	<p>The STA-ID refers to the AID described in 9.4.1.3 (AID field). The 11 LSBs of the AID field are used to address the STAs in this field.(#1002)</p> <p>For RUs that carry a broadcast allocation:</p> <ul style="list-style-type: none"> For single BSS AP, the STAID for broadcast will be 0 For Multiple BSS AP, the STAID for broadcast to a specific BSS will follow the group addressed AID assignment in the TIM according to the existing Multi-BSSID TIM operation For multiple BSS AP, the STAID for broadcast to all BSS of the AP is set to 2047(#2681) STAID value 2046 is used to indicate that the RU carries no data When a STA transmits on the uplink using the HE MU PPDU format, the STA-ID field is populated by the AID of the transmitter assigned by the AP
B11-B13	NSTS	3	<p>Number of spatial streams.</p> <p>Set to the number of space time streams minus 1.(#Ed)</p>
B14	Tx Beam-forming	1	<p>Use of transmit beamforming.</p> <p>Set to 1 if a beamforming steering matrix is applied to the waveform in an SU transmission. Set to 0 otherwise.</p>
B15-B18	MCS	4	Modulation and coding scheme

95. claim 23 recited “wherein when the number of MU-MIMO users indicates two or more users, the user specific field of the HE-SIG-B includes user

fields for MU-MIMO allocation.” *E.g.*, ’210 Patent File History, 126. But the examiner failed to recognize that 802.11ax_D0.5 describes the features of this wherein clause. For example, 802.11ax_D0.5 describes that the “User Specific field of a HE-SIG-B content channel ... consists of **one or more** ... user Block fields.” 802.11ax_D0.5_IDS, §26.3.10.8.1, Figure 26-20 (emphasis added).

96. 802.11ax_D0.5 also describes the format for the user field for the MU-MIMO allocation as including the **Spatial Configuration field (SCF)**. 802.11ax_D0.5_IDS, §26.3.10.8.5, Table 26-23. Table 26-23 is reproduced below:

The HE-SIG-B user field for an STA in MU-MIMO allocation contain the subfields shown in Fields of the HE-SIG-B user field for an.

Table 26-23—Fields of the HE-SIG-B user field for an(#2817) MU-MIMO allocation(#2037)

Bit	Field	Number of bits	Description
B0-B10	STA-ID	11	The STA-ID refers to the AID described in 9.4.1.8 (AID field). The 11 LSBs of the AID field are used to address STAs in this field.(#1003)
B11-B14	Spatial Configuration	4	Indication for the number of spatial streams for a STA in an(#2817) MU-MIMO allocation. See Spatial Configuration subfield encoding .
B15-B18	MCS	4	Modulation and coding scheme. Set to n for MCS n , where $n = 0, 1, 2, \dots, 11$ Values 12 to 15 are reserved
B19	DCM	1	Indicates whether or not dual carrier modulation is used. Set to 1 to indicate that the payload of the HE MU PPDU is modulated with dual carrier modulation for the MCS. Set to 0 indicates that the payload of the PPDU is not modulated with dual carrier modulation for the MCS.
B20	Coding	1	Indicates whether BCC or LDPC is used. Set to 0 for BCC Set to 1 for LDPC
NOTE—Integer fields are transmitted in unsigned binary format, LSB first, where the LSB is in the lowest numbered bit position.(#1010)			

802.11ax_D0.5_IDS, Table 26-23 (annotated)

97. Claim 23 also recited, “wherein when the number of MU-MIMO users indicates a single user, the user specific field of the HE-SIG-B includes one user field for non-MU-MIMO allocation.” ’210 Patent File History, 126. But the examiner again did not appreciate that 802.11ax_D0.5_IDS discloses this feature. For example, 802.11ax_D0.5_IDS describes that the “last User Block field may contain information for one or two STAs depending on” the number of users indicated. 802.11ax_D0.5_IDS, §26.3.10.8.1 (emphasis added).

98. 802.11ax_D0.5_IDS also describes that when “the SIGB Compression field in the HE-SIG-A field of an HE MU PPDU is set to 1 (indicating full bandwidth MU-MIMO transmission), the Common Block field is not present and the content channel consists of only the User Specific field.” 802.11ax_D0.5_IDS, §26.3.10.8.1. And 802.11ax_D0.5_IDS describes indicating the number of MU-MIMO users in the HE-SIG-A “Number of HE-SIG-B or MU-MIMO Users” field when SIGB Compression field is 1. *Id.*, Table 26-17.

99. The format for the HE-SIG-B user field for the non-MU-MIMO allocation is shown in Table 26-22 and includes the NSTS field:

The HE-SIG-B user field for an(#916) SU allocation contain the subfields shown in Fields of the HE-SIG-B user field for an.

Table 26-22—Fields of the HE-SIG-B user field for an(#916) non-MU-MIMO(#1101) allocation(#2037)

Bit	Field	Number of bits	Description
B0-B10	STA-ID	11	<p>The STA-ID refers to the AID described in 9.4.1.8 (AID field). The 11 LSBs of the AID field are used to address the STAs in this field.(#1002)</p> <p>For RUs that carry a broadcast allocation:</p> <ul style="list-style-type: none">— For single BSS AP, the STAID for broadcast will be 0— For Multiple BSS AP, the STAID for broadcast to a specific BSS will follow the group addressed AID assignment in the TIM according to the existing Multi-BSSID TIM operation— For multiple BSS AP, the STAID for broadcast to all BSS of the AP is set to 2047(#2681)— STAID value 2046 is used to indicate that the RU carries no data— When a STA transmits on the uplink using the HE MU PPDU format, the STA-ID field is populated by the AID of the transmitter assigned by the AP
B11-B13	NSTS	3	<p>Number of spatial streams.</p> <p>Set to the number of space time streams minus 1.(#Ed)</p>
B14	Tx Beam-forming	1	<p>Use of transmit beamforming.</p> <p>Set to 1 if a beamforming steering matrix is applied to the waveform in an SU transmission.</p> <p>Set to 0 otherwise.</p>
B15-B18	MCS	4	Modulation and coding scheme

802.11ax_D0.5_IDS, Table 26-22 (annotated)

100. The examiner committed a clear error by allowing claims 23 and 31 over 802.11ax_D0.5_IDS. Likewise, the examiner erred by allowing claims 24 and 30. As shown above, the user field for single user include **NSTS** and the user field for multi-user includes **SCF**.

X. MANNER IN WHICH THE PRIOR ART REFERENCES RENDER THE '210 CLAIMS UNPATENTABLE

A. Ground 1A: 802.11ax_D1.0 Renders Claims 6-9 Obvious

1. Claim 6

[6pre] A wireless communication method of a wireless communication terminal, the method comprising:

101. 802.11ax_D1.0 renders obvious a wireless communication method of a wireless communication terminal (station or STA). 802.11ax_D1.0 describes the standards for a STAs to “decode their payloads.” *E.g.*, 802.11ax_D1.0, 286. A POSITA would have recognized that 802.11ax_D1.0 described standard structures and methods for implementing High Efficiency Wireless LAN MAC and PHY features. 802.11ax_D1.0, 1. Specifically, 802.11ax_D1.0 requires “Mandatory support for DL MU-MIMO by an HE AP supports 4 or more spatial streams when MU-MIMO is done on the entire PPDU bandwidth.” 802.11ax_D1.0, 35.

[6.1] receiving a high efficiency multi-user PHY protocol data unit (HE MU PPDU), wherein a preamble of the HE MU PPDU includes high efficiency signal A field (HE-SIG-A) and high efficiency signal B field (HE-SIG-B); and

102. 802.11ax_D1.0 renders obvious a STA receiving an HE MU PPDU in the downlink (DL). *E.g.*, 802.11ax_D1.0, §27.5 (MU operation). “DL MU transmission allows an AP to simultaneously transmit to more than one non-AP STA. The AP uses the HE MU PPDU for DL MU transmission.” *Id.*, 264, 188. A POSITA would have recognized that after the AP transmits the HE MU PPDU, a non-AP STA receives it. *Id.* The **HE MU PPDU** includes a preamble with **HE-SIG-A** and **HE-SIG-B** fields. 802.11ax_D1.0, 293. The **HE MU PPDU** format, including the **HE-SIG-A** and **HE-SIG-B** fields, is shown in FIG. 28-6, reproduced below:



Figure 28-6—HE MU PPDU format

802.11ax_D1.0, Figure 28-6 (annotated)

103. As shown in Figure 28-6 above, the **HE MU PPDU** format includes a preamble (with **HE-SIG-A** and **HE-SIG-B** fields) and the data (or payload).

[6.2] decode the received HE MU PPDU based on information obtained from the preamble,

104. 802.11ax_D1.0 renders obvious the receiving STA decodes the HE MU PPDU based on information in the preamble. Specifically, 802.11ax_D1.0 describes that at the receiver, “the PHY preamble is processed to aid in the detection, demodulation, and delivery of the PSDU.” 802.11ax_D1.0, 253. 802.11ax_D1.0 further declares that “The HE-SIG-A field carries information required to interpret HE PPDUs” which includes the HE MU PPDU. *Id.*, 272. 802.11ax_D1.0 also describes that the HE-SIG-B user fields contain information for the station to decode its payload. *Id.*, 312. A POSITA would recognize that 802.11ax PPDUs are like other 802.11 PPDUs in that the preamble is designed to provide information to the receiver that is necessary to demodulate and decode the data portion of the PPDU.

105. Specifically, the “HE-SIG-A field carries information required to

interpret HE PPDU's." 802.11ax_D1.0, 298. And the HE-SIG-B includes one or more User Block fields for one or two stations to "decode their payloads." *Id.*, 312. For example, HE-SIG-B may include RU allocation signaling (when the Common field is present), and user-specific information. *Id.*, 264-265.

106. For at least the above reasons, 802.11ax_D1.0 describes [6.2]. To the extent it is argued that 802.11ax_D1.0 does not disclose decoding the received HE MU PPDU based on information, a POSITA would have found it obvious that the receiver decodes the HE MU PPDU based on information obtained from the preamble, which includes the HE-SIG-A and HE-SIG-B fields. For example, a POSITA would have recognized that the preamble of the HE MU PPDU includes information necessary to decode the payload, such as the MCS scheme indicated by the HE-SIG-B user field. *E.g.*, 802.11ax_D1.0, 321-322.

[6.3] wherein when a SIG-B compression field of the HE-SIG-A indicates full bandwidth multi User-Multiple Input Multiple Output (MU-MIMO) transmission, a format of user field(s) included in a user specific field of the HE-SIG-B is identified based on a number of MU-MIMO users indicated by a subfield of the HE-SIG-A,

107. 802.11ax_D1.0 renders obvious [6.3]. First, 802.11ax_D1.0 describes that the SIG-B compression field of the HE-SIG-A being set to 1 indicates full bandwidth. *E.g.*, 802.11ax_D1.0, 264-265, 303, Table 28-17, 312, 324.

Table 28-17—HE-SIG-A field of an HE MU PPDU (continued)

...

B18-B21	Number Of HE-SIG-B Symbols Or MU-MIMO Users	4	If the SIGB Compression field is 0, indicates the number of OFDM symbols in the HE-SIG-B field minus 1. If the SIGB Compression field is 1, indicates the number of MU-MIMO users minus 1.
B22	SIGB Compression	1	Set to 1 for full BW MU-MIMO Set to 0 otherwise.

802.11ax_D1.0, Fields of HE MU PPDU HE-SIG-A (annotated)

802.11ax_D1.0 describes that “[w]hen the SIGB Compression field in the HE-SIG-A field of an HE MU PPDU is set to 1 (indicating full bandwidth MU-MIMO transmission), the number of STAs in the MU-MIMO group is indicated in the SIGB Number of Symbols/Number of MU-MIMO Users field in the HE-SIG-A field.” *Id.*, 324; *see also id.*, §28.3.3.8.3.

108. Next, Next, 802.11ax_D1.0 explains that the “contents of the User field differ based on whether the field addresses a single STA in an RU or a STA in an MU-MIMO allocation in an RU.” 802.11ax_D1.0, 320. Put simply, when the number of MU-MIMO users indicated is one (the value of the HE-SIG-A field is zero), then the receiver identifies the format of the HE-SIG-B user field for a single-user (SU) allocation, the subfields of which are shown in Table 28-22.

802.11ax_D1.0, 320-324. By contrast, when the number of MU-MIMO users indicated is more than one (the value of the HE-SIG-A field is non-zero), then the receiver identifies the format of the HE-SIG-B user field for a MU-MIMO

allocation, the subfields of which are shown in Table 28-22. 802.11ax_D1.0, 320-324. Note that when in full bandwidth, the HE-SIG-B does not include a Common field, and, consequently, does not include RU allocation signaling. *E.g.*, 802.11ax_D1.0, §28.3.3.8.3. Thus, the number of MU-MIMO users is indicated in the HE-SIG-A field. 802.11ax_D1.0, 324, §28.3.3.8.3.

109. 802.11ax_D1.0 explains that the “contents of the User field differ based on whether the field addresses a single STA in an RU or a STA in an MU-MIMO allocation in an RU.” *Id.*, 320. The two formats for the HE-SIG-B user fields are shown in Tables 28-22 (non-MU-MIMO) and 28-23 (MU-MIMO) below:

Table 28-22—Fields of the HE-SIG-B user field for an non-MU-MIMO allocation

Bit	Field	Number of bits	Description
B0-B10	STA-ID	11	<p>The STA-ID refers to the AID described in 9.4.1.8 (AID field). The 11 LSBs of the AID field are used to address the STAs in this field.</p> <p>For RUs that carry a broadcast allocation:</p> <ul style="list-style-type: none"> For single BSS AP, the STAID for broadcast will be 0 For Multiple BSS AP, the STAID for broadcast to a specific BSS will follow the group addressed AID assignment in the TIM according to the existing Multi-BSSID TIM operation For multiple BSS AP, the STAID for broadcast to all BSS of the AP is set to 2047 <p>And further:</p> <ul style="list-style-type: none"> STAID value 2046 is used to indicate that the RU carries no data When a STA transmits on the uplink using the HE MU PPDU format, the STA-ID field is populated by the AID of the transmitter assigned by the AP
B11-B13	NSTS	3	<p>Number of spatial streams.</p> <p>Set to the number of space time streams minus 1.</p>
B14	Tx Beam-forming	1	<p>Use of transmit beamforming.</p> <p>Set to 1 if a beamforming steering matrix is applied to the waveform in an SU transmission.</p> <p>Set to 0 otherwise.</p>
B15-B18	MCS	4	<p>Modulation and coding scheme</p> <p>Set to n for MCS$_n$, where $n = 0, 1, 2, \dots, 11$</p> <p>Values 12 to 15 are reserved</p>

802.11ax_D1.0, Table 28-22 (annotated highlighting **NSTS** field)

Table 28-23—Fields of the HE-SIG-B user field for an MU-MIMO allocation

Bit	Field	Number of bits	Description
B0-B10	STA-ID	11	The STA-ID refers to the AID described in 9.4.1.8 (AID field). The 11 LSBs of the AID field are used to address STAs in this field.
B11-B14	Spatial Configuration	4	Indication for the number of spatial streams for a STA in an MU-MIMO allocation. See Table 28-24 (Spatial Configuration subfield encoding).
B15-B18	MCS	4	Modulation and coding scheme. Set to n for MCS n , where $n = 0, 1, 2, \dots, 11$ Values 12 to 15 are reserved
B19	DCM	1	Indicates whether or not dual carrier modulation is used. Set to 1 to indicate that the payload of the HE MU PPDU is modulated with dual carrier modulation for the MCS. Set to 0 indicates that the payload of the PPDU is not modulated with dual carrier modulation for the MCS.
B20	Coding	1	Indicates whether BCC or LDPC is used. Set to 0 for BCC Set to 1 for LDPC
NOTE—Integer fields are transmitted in unsigned binary format, LSB first, where the LSB is in the lowest numbered bit position.			

802.11ax_D1.0, Table 28-23 (highlighting SCF)

As shown above, and in 802.11ax_D1.0, the format for the user field for the MU-MIMO allocation includes the SCF. *Id.*, 265, 323. The SCF is indicated by Table 28-24, and shows that the minimum number of users is 2. *Id.* The format for the user field for the non-MU-MIMO allocation includes a field for number of spatial streams (or space time streams) (NSTS) and for transmit beamforming (TxBF). *Id.*, 321-322.

110. 802.11ax_D1.0 describes that the format of the user fields (shown in Tables 28-22 and 28-23 above) are identified based on the number of MU-MIMO users indicated by a subfield of the HE-SIG-A when operating in full bandwidth.

802.11ax_D1.0, 320-324. Specifically, 802.11ax_D1.0 explains that “[w]hen the SIGB Compression field in the HE-SIG-A field of an HE MU PPDU is set to 1 (indicating full bandwidth MU-MIMO transmission), the number of STAs in the MU-MIMO group is indicated in the SIGB Number of Symbols/Number of MU-MIMO Users field in the HE-SIG-A field.” *Id.*, 324; *see also id.*, 264-265. Thus, in 802.11ax_D1.0, when in full bandwidth, the user field for a non-MU-MIMO allocation is identified and used if the HE-SIG-A field indicates one user; whereas the format of the user field for a MU-MIMO allocation is identified and used if the HE-SIG-A field indicates more than one user. Put differently, if the station receives data via a non-MU-MIMO allocation, the station interprets the user field depending on the format for non-MU-MIMO allocation per Table 28-22. 802.11ax_D1.0, 320-324, Table 28-22. But if the station receives data via MU-MIMO allocation, the station interprets the user field depending on the format for MU-MIMO allocation per Table 28-23. *Id.*, 320-324, Table 28-23–28-24.

111. 802.11ax_D1.0 describes that the format of the user fields (shown in Tables 28-22 and 28-23 above) are identified based on the number of MU-MIMO users indicated by a subfield of the HE-SIG-A when operating in full bandwidth. Specifically, 802.11ax_D1.0 explains that “[w]hen the SIGB Compression field in the HE-SIG-A field of an HE MU PPDU is set to 1 (indicating full bandwidth MU-MIMO transmission), the number of STAs in the MU-MIMO group is indicated in

the SIGB Number of Symbols/Number of MU-MIMO Users field in the HE-SIG-A field.” *Id.*, 324; see also *id.*, 264-265. Thus, in 802.11ax_D1.0, when in full bandwidth, the user field for a non-MU-MIMO allocation is identified and used if the HE-SIG-A field indicates one user; whereas the format of the user field for a MU-MIMO allocation is identified and used if the HE-SIG-A field indicates more than one user.

112. 802.11ax_D1.0 describes [6.3]. To the extent it is argued that 802.11ax_D1.0 does not describe [6.3], a POSITA would have found it obvious from 802.11ax_D1.0 that the format of the user fields was identified based on the number of MU-MIMO users indicated by a subfield of the HE-SIG-A when operating in full bandwidth. 802.11ax_D1.0 discloses element [6.3]. To the extent it is argued that 802.11ax_D1.0 does not disclose element [6.3], a POSITA would have found it obvious from 802.11ax_D1.0 that, when SIGB compression indicates full bandwidth, the format of the HE-SIG-B user field is identified based on the number of MU-MIMO users indicated by the HE-SIG-A field.

113. First, a POSITA would have understood that 802.11ax_D1.0 describes all of the following:

- The HE-SIG-B user specific field includes user blocks for one or multiple stations, depending on the number of users indicated by RU allocation signaling. 802.11ax_D1.0, 312.

- SIGB Compression field in HE-SIG-A set to 1 indicates full bandwidth, and when operating in full bandwidth, HE-SIG-B does not include a Common field or RU allocation signaling. *Id.*, 264-265.
- When operating in full bandwidth, “the number of STAs in the MU-MIMO group is indicated in the SIGB Number of Symbols/Number of MU-MIMO Users field in the HE-SIG-A field.” *Id.*, 324.
- The contents of the User field differ based on whether the field addresses a single station or a station in an MU-MIMO allocation. *Id.*, 320.
- The HE-SIG-B user field for a single-user (SU) allocation contain the subfields shown in Table 28-22 (Fields of the HE-SIG-B user field for an non-MU-MIMO allocation). *Id.*, 321-322.
- The HE-SIG-B user field for an STA in MU-MIMO allocation contain the subfields shown in Table 28-23 (Fields of the HE-SIG-B user field for an MU-MIMO allocation). *Id.*, 322.

114. A POSITA reviewing 802.11ax_D1.0 would have found it obvious that when a single user is indicated in the HE-SIG-A field, the receiver would have identified the HE-SIG-B user field format for the single-user (SU) allocation, which in 802.11ax_D1.0 includes the subfields shown in Table 28-22 for a non-MU-MIMO allocation. 802.11ax_D1.0, 321-322. A POSITA would have recognized that 1) the user field format for MU-MIMO allocation did not support

the single-user use case because it included NSTS encoding for a minimum of two stations; and 2) the only use field format that supported the single-use use case was the format for non-MU-MIMO allocation, shown in Table 28-22. *Id.*, 320-322, Table 28-22.

115. Likewise, a POSITA would have found it obvious that when multiple users are indicated in the HE-SIG-A field, the receiver would have identified the HE-SIG-B user field format for the MU-MIMO allocation, which includes the subfields shown in Table 28-23 for MU-MIMO allocation. 802.11ax_D1.0, 322. A POSITA would have recognized that the SCF encoding for the NSTS was for a minimum of two stations. *E.g.*, 802.11ax_D1.0, Table 28-23–28-24. Thus, the only description for the MU-MIMO format for the user field in 802.11ax_D1.0 was the format shown in Table 28-23. *Id.*

[6.4] wherein when the number of MU-MIMO users indicates two or more users, the user specific field of the HE-SIG-B includes user fields for MU-MIMO allocation, and

116. *See, supra*, [6.3] for a discussion of the user field format for supporting the MU-MIMO allocation. 802.11ax_D1.0 renders obvious that when the number of MU-MIMO users indicates two or more users, the HE-SIG-B includes two or more user blocks, and the user specific field of the HE-SIG-B includes user fields for MU-MIMO allocation. For example, 802.11ax_D1.0 explains that the “User Specific field of the HE-SIG-B content channel consists of

one or more User Block fields” and “[e]ach User Block field is made up of two user fields that contain information for two STAs to decode their payloads.” The User Block fields are shown below:

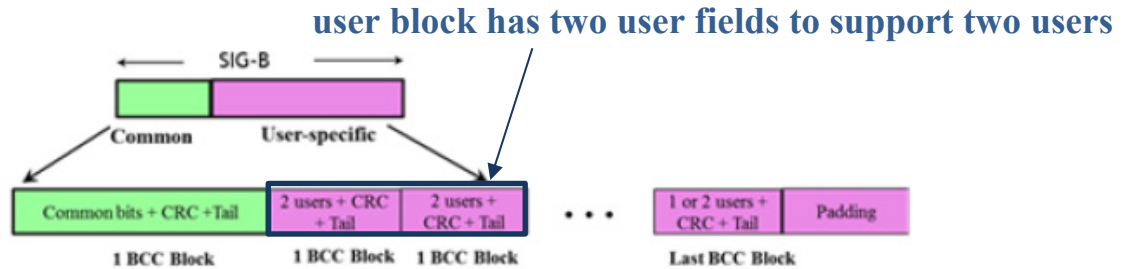


Figure 28-20—HE-SIG-B field encoding structure in each 20 MHz

802.11ax_D1.0, FIG. 28-20 (annotated)

When multiple users are indicated by the HE-SIG-A subfield, the format of the user field for MU-MIMO allocation is used. *Supra*, §X.A.1.[6.3]. The format of the user field for MU-MIMO allocation is shown in Table 28-23. 802.11ax_D1.0, 265, 320-324. The user field for MU-MIMO allocation includes a **SCF** derived from the (minimum of 2) MU-MIMO users indicated by the HE-SIG-A field. 802.11ax_D1.0, 320-324; *supra*, §X.A.1.[6.3].

[6.5] wherein when the number of MU-MIMO users indicates a single user, the user specific field of the HE-SIG-B includes one user field for non-MU-MIMO allocation.

117. See, *supra*, [6.3] for a discussion of the user field format for supporting the SU or non-MU-MIMO user case. 802.11ax_D1.0 renders obvious that when the number of MU-MIMO users indicates one user, the HE-SIG-B

includes one user blocks, and the user specific field of the HE-SIG-B includes user fields for non-MU-MIMO allocation. When the number of MU-MIMO users indicates one user, the user-specific field of HE-SIG-B includes one user block, which in turn includes a user field for non-MU-MIMO allocation. *Id.* For example, 802.11ax_D1.0 explains that the “User Specific field of the HE-SIG-B content channel consists of one or more User Block fields.” 802.11ax_D1.0, 312 (emphasis added). Additionally, the “last User Block field may contain information for one or two STAs depending on the number of users indicated” by the HE-SIG-A field. *Id.* (emphasis added). Thus, when a single user is indicated, the user-specific field of HE-SIG-B would include just a single (i.e., one) user block field containing information for one STA, which information would be provided in a user field according to the format for non-MU-MIMO allocation. 802.11ax_D1.0 describes the “User Specific field of the HE-SIG-B content channel consists of one or more User Block fields,” as shown below:

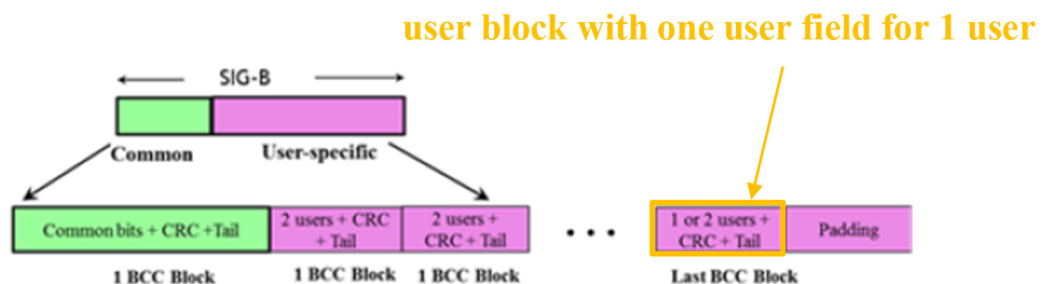


Figure 28-20—HE-SIG-B field encoding structure in each 20 MHz

802.11ax_D1.0, FIG. 28-20 (annotated)

802.11ax_D1.0 describes that the “last User Block field may contain information for one or two STAs depending on the number of users indicated” by the HE-SIG-A field. 802.11ax_D1.0, 312, 342. The format of the user field for non-MU-MIMO allocation is shown in Table 28-22. *Id.*, 264-265, 321-322, Table 28-22; *supra*, §X.A.1.[6.5]. In Table 28-22, the user field for non-MU-MIMO allocation includes a **NSTS** field and TxBF field, but does not include the **SCF** field. *Id.*, 264-265, 321-322.

118. A POSITA would have recognized that 802.11ax_D1.0 does not require multiple of the user block fields reserved for 2 users (purple annotation in [6.4]) when there is only one user. 802.11ax_D1.0, 312 (“User Specific field of the HE-SIG-B content channel consists of one or more User Block fields.”) (emphasis added). The number of users indicated in the HE-SIG-A field starts from zero, which indicates one user, and goes up to indicate additional users. 802.11ax_D1.0, Table 28-17. The transmission of an HE MU PPDU can thus be directed to just a single user, which a POSITA would have understood and found obvious 802.11ax_D1.0 to require just a single (i.e. one) user block in the user-specific field of HE-SIG-B. 802.11ax_D1.0, 312, 320-324.

119. Despite the depiction in FIG. 28-20 of multiple user blocks that can be used in some examples for a MU-MIMO allocation, the figure nonetheless shows how the number of user block fields is not fixed, but instead varies depending on

the number of indicated users. *Id.* Likewise, a POSITA would have recognized that HE-SIG-B supports transmissions to fewer than 3 users, which also means that the HE-SIG-B would have included just one User block field (i.e., for 1 or 2 users). *E.g.*, 802.11ax_D1.0, 312, 321-324. A POSITA thus would have recognized that only a single (i.e., one) user block would be provided for the case where a single user is indicated for non-MU-MIMO allocation. *Id.*, 312 (“User Specific field of the HE-SIG-B content channel consists of one or more User Block fields”) (emphasis added).

120. Likewise, for transmissions to single users, the one user block field would have included a single (i.e., one) user field. The provision of a one user field for a single-user transmission would have been obvious, for example, to reduce the overhead of the HE MU PPDU preamble, to avoid wasting bandwidth as a result of including unused user fields, and to increase throughput. *E.g.*, SAMSUNG-1031, at slide 15. That the last user block field would only include one user field for single-user transmissions is also evident from its very existence: if both user fields of the last user block were transmitted for the single-user transmission, then any of the user block fields could support a single user, and a special “last user block” would not have been necessary. That 802.11ax_D1.0 designates the last user block field for supporting one user means that it would not require both user fields to be transmitted when supporting a single user.

121. As discussed above, when one user is indicated by the HE-SIG-A subfield, the format of the user field for non-MU-MIMO allocation is used. *Supra*, §IV.A.1.[6.3]-[6.4]; SAMSUNG-1004, 320-324. The user field format for non-MU-MIMO allocation is shown in Table 28-22. SAMSUNG-1004, 264-265, 320-322, Table 28-22. In Table 28-22, the user field for non-MU-MIMO allocation includes a **NSTS** field and TxBF field, but does not include the **SCF** field. *Id.*, 264-265, 320-322.

122. 802.11ax_D1.0 describes that, in full bandwidth operation, the number of MU-MIMO users is indicated by the HE-SIG-A field, and that “there is no RU signaling in the HE-SIG-B common field.” 802.11ax_D1.0, 264-265. Thus, a POSITA would have understood and found it obvious that when a single user is indicated by the HE-SIG-A, there would be no need for multiple User Blocks in the user-specific field of the HE-SIG-B, and the only User Block field provided in this scenario would be the last User Block field that would have contained information for the single (one) STA. 802.11ax_D1.0, 312, 342.

123. Likewise, a POSITA would have understood and found it obvious that when a single user is indicated by the HE-SIG-A, the receiver would identify the non-MU-MIMO format for the HE-SIG-B user field as described in detail in Table 28-22 of 802.11ax_D1.0. 802.11ax_D1.0, 320-321 (“The HE-SIG-B user field for an SU allocation contain the subfields shown in Table 28-22 (Fields of the HE-

SIG-B user field for an non-MU-MIMO allocation).”). Recall that the HE-SIG-B field is only in the HE MU-PPDU. *Id.*, 267-268. Thus, the reference to “SU” in the paragraphs introducing Table 28-22 refer to the single-user recipient of the HE MU-PPDU. 802.11ax_D1.0, 320-324.

124. In light of 802.11ax_D1.0’s description that the last user block field may contain information for only “one” STA depending on the number of users indicated, a POSITA would have understood and found obvious that the last (and only) user block field for the case of a single user would not include two user fields for two STAs as would ordinarily be the case for multiple users for MU-MIMO allocation. 802.11ax_D1.0, 312. This was in fact recognized in official comments on the draft by the Critical Date of the ’210 Patent. SAMSUNG-1035, CID5264; *see also* SAMSUNG-1036, 3 (adding clarification concerning single user field in HE-SIG-B). While not prior art, SAMSUNG-1035 is evidence of how a POSITA at that time was interpreting 802.11ax-D1.0. Regardless, even if the user block included two user fields when a single user is indicated (e.g., including one unused user field), it would still include among them one user field for non-MU-MIMO allocation for the reasons explained above.

125. 802.11ax_D1.0 describes that, in full bandwidth operation, the number of MU-MIMO users is indicated by the HE-SIG-A field, and that “there is no RU signaling in the HE-SIG-B common field.” 802.11ax_D1.0, 264-265.

Thus, a POSITA would have found it obvious that when a single user (SU) was indicated by the HE-SIG-A, the last User Block field would have contained information for the single (one) STA.

126. A POSITA would have found it obvious that when a single user (SU) was indicated by the HE-SIG-A, the receiver would identify the non-MU-MIMO format for the HE-SIG-B user field as described in detail in Table 28-22 of 802.11ax_D1.0. 802.11ax_D1.0, 321 (“The HE-SIG-B user field for an SU allocation contain the subfields shown in Table 28-22 (Fields of the HE-SIG-B user field for an non-MU-MIMO allocation).”). Recall that the HE-SIG-B field is only in the HE MU PPDU. *Id.*, 267-268. Thus, the reference to “SU” in the paragraphs introducing Table 28-22 refer to the single user recipient of the HE MU PPDU. 802.11ax_D1.0, 321.

2. Claim 7

[7pre] The wireless communication method of claim 6,

[7.1] wherein the user field(s) for MU-MIMO allocation includes a spatial configuration field indicating the total number of spatial streams in an MU-MIMO allocation and the number of spatial streams for each terminal in the MU-MIMO allocation, and

127. *See, supra*, §X.A.1.[6.3]-[6.4] for the discussion of MU-MIMO user field format. Table 28-23 shows that the user field for MU-MIMO allocation includes the SCF. 802.11ax_D1.0, 265, 320-324, Tables 28-23 & 28-24.

128. 802.11ax_D1.0 describes that a “user field for an MU-MIMO

allocation includes a Spatial Configuration subfield” that “indicates the number of spatial streams for each STA and the total number of spatial streams in the MU-MIMO allocation.” 802.11ax_D1.0, 323. This subfield shown in Tables 28-23-28-24. *Id.*, 323. Likewise, 802.11ax_D1.0 explains that the “total number of spatial streams (total NSTS) is computed by summing all columns for the row signaled by the spatial configuration subfield and is indicated in Table 28-24 (Spatial Configuration subfield encoding) under the column Total Nsts.” *Id.*, 324.

[7.2] wherein the user field for non-MU-MIMO allocation includes a number of space time streams (NSTS) field.

129. *See, supra*, §X.A.1.[6.3]&[6.5] for the discussion of **non-MU-MIMO** user field format. Table 28-22 shows that the user field for **non-MU-MIMO** allocation includes the **NSTS**. 802.11ax_D1.0, 265, 320-322, Tables 28-22. “The number of spatial streams ... is indicated by the NSTS field in user specific block as defined in Table 28-22 (Fields of the HE-SIG-B user field for an non-MU-MIMO allocation).” *Id.*, 265.

3. Claim 8

[8] The wireless communication method of claim 6, wherein the user field(s) for non-MU-MIMO allocation is a user field based on orthogonal frequency division multiple access (OFDMA) allocation.

130. The '210 Patent describes FIG. 13(d)-1 as “a user field for an OFDMA transmission.” '210 Patent, 20:35-36. FIG. 13(d)-1 is reproduced below:

Field	Bit	Descriptions
AID	11	STA ID
NSTS	3	# of Spatial Streams
TxBF	1	TxBF on/off
MCS	4	
DCM	1	
Coding	1	BCC/LDPC
Total	21	

(d)-1

'210 Patent, FIG. 13(d)-1 (annotated)

The '210 Patent describes that “when one user is allocated to one resource unit (i.e., non-MU-MIMO allocation), the user field includes a number of space time streams (NSTS) field, a TxBF field,” etc. '210 Patent, 20:33-53. The '210 Patent does not provide further description of what the user field based on OFDMA would include beyond the description of FIG. 13(d)-1.

131. Likewise, 802.11ax_D1.0 also describes that “contents of the User field differ based on whether the field addresses a single STA in an RU or a STA in an MU-MIMO allocation in an RU.” 802.11ax_D1.0, 320. “The HE-SIG-B user field for an SU allocation contain the subfields shown in Table 28-22 (Fields of the HE-SIG-B user field for an non-MU-MIMO allocation).” *Id.*, 321. And as shown in Table 28-22, the user field includes subfields for NSTS and TxBF, among other things:

5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52

Table 28-22—Fields of the HE-SIG-B user field for a non-MU-MIMO allocation

Bit	Field	Number of bits	Description
B0-B10	STA-ID	11	The STA-ID refers to the AID described in 9.4.1.8 (AID field). The 11 LSBs of the AID field are used to address the STAs in this field. For RUs that carry a broadcast allocation: <ul style="list-style-type: none"> For single BSS AP, the STAID for broadcast will be 0 For Multiple BSS AP, the STAID for broadcast to a specific BSS will follow the group addressed AID assignment in the TIM according to the existing Multi-BSSID TIM operation For multiple BSS AP, the STAID for broadcast to all BSS of the AP is set to 2047 And further: <ul style="list-style-type: none"> STAID value 2046 is used to indicate that the RU carries no data When a STA transmits on the uplink using the HE MU PPDU format, the STA-ID field is populated by the AID of the transmitter assigned by the AP
B11-B13	NSTS	3	Number of spatial streams. Set to the number of space time streams minus 1.
B14	Tx Beam-forming	1	Use of transmit beamforming. Set to 1 if a beamforming steering matrix is applied to the waveform in an SU transmission. Set to 0 otherwise.
B15-B18	MCS	4	Modulation and coding scheme Set to n for MCS $_n$, where $n = 0, 1, 2, \dots, 11$ Values 12 to 15 are reserved

NSTS
TxBF

802.11ax_D1.0, Table 28-22 (annotated)

Thus, the '210 Patent's description of the user field based on orthogonal frequency division multiple access (OFDMA) allocation aligns with the non-MU-MIMO user field format described in 802.11ax_D1.0, Table 28-22. 802.11ax_D1.0 Table 28-22 describes that the user field(s) for non-MU-MIMO allocation is a user field based on orthogonal frequency division multiple access (OFDMA) allocation. E.g., 802.11ax_D1.0, 295, Table 28-22.

4. Claim 9

[9] The wireless communication method of claim 6, wherein the number of MU-MIMO users is indicated by a number of HE-SIG-B symbols field in the HE-SIG-A.

132. *See, supra*, §X.A.1.[6.3]. 802.11ax_D1.0 describes that the SIG-B compression field of the HE-SIG-A being set to 1 indicates full bandwidth. *E.g.*, 802.11ax_D1.0, 264-265, 303, Table 28-17, 312, 324. In that scenario, the “number of STAs in the MU-MIMO group is indicated in the Number Of HE-SIG-B Symbols Or MU-MIMO Users field in HE-SIG-A.” *Id.*, 265

Table 28-17—HE-SIG-A field of an HE MU PPDU (continued)

...

B18-B21	Number Of HE-SIG-B Symbols Or MU-MIMO Users	4	If the SIGB Compression field is 0, indicates the number of OFDM symbols in the HE-SIG-B field minus 1. If the SIGB Compression field is 1, indicates the number of MU-MIMO users minus 1.
B22	SIGB Compression	1	Set to 1 for full BW MU-MIMO. Set to 0 otherwise.

802.11ax_D1.0, Fields of HE MU PPDU HE-SIG-A

802.11ax_D1.0 describes that “[w]hen the SIGB Compression field in the HE-SIG-A field of an HE MU PPDU is set to 1 (indicating full bandwidth MU-MIMO transmission), the number of STAs in the MU-MIMO group is indicated in the SIGB Number of Symbols/Number of MU-MIMO Users field in the HE-SIG-A field.” *Id.*, 324; *see also id.*, §28.3.3.8.3.

B. [GROUND 1B] – 802.11ax_D1.0 and Bharadwaj Render Claims 1-5 Obvious

1. The Predictable Combination of 802.11ax_D1.0 and Bharadwaj

133. 802.11ax_D1.0 discloses stations that perform various functions for

supporting MU-MIMO. *E.g.*, 802.11ax_D1.0, 35. To the extent that the stations of 802.11ax_D1.0 are not understood to include specific circuitry, including a communication unit and a processor, a POSITA would have found obvious to include this circuitry in stations to perform the processing and radio communications, including receiving and decoding transmissions to support HE MU-MIMO operations, per Bharadwaj. *Supra* §IX.C.

2. Reasons to Combine

134. Like 802.11ax_D1.0, Bharadwaj describes preamble designs for enabling MU-MIMO communications between an access point (AP) and a station in an high-efficiency wireless local area network (HE-WLAN). Bharadwaj, ¶[0065]. As discussed above, in §IX.C, *supra*, Bharadwaj discloses a HE-WLAN that includes an AP 105 and a station 110. Bharadwaj, ¶¶[0060]-[0065]. Bharadwaj's station performs functions, including receiving and decoding HE MU PPDUs transmissions. Bharadwaj, ¶¶[0094], [0129], [0132]. To perform these functions, Bharadwaj provides various components included in the station. Bharadwaj, ¶¶[0060]-[0065], [0149]-[0160].

135. In FIG. 13A, Bharadwaj's station (STA 110) includes a processor 1305, memory 1310, and transceiver 1320. Bharadwaj, ¶¶[0150]-[0160]. The processor 1305 processes information received through the transceiver(s) 1320. *Id.*, ¶[0150]. The transceiver(s) 1320 communicate bi-directionally with other

wireless devices. *Id.*, ¶[0152]. The station includes modules implemented in hardware, software stored in memory 1310, or a combination of hardware and software for carrying various MU-MIMO functions, including decoding a transmission frame (¶[0008]), decoding the HE-SIG-B fields, specifically, (¶[0085]), determining a number of MU-MIMO users (¶[0157]), and determining the number of spatial streams for the station (¶[0156]). *E.g.*, Bharadwaj, [0008], [0149]-[0160].

136. Combining the teachings of 802.11ax_D1.0 with Bharadwaj would have merely involved combining prior art elements according to known methods to yield predictable results. Bharadwaj discloses communication devices, stations and APs in an IEEE802.11ax Wi-Fi network (e.g., HE-WLAN). Bharadwaj, [0005], [0060]-[0065]. Bharadwaj specifically discusses implementation of the HE MU-MIMO preamble designs with the HE-SIG-A and the HE-SIG-B fields, as well as the format for the user field in HE-SIG-B for MU-MIMO allocation. *E.g.*, Bharadwaj, [0069], [0093], [0157]. POSITA would have been motivated to combine the teachings of 802.11ax_D1.0 with Bharadwaj to realize implementation details, e.g., processing circuitry and radio circuitry for receiving and processing transmissions that include HE MU PPDU's.

137. The combination would have been predictable and foreseeable because Bharadwaj discloses communications between a station and an AP within

a HE-WLAN environment, consistent with IEEE802.11. Also, the combination merely involves incorporating known hardware and software elements expressly disclosed by Bharadwaj to implement the various HE MU PPDU described by 802.11ax_D1.0. A POSITA would have understood such hardware and/or software functionality as likely present, even if not expressly disclosed by 802.11ax_D1.0. Bharadwaj, [0005], [0060]-[0065], [0149]-[0160].

138. The combination is predictable at least because elements of the combined system would each perform similar functions they had been known to perform prior to the combination. For example, the station in 802.11ax_D1.0 would still perform the same or similar functions, including performing the decoding of HE MU PPDU, as it did prior to the combination with Bharadwaj. *Id.* Thus, a POSITA would have had a reasonable expectation of success applying the processor and communication unit descriptions of Bharadwaj when implementing the preamble designs of the 802.11ax_D1.0 amendments to the standard.

3. Analysis – Claim 1

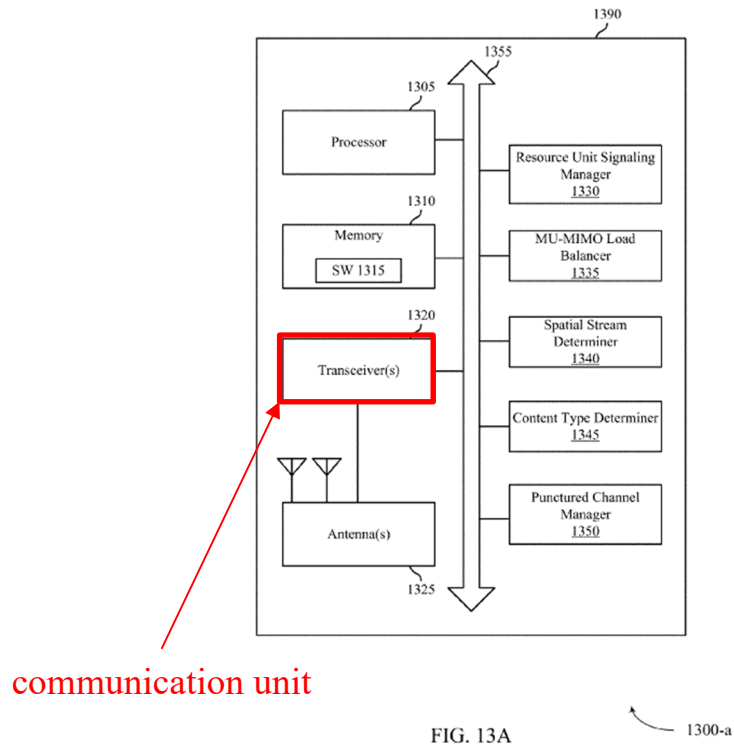
[1pre] A wireless communication terminal, the terminal comprising:

139. The 802.11ax_D1.0-Bharadwaj combination renders [1pre] obvious. In the combination, 802.11ax_D1.0 describes a wireless communication terminal (station or STA). 802.11ax_D1.0 describes the standards for a STAs to “decode

their payloads.” *E.g.*, 802.11ax_D1.0, 286. A POSITA would have recognized that 802.11ax_D1.0 described standard structures and methods for implementing High Efficiency Wireless LAN MAC and PHY features. 802.11ax_D1.0, 1. Specifically, 802.11ax_D1.0 requires “Mandatory support for DL MU-MIMO by an HE AP supports 4 or more spatial streams when MU-MIMO is done on the entire PPDU bandwidth.” 802.11ax_D1.0, 35. Bharadwaj also describes stations in communication with an AP in a HE-WLAN compliant with 802.11ax. Bharadwaj, [0060]-[0065].

[1.1] a communication unit; and

140. The 802.11ax_D1.0-Bharadwaj combination renders [1.1] obvious. In the combination, Bharadwaj describes that the station includes a communication unit (transceiver(s) 1320). The components of the station are shown in FIG. 13A:



Bharadwaj, FIG. 13A (annotated)

“The transceiver(s) 1320 communicate bi-directionally with other wireless devices, such as APs 105, STAs 110, or other devices.” Bharadwaj, [0151]. “The processor 1305 processes information received through the transceiver(s) 1320 and information to be sent to the transceiver(s) 1320 for transmission through the antenna (s) 1325.” *Id.*, [0150].

[1.2] a processor configured to process signals transmitted and received through the communication unit, wherein the processor is configured to:

141. The 802.11ax_D1.0-Bharadwaj combination renders [1.2] obvious. In the combination, Bharadwaj describes that the station includes a processor configured to process signals transmitted and received through the communication

unit. The components of the station are shown in FIG. 13A:

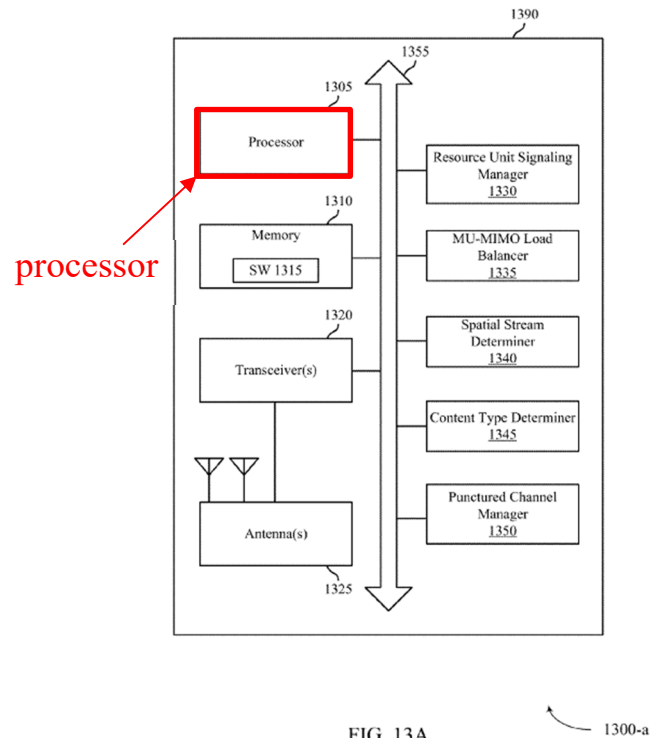


FIG. 13A

Bharadwaj, FIG. 13A (annotated)

“The processor 1305 processes information received through the transceiver(s) 1320 and information to be sent to the transceiver(s) 1320 for transmission through the antenna (s) 1325.” *Id.*, [0150].

[1.3] receive, through the communication unit, a high efficiency multi-user PHY protocol data unit (HE MU PPDU), wherein a preamble of the HE MU PPDU includes high efficiency signal A field (HE-SIG-A) and high efficiency signal B field (HE-SIG-B), and

142. *See, supra*, §X.A.1.[6.1].

[1.4] decode the received HE MU PPDU based on information obtained from the preamble,

143. *See, supra*, §X.A.1.[6.2].

[1.5] wherein when a SIG-B compression field of the HE-SIG-A indicates full bandwidth multi User-Multiple Input Multiple Output(MU-MIMO) transmission, a format of user field(s) included in a user specific field of the HE-SIG-B is identified based on a number of MU-MIMO users indicated by a subfield of the HE-SIG-A,

144. See, *supra*, §X.A.1.[6.3].

[1.6] wherein when the number of MU-MIMO users indicates two or more users, the user specific field of the HE-SIG-B includes user fields for MU-MIMO allocation, and

145. See, *supra*, §X.A.1.[6.4].

[1.7] wherein when the number of MU-MIMO users indicates a single user, the user specific field of the HE-SIG-B includes one user field for non-MU-MIMO allocation.

146. See, *supra*, §X.A.1.[6.5].

4. Claim 2

[2pre] The wireless communication terminal of claim 1,

[2.1] wherein the user field(s) for MU-MIMO allocation includes a spatial configuration field indicating the total number of spatial streams in an MU-MIMO allocation and the number of spatial streams for each terminal in the MU-MIMO allocation, and

147. See, *supra*, §X.A.2.[7.1].

[2.2] wherein the user field for non-MU-MIMO allocation includes a number of space time streams (NSTS) field.

148. See, *supra*, §X.A.2.[7.2].

5. Claim 3

[3] The wireless communication terminal of claim 1, wherein the user field(s) for non-MU-MIMO allocation is a user field based on orthogonal frequency division multiple access (OFDMA) allocation.

149. *See, supra*, §C.A.2.[8].

6. Claim 4

[4] The wireless communication terminal of claim 1, wherein the number of MU-MIMO users is indicated by a number of HE-SIG-B symbols field in the HE-SIG-A.

150. *See, supra*, §X.A.4.[9].

7. Claim 5

[5] The wireless communication terminal of claim 1, wherein the HE-SIG-A includes the SIG-B compression field and the specific subfield, and wherein the SIG-B compression field indicates whether full bandwidth MU-MIMO transmission is used, and when the SIG-B compression field indicates full bandwidth MU-MIMO transmission, the specific subfield indicates the number of MU-MIMO users.

151. *See, supra*, §X.A.1.[6.3]. The 802.11ax_D1.0-Bharadwaj combination renders [5] obvious. 802.11ax_D1.0 describes that the SIG-B compression field of the HE-SIG-A being set to 1 indicates full bandwidth. *E.g.*, 802.11ax_D1.0, 264-265, 303, Table 28-17, 312, 324.

Table 28-17—HE-SIG-A field of an HE MU PPDU (continued)

...

B18-B21	Number Of HE-SIG-B Symbols Or MU-MIMO Users	4	If the SIGB Compression field is 0, indicates the number of OFDM symbols in the HE-SIG-B field minus 1. If the SIGB Compression field is 1, indicates the number of MU-MIMO users minus 1.
B22	SIGB Compression	1	Set to 1 for full BW MU-MIMO. Set to 0 otherwise.

802.11ax_D1.0, Fields of HE MU PPDU HE-SIG-A

802.11ax_D1.0 describes that “[w]hen the SIGB Compression field in the HE-SIG-A field of an HE MU PPDU is set to 1 (indicating full bandwidth MU-MIMO transmission), the number of STAs in the MU-MIMO group is indicated in the SIGB Number of Symbols/Number of MU-MIMO Users field in the HE-SIG-A field.” *Id.*, 324; *see also id.*, §28.3.3.8.3. As shown in Table 28-17, both the SIB Compression field and the “Number of HE-SIG-B Symbols or MU-MIMO Users” field are subfields of the HE-SIG-A.

C. [GROUND 2] – Bharadwaj and Sun Render Claims 1-9 Obvious

1. The Predictable Combination of Bharadwaj and Sun

152. Bharadwaj describes that, in full bandwidth, determining the number of MU-MIMO users from a HE-SIG-A field, and that the user field in HE-SIG-B for a MU-MIMO allocation indicates a spatial configuration for a number of users indicated by the common field of the HE-SIG-A. Bharadwaj, however, does not expressly disclose the format of the user field in HE-SIG-B for single-user allocation. In the same field of endeavor, Sun describes that the user specific field of the HE-SIG-B has two possible structures: one for the single-user mode and one for the multi-user mode. In the Bharadwaj-Sun combination (“Bharadwaj/Sun”), Bharadwaj applies the format for the user field for the non-MU-MIMO (SU) allocation, as suggested by Sun, based on the number of users determined from the HE-SIG-A field indicating a single user.

2. *Reasons to Combine*

153. Multiple reasons would have prompted a POSITA to implement the Bharadwaj-Sun combination. First, Bharadwaj and Sun are analogous art in that they are both concerned with the design of the PHY data unit for supporting MU-MIMO transmissions in the downlink. Bharadwaj pertains to preamble designs for HE MU PPDU for supporting MU-MIMO operations. *E.g.*, Bharadwaj, [0065]. Likewise, Sun pertains to the design of the PHY data unit for downlink signaling, including HE-SIG-B formats. Sun, ¶¶[0011]-[0012], [0031], [0082]-[0087], Abstract. In addition, both Bharadwaj and Sun describe MU-MIMO downlink PHY data unit structures in the context of 802.11ax. Bharadwaj, ¶[0064]; Sun, ¶[0031].

154. Bharadwaj describes preamble designs for supporting HE MU-MIMO operations, and such preamble designs include details pertaining to the HE-SIG-A and HE-SIG-B fields. Bharadwaj, ¶¶[0064]-[0065], [0069], [0093], [0097], [0117], [0125]. Bharadwaj specifically describes the “user field for an MU-MIMO allocation, e.g., in a HE-SIG-B field” that includes the “spatial configuration subfield.” Bharadwaj, ¶[0093], FIG. 7 (spatial configuration subfield encoding). Despite also contemplating that the HE MU PPDU would have also supported the single-user scenario, Bharadwaj does not describe the user field format for the non-MU-MIMO allocation. Bharadwaj, ¶[0096] (describing that “the station may

differentiate between SU and MU-MIMO allocations” and that “the content of the SU and MU dedicated portions of a HE-SIG-B field may be different”), FIGS. 15C (B8:B9 full BW MU-MIMO or MU PPDU targeted to single user), 18B (B0:B4 SIGB Compression and Number of HE-SIG-B Symbols/MU-MIMO users, B8:B9 full BW MU-MIMO or MU PPDU targeted to single user), 21A-C. Thus, a POSITA implementing Bharadwaj’s preamble designs would have been motivated to look to another reference, like Sun, for a description of the format of the user field to support non-MU-MIMO allocations and the single-user transmission scenario. A POSITA would have combined the teachings of Bharadwaj with Sun to realize implementation details for the HE-SIG-A and HE-SIG-B fields of the HE MU PPDU to better support both MU-MIMO and non-MU-MIMO allocations.

155. Sun describes multiple different formats for HE-SIG-B user blocks, including describing formats for supporting the non-MU-MIMO allocation. Sun, ¶¶[0082]-[0087], FIGS. 16A-D. Specifically, Sun describes the contents of each field for the user block for the single-user mode, which includes the Nsts field and the TxBF field. Sun, ¶[0084], FIG. 16B. A POSITA would have found it obvious to look to Sun for modifying Bharadwaj to include the user field format for SU (non-MU-MIMO) allocation to complement Bharadwaj’s disclosure of the MU-MIMO user field format.

156. The combination would have been predictable and foreseeable for at

least the following reasons:

1) both Bharadwaj and Sun describe designs for a PHY data unit (or PPDU) to support communications between an AP and a station within a high-efficiency Wi-Fi network, consistent with 802.11ax;

2) both Bharadwaj and Sun describe the PPDU design for supporting MU-MIMO downlink transmission as including HE-SIG-A and HE-SIG-B fields; and

3) Bharadwaj already describes the format for the user field for the MU-MIMO allocation, while also recognizing the single-user scenario, and the combination merely involves the addition to Bharadwaj of the user field format for the single-user allocation, as taught by Sun.

157. The combination is obvious also because elements of the combined system would each perform similar functions they had been known to perform in similar contexts outside the combination. For example, the station in Bharadwaj would still perform the same or similar functions, including decoding the HE-SIG-A to determining the number of MU-MIMO users and decoding the HE-SIG-B to determine the MU-MIMO allocation, as it did prior to the combination with Sun.

Id. After the combination, when the station of Bharadwaj determines that the MU PPDU HE-SIG-A indicates one user, the station would then recognize the format for the HE-SIG-B user field as structured for the single-user (or non-MU-MIMO) allocation.

158. A POSITA would have had a reasonable expectation of success implementing the combination, especially considering the substantially similar 802.11ax techniques described in each reference. Additionally, combining the teachings of Bharadwaj with Sun. First, combining the teachings of Bharadwaj with Sun would have merely involved combining prior art elements according to known methods to yield predictable results. Bharadwaj and Sun disclose communication devices, stations and APs in an IEEE802.11ax Wi-Fi network (e.g., high-efficiency (“HE”) WLAN). Bharadwaj, ¶¶[0005], [0060]-[0065]; Sun, ¶¶[0031]-[0040]. Bharadwaj specifically discusses implementation of the HE MU-MIMO preamble designs with the HE-SIG-A and the HE-SIG-B fields, as well as the format for the user field in HE-SIG-B for MU-MIMO allocation. *E.g.*, Bharadwaj, ¶¶[0069], [0093], [0157].

3. Analysis – Claim 1

[1pre] A wireless communication terminal, the terminal comprising:

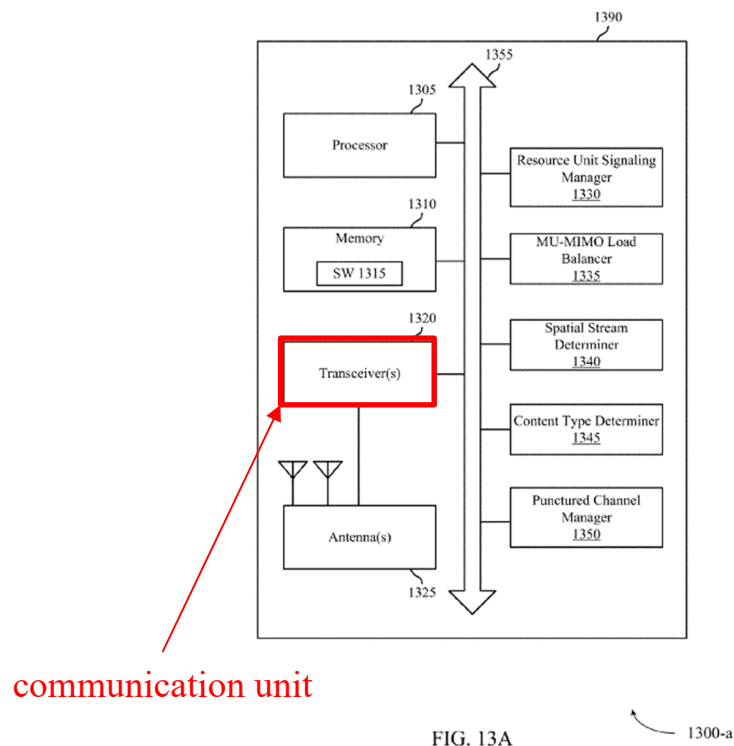
159. Bharadwaj/Sun renders [1pre] obvious. In the combination, Bharadwaj describes that the HE-WLAN 100 includes an AP 105 and wireless stations (wireless communication terminal). Bharadwaj, ¶[0061]. The stations can be “mobile handsets, tablet computers, personal digital assistants (PDAs), other handheld devices, netbooks, notebook computers, tablet computers, laptops, desktop computers,” etc. *Id.* Bharadwaj’s stations and APs communicate in an

HE-WLAN compliant with 802.11ax. *Id.*, [0064]-[0065].

[1.1] a communication unit; and

160. *See, supra*, §X.B.3.[1.1] for Bharadwaj describing a communication unit.

161. Bharadwaj/Sun renders [1.1] obvious. Bharadwaj describes that the station includes a communication unit, which includes transceiver(s) 1320. The components of the station are shown in FIG. 13A:



Bharadwaj, FIG. 13A (annotated)

162. “The transceiver(s) 1320 communicate bi-directionally with other wireless devices, such as APs 105, STAs 110, or other devices.” Bharadwaj, [0151]. “The processor 1305 processes information received through the

transceiver(s) 1320 and information to be sent to the transceiver(s) 1320 for transmission through the antenna(s) 1325.” *Id.*, [0150].

[1.2] a processor configured to process signals transmitted and received through the communication unit, wherein the processor is configured to:

163. *See, supra*, §IV.B.3.[1.2].

164. Bharadwaj/Sun renders [1.2] obvious. In the Bharadwaj-Sun combination, Bharadwaj describes that the station includes a processor configured to process signals transmitted and received through the communication unit. The components of the station are shown in FIG. 13A:

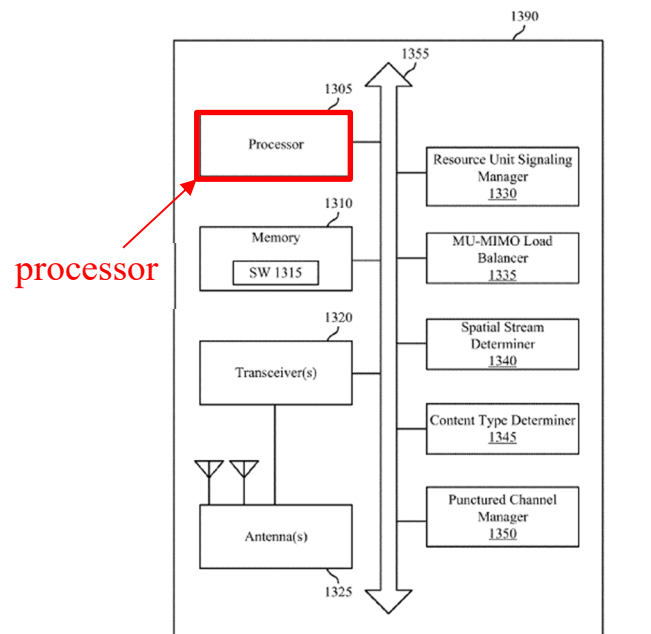


FIG. 13A

1300-a

Bharadwaj, FIG. 13A (annotated)

“The processor 1305 processes information received through the transceiver(s) 1320 and information to be sent to the transceiver(s) 1320 for transmission through the antenna (s) 1325.” *Id.*, [0150].

[1.3] receive, through the communication unit, a high efficiency multi-user PHY protocol data unit (HE MU PPDU), wherein a preamble of the HE MU PPDU includes high efficiency signal A field (HE-SIG-A) and high efficiency signal B field (HE-SIG-B), and

165. *See, supra*, §X.C.3.[1.1]-[1.2]. Bharadwaj/Sun renders [1.3] obvious.

In the Bharadwaj-Sun combination, Bharadwaj describes a processor (processor connected to transceiver) configured to receive an HE MU PPDU. *E.g.*, Bharadwaj, [0139], [0172], FIG. 25. Bharadwaj also describes that the HE MU PPDU includes HE-SIG-A and HE-SIG-B fields. *Id.*, ¶¶[0095]-[0097], FIGS. 3, 21A-C. A POSITA would have recognized that Bharadwaj disclosed the HE MU PPDU based on Bharadwaj’s disclosure of the HE-SIG-B field, which only appears in the HE MU PPDU.

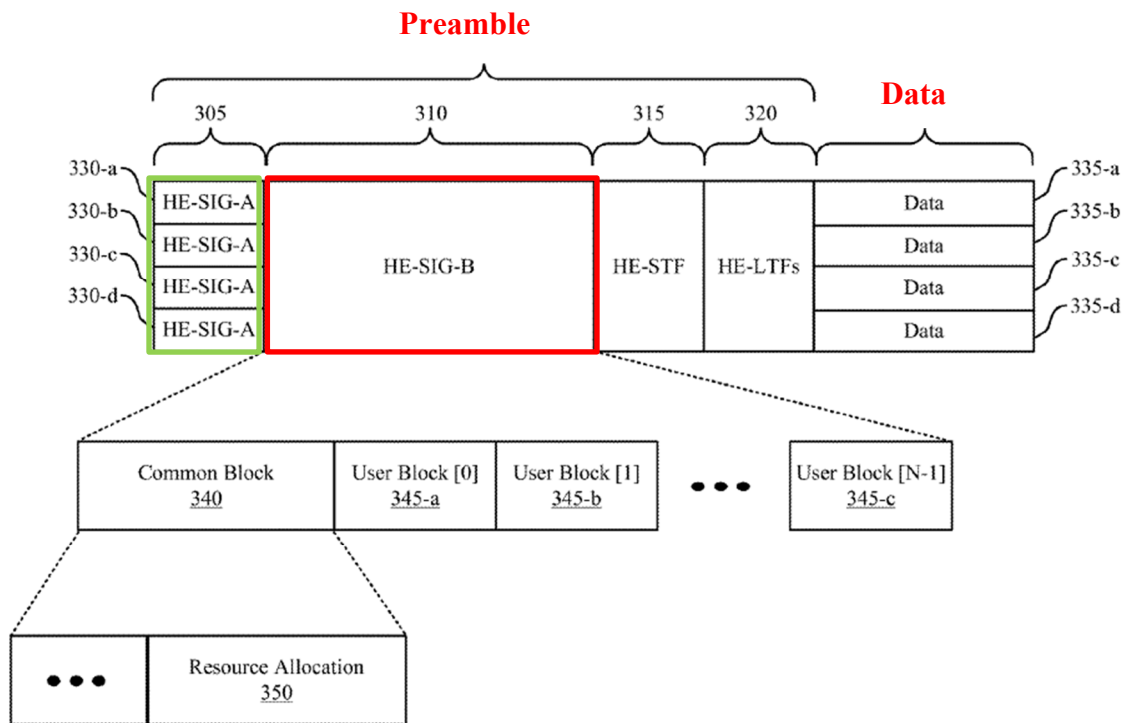


FIG. 3

300

SAMSUNG-1013, FIG. 3 (annotated)

Bharadwaj discloses that the User Blocks 345 are part of an HE MU PPDU.

SAMSUNG-1013, ¶[0094].

[1.4] decode the received HE MU PPDU based on information obtained from the preamble,

166. Bharadwaj/Sun renders [1.4] obvious. Bharadwaj describes information provided in a preamble is used by a device to decode the subsequent data. SAMSUNG-1013, ¶[0065]. Per Bharadwaj, HE-WLAN preambles can be used to schedule multiple devices” for single-user simultaneous transmission and/or MU-MIMO transmissions. *Id.*; see also *id.*, ¶[0069]. Bharadwaj also

describes that the first WLAN signaling field (i.e., the HE-SIG-A) includes information to decode the second WLAN signaling field (i.e., the HE-SIG-B). *Id.*, ¶¶[0069]-[0071]. The second WLAN signaling field (i.e., the HE-SIG-B) includes information usable by the station to “decode data in the data field” of the HE MU PPDU. *Id.*, ¶¶[0072], [0094]. Thus, a POSITA would have recognized, or found it obvious, that Bharadwaj describes decoding the received HE MU PPDU based on information obtained from the preamble.

[1.5] wherein when a SIG-B compression field of the HE-SIG-A indicates full bandwidth multi User-Multiple Input Multiple Output(MU-MIMO) transmission, a format of user field(s) included in a user specific field of the HE-SIG-B is identified based on a number of MU-MIMO users indicated by a subfield of the HE-SIG-A,

167. Bharadwaj/Sun renders [1.5] obvious. In the Bharadwaj-Sun combination, Bharadwaj describes that full bandwidth is indicated by the SIGB Compression bit being set to 1 in the HE-SIG-A. SAMSUNG-1013, FIGS. 21A-B, shown below:

	B18: B21	SIGB Number of Symbols/ Number of MU- MIMO Users	4	When SIGB compression field=0, indicates the number of HE-SIG-B symbols. Set to n for n+1 HE-SIG-B symbol, where n=0, 1, 2, ..., 15. When SIGB compression field=1, indicates the number of MU-MIMO users minus 1.	
	Bits	Field	# of bits	Description	
Two parts of HE- SIG-A	HE-SIG- A1	B22	SIGB Compressi on	1	Set to 1 for full BW MU-MIMO. Set to 0 otherwise.

SAMSUNG-1013, FIGS. 21A-B (annotated)

When in SIGB compression is set to 1, the “SIB Number of Symbols/Number of

MU-MIMO Users” field indicates the number of MU-MIMO users. *Id.*

Bharadwaj also describes that in the full bandwidth mode, no RU signal information is transmitted in a HE-SIG-B field. *Id.*, ¶[0097]. A POSITA would have found it obvious, therefore, that the number of MU-MIMO users was determined from the HE-SIG-A field when in full bandwidth.

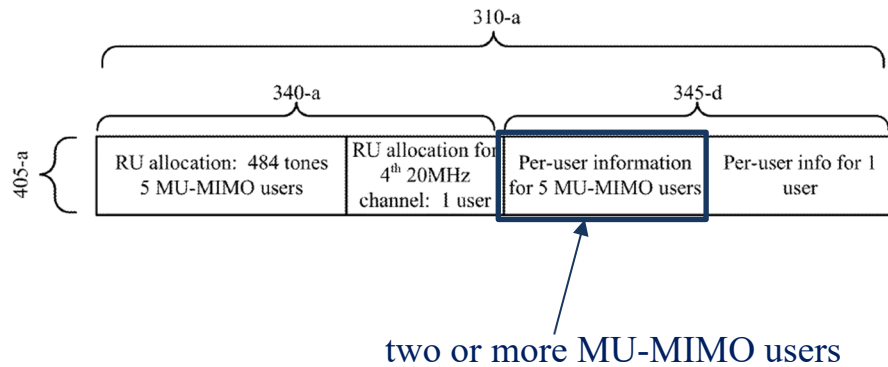
168. Bharadwaj also describes that “the station may differentiate between SU and MU-MIMO allocations.” Bharadwaj, ¶[0096]. A POSITA reading Bharadwaj would have recognized that, in full bandwidth, such differentiation would have at least included determining the number of users from the HE-SIG-A field. In the combination, as described above, Sun differentiates the MU-MIMO user block from the single-user user block, by including an Nsts subfield, as opposed to fields for spatial information pertaining to MU-MIMO. Bharadwaj, ¶[0093]; Sun, ¶[0084], FIG. 16B; *supra*, §X.C.1-2. A POSITA would have understood and found it obvious that after Bharadwaj differentiates between SU and MU-MIMO, it would have identified the correct format for the user field, as taught by Sun.

[1.6] wherein when the number of MU-MIMO users indicates two or more users, the user specific field of the HE-SIG-B includes user fields for MU-MIMO allocation, and

169. Bharadwaj/Sun renders [1.6] obvious. In the Bharadwaj- Sun combination, Bharadwaj describes that when the number of MU-MIMO users is

two or more, the HE-SIG-B field includes user fields for MU-MIMO allocation.

For example, Bharadwaj describes the HE-SIG-B field includes user blocks, as shown in FIG. 5:



Bharadwaj, FIG. 5 (annotated)

User blocks 345-d each include per user information for MU-MIMO users.

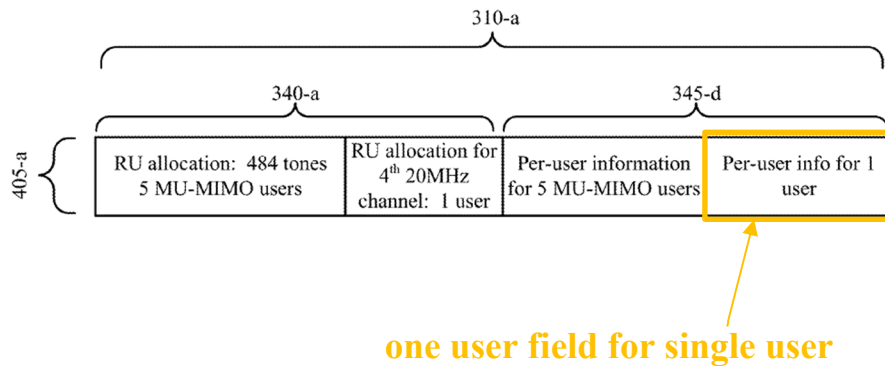
Bharadwaj, ¶[0085]-[0087], FIGS. 3, 5, 8 (full bandwidth mode).

170. Bharadwaj also describes that the “user field for an MU-MIMO allocation, e.g. in a HE-SIG-B field, may include a spatial configuration subfield of 4 bits indicating the number of spatial streams for each multiplexed STA, the index of the spatial stream, and the total number of spatial streams.” Bharadwaj, ¶[0093].

[1.7] wherein when the number of MU-MIMO users indicates a single user, the user specific field of the HE-SIG-B includes one user field for non-MU-MIMO allocation.

171. Bharadwaj/Sun renders [1.7] obvious. In the Bharadwaj-Sun combination, Bharadwaj describes that when the number of MU-MIMO users

indicates a single user, the HE-SIG-B field includes a user field for non-MU-MIMO (SU) allocation for one or more users. For example, Bharadwaj describes the HE-SIG-B field includes user blocks for a single user, as shown in FIG. 5:



Bharadwaj, FIG. 5 (annotated)

Bharadwaj, ¶¶[0086] (“User blocks 345-d and 345-e each include ... per-user information for SU users in user blocks.”), [0085], [0087], FIGS. 3, 5, 8 (full bandwidth mode).

172. In the combination, Sun also describes the HE-SIG-B as including “one or more user blocks 1310 respectively corresponding to *one* or more users (e.g., one or more client stations 25) that are scheduled to receive data.” Sun, ¶[0073] (emphasis added). When a single user is indicated, a single user block 1310 would thus provide a user field for a single user. *Id.* The HE-SIG-B and user blocks are illustrated in FIGS. 13A-B, reproduced below. Sun, ¶¶[0072]-[0073], FIGS. 13A-B:

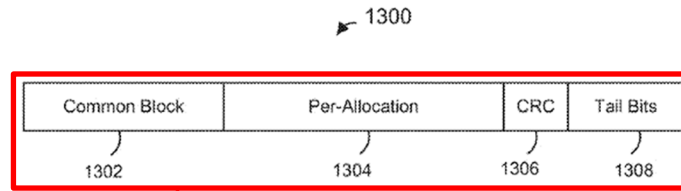
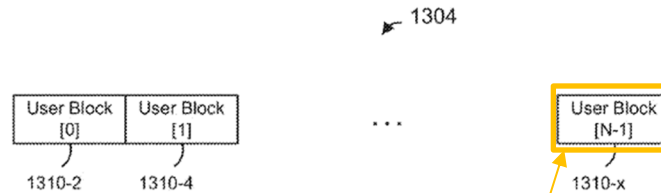


Fig. 13A HE-SIG-B



user block with one user field for one user

Fig. 13B

Sun, FIGS. 13A-B (annotated)

4. Claim 2

[2pre] The wireless communication terminal of claim 1,

[2.1] wherein the user field(s) for MU-MIMO allocation includes a spatial configuration field indicating the total number of spatial streams in an MU-MIMO allocation and the number of spatial streams for each terminal in the MU-MIMO allocation, and

173. Bharadwaj/Sun renders [2.1] obvious. Bharadwaj describes that “user field for an MU-MIMO allocation, e.g. in a HE-SIG-B field, may include a spatial configuration subfield of 4 bits indicating the number of spatial streams for each multiplexed STA, the index of the spatial stream, and the total number of spatial streams.” Bharadwaj, ¶[0093].

[2.2] wherein the user field for non-MU-MIMO allocation includes a number of space time streams (NSTS) field.

174. Bharadwaj/Sun renders [2.2] obvious. In the combination, Sun describes that the user field for the non-MU-MIMO allocation includes a number of space time streams field, as shown in FIG. 16B below:

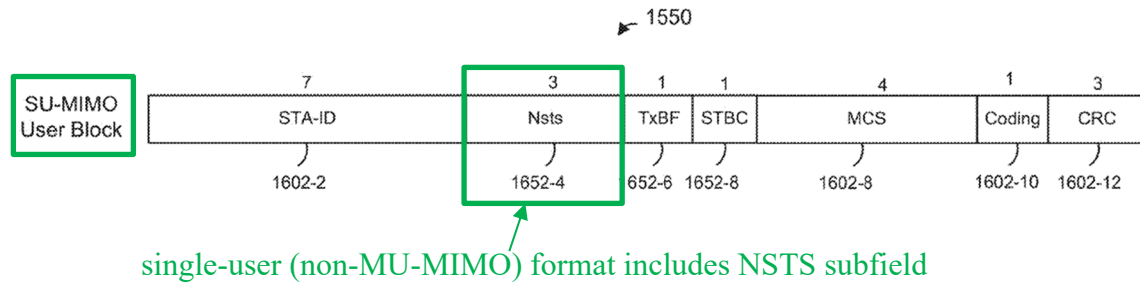


Fig. 16B

Sun, FIG. 16B (annotated)

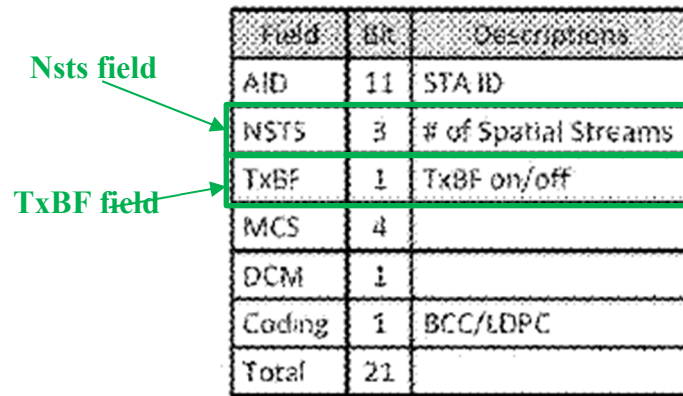
“The Nsts subfield 1652-4 includes an indication of a number of spatial or space time streams allocated to the station 25 indicated by the STA-ID subfield 1602-2 for SU transmission to the client station.” Sun, ¶[0084].

5. Claim 3

The wireless communication terminal of claim 1, wherein the user field(s) for non-MU-MIMO allocation is a user field based on orthogonal frequency division multiple access (OFDMA) allocation.

175. Bharadwaj/Sun renders [1.3] obvious.

176. In the '210 patent, FIG. 13(d)-1 illustrates the user field for non-MU-MIMO allocation is a user field based on orthogonal frequency division multiple access (OFDMA) allocation. The '210 Patent describes FIG. 13(d)-1 as “a user field for an OFDMA transmission.” '210 Patent, 20:35-36. FIG. 13(d)-1 is reproduced below:



Field	Bit	Descriptions
AID	11	STA ID
NSTS	3	# of Spatial Streams
TxBF	1	TxBF on/off
MCS	4	
DCM	1	
Coding	1	BCC/LDPC
Total	21	

(d)-1

'210 Patent, FIG. 13(d)-1 (annotated)

The '210 Patent describes that “when one user is allocated to one resource unit (i.e., non-MU-MIMO allocation), the user field includes a number of space time streams (NSTS) field, a TxBF field,” etc., as illustrated in FIG. 13(d)-1. '210 Patent, 20:33-53. The '210 Patent does not provide further description of what the user field based on OFDMA would include beyond the description of FIG. 13(d)-1.

177. But like the 210 Patents description of FIG. 13(d)-1, Sun also describes the HE-SIG-B user block for SU (i.e., non-MU-MIMO) resource unit (allocation). And as shown in FIG. 16B, the user field includes subfields for NSTS and TxBF, among other things:

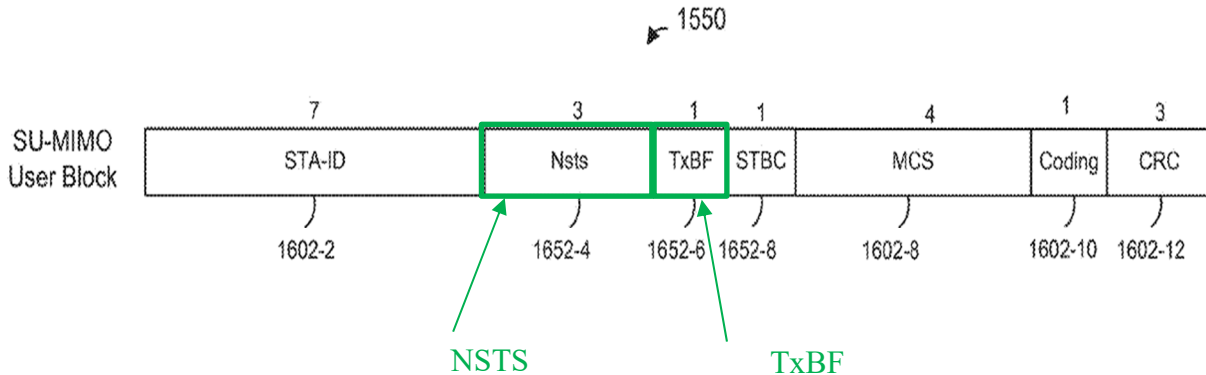


Fig. 16B

Sun, FIG. 16B (annotated)

Thus, the '210 Patent's description of the user field based on orthogonal frequency division multiple access (OFDMA) allocation aligns with Sun's description of the SU-MIMO user block, which also includes the Nsts and TxBF fields. *E.g.*, Sun, ¶[0084], FIG. 16B.

6. Claim 4

[4] The wireless communication terminal of claim 1, wherein the number of MU-MIMO users is indicated by a number of HE-SIG-B symbols field in the HE-SIG-A.

178. Bharadwaj/Sun renders [4] obvious. For example, Bharadwaj describes that “a field in the SIG-A field corresponding to the number of SIG-B symbols may be re-interpreted or repurposed” to indicate the number of MU-MIMO users. Bharadwaj, ¶[0097], FIGS. 21A-C. The HE-SIG-A field is reproduced below:

	B18: B21	SIGB Number of Symbols/ Number of MU- MIMO Users	4	When SIGB compression field=0, indicates the number of HE-SIG-B symbols. Set to n for n+1 HE-SIG-B symbol, where n = 0, 1, 2, ..., 15. When SIGB compression field=1, indicates the number of MU-MIMO users minus 1.
Two parts of HE- SIG-A	Bits	Field	# of bits	Description
HE-SIG- A1	B22	SIGB Compressi on	1	Set to 1 for full BW MU-MIMO. Set to 0 otherwise.

Bharadwaj, FIGS. 21A-B (partial, annotated)

7. Claim 5

[5] The wireless communication terminal of claim 1, wherein the HE-SIG-A includes the SIG-B compression field and the specific subfield, and wherein the SIG-B compression field indicates whether full bandwidth MU-MIMO transmission is used, and when the SIG-B compression field indicates full bandwidth MU-MIMO transmission, the specific subfield indicates the number of MU-MIMO users.

179. See, *supra*, §X.C.5 (claim 4). Bharadwaj/Sun renders [5] obvious. In the combination, as shown in FIGS. 21A-B, Bharadwaj describes that the **HE-SIG-A** field includes the **SIGB Compression field** and the “**specific subfield.**” SAMSUNG-1013, FIGS. 21A-B, reproduced below:

	B18: B21	SIGB Number of Symbols/ Number of MU- MIMO Users	4	When SIGB compression field=0, indicates the number of HE-SIG-B symbols. Set to n for n+1 HE-SIG-B symbol, where n = 0, 1, 2, ..., 15. When SIGB compression field=1, indicates the number of MU-MIMO users minus 1.
Two parts of HE- SIG-A	Bits	Field	# of bits	Description
HE-SIG- A1	B22	SIGB Compressi on	1	Set to 1 for full BW MU-MIMO. Set to 0 otherwise.

SAMSUNG-1013, FIGS. 21A-B (partial, annotated)

As shown above, the SIGB compression field being set to 1 indicates “full BW MU-MIMO.” Likewise, “[w]hen SIB compression field=1,” the SIGB Number of Symbols/Number of MU-MIMO Users” field (specific subfield) of the HE-SIG-A “indicates the number of MU-MIMO users minus 1.” SAMSUNG-1013, FIGS. 21A-B; ¶[0097].

8. Claim 6

[6pre] A wireless communication method of a wireless communication terminal, the method comprising:

180. *See, supra*, X.C.3.

[6.1] receiving a high efficiency multi-user PHY protocol data unit (HE MU PPDU), wherein a preamble of the HE MU PPDU includes high efficiency signal A field (HE-SIG-A) and high efficiency signal B field (HE-SIG-B); and

181. *See, supra*, §X.C.3.[1.3].

[6.2] decode the received HE MU PPDU based on information obtained from the preamble,

182. *See, supra*, §X.C.3.[1.4].

[6.3] wherein when a SIG-B compression field of the HE-SIG-A indicates full bandwidth multi User-Multiple Input Multiple Output (MU-MIMO) transmission, a format of user field(s) included in a user specific field of the HE-SIG-B is identified based on a number of MU-MIMO users indicated by a subfield of the HE-SIG-A,

183. *See, supra*, §X.C.3.[1.5].

[6.4] wherein when the number of MU-MIMO users indicates two or more users, the user specific field of the HE-SIG-B includes user fields for MU-MIMO allocation, and

184. *See, supra*, §X.C.3.[1.6].

[6.5] wherein when the number of MU-MIMO users indicates a single user, the user specific field of the HE-SIG-B includes one user field for non-MU-MIMO allocation.

185. See, *supra*, §X.C.3.[1.7].

9. Claim 7

[7pre] The wireless communication method of claim 6,

[7.1] wherein the user field(s) for MU-MIMO allocation includes a spatial configuration field indicating the total number of spatial streams in an MU-MIMO allocation and the number of spatial streams for each terminal in the MU-MIMO allocation, and

186. See, *supra*, X.C.4.[2.1].

[7.2] wherein the user field for non-MU-MIMO allocation includes a number of space time streams (NSTS) field.

187. See, *supra*, X.C.4.[2.2].

10. Claim 8

[8] The wireless communication method of claim 6, wherein the user field(s) for non-MU-MIMO allocation is a user field based on orthogonal frequency divisional multiple access (OFDMA) allocation.

188. *See, supra*, §X.C.5 (claim 3).

11. Claim 9

[9] The wireless communication method of claim 6, wherein the number of MU-MIMO users is indicated by a number of HE-SIG-B symbols field in the HE-SIG-A.

189. *See, supra*, X.C.5 (claim 4).

XI. CONCLUSION

190. For all the reasons I have noted in the foregoing paragraphs, claims 1-9 of the '210 Patent are obvious in view of the references discussed above.

191. I currently hold the opinions set expressed in this declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

APPENDIX A

CHRISTOPHER J. HANSEN

1701 Penny Way
Los Altos, CA 94024

(650) 282-0215 (cell)
(408) 899-8298 (office)
chris@covariantcorp.com

I. SUMMARY

- Senior electrical engineer - more than 25 years in industry plus Ph.D. (UCLA 1997).
- Named inventor on more than 125 issued patents, including many related to IEEE802.11/Wi-Fi and Bluetooth wireless standards.
- Technical skills encompass wireless network physical layer (PHY) design, systems engineering, communication theory, integrated circuit (IC) design, signal processing, RF/microwave systems, intellectual property, and standardization.
- Experience with multiple successful product developments (802.11 WLAN chipsets and cellular base-station systems), research in new technologies (802.11n MIMO and 60 GHz), and leading standards bodies (IEEE 802.11, Bluetooth SIG, Wireless Gigabit Alliance).

II. EXPERIENCE

Covariant Corporation, Los Altos, California

President

August 2013 – present

- Consulting in wireless communication systems, signal processing, standards, and intellectual property.
- Recent clients include Octoscope, Google, and Peraso Technologies.
- Example projects:
 - Developed and executed IEEE 802.11 standards strategy for a technology startup company. Led standards participation in industry special interest group and IEEE 802.11ay and 802.11md task groups. Developed simulations in Matlab to support standards contributions.

- Developed Matlab tools to predict mmwave system performance including impact of cascade non-linearities and temperature variations.
- Analyzed patent portfolio for potential standards related patents related to IEEE 802.11 standards and Wi-Fi Alliance specifications. Developed claim charts for appropriate patents.
- Developed Matlab simulation tools as part of technical support for patent litigation. Analyzed performance benefits of physical layer features in IEEE 802.11 standards.
- Reviewed C, assembler, Verilog, and VHDL code for technical support in patent litigation.
- Developed and prototyped novel radar detection algorithms in Matlab and C for specialized radio receiver,

Apple, Cupertino, California

Senior Wireless System Architect

June 2012 – July 2013

- Analysis of 802.11 wireless networks for iOS products.

Broadcom Corporation, Sunnyvale, California

Associate Technical Director, Office of the CTO

March 2011 – May 2012

Senior Principal Scientist, Office of the CTO

March 2007 - March 2011

Principal Scientist, Office of the CTO

March 2006 - March 2007

Engineering Manager, Wireless LAN Business Unit

June 2004 - March 2006

Senior Staff Scientist, Wireless LAN Business Unit

January 2000 - June 2004

- Analysis and development of new wireless networking technologies for application to WiGig (60 GHz wireless), WirelessHD, Bluetooth, Wimedia Ultrawideband, IEEE 802.11, and 802.15 systems. Investigation of inter-networking, antenna systems, beamforming techniques, signal processing and advanced devices employing multiple wireless technologies.
- Secretary, board member, and vice chair of the Technical Working Group of the Wireless Gigabit Alliance.
- Vice chair of the IEEE 802.11ad (60 GHz MAC/PHY) task group.
- Developed BT/802.11 technology and co-chaired the Bluetooth SIG 802.11 AMP (Alternate MAC/PHY) Study Group. The resulting specification was the hallmark feature of the Bluetooth 3.0 release.
- Developed significant intellectual property related to wireless networks and contributed to the management of company patent portfolio through patent review committee.

- Project manager and lead physical layer (PHY) systems engineer for 802.11n proposal to the IEEE. Key elements of this proposal and further contributions became the basis of the IEEE 802.11n standard including MIMO-OFDM physical layer and enhanced MAC layer for higher throughput wireless networks. Made contributions in the areas of preamble design, advanced channel coding, MIMO-OFDM, channel estimation, and multiple antenna beamforming. (See: https://en.wikipedia.org/wiki/IEEE_802.11n-2009)
- Led Broadcom effort to standardize power control and dynamic frequency selection for wireless networks in IEEE 802.11 Task Group H. Proposal is now part of 802.11h standard. (See: https://en.wikipedia.org/wiki/IEEE_802.11h-2003)
- System engineering for 802.11a/b/g wireless local area network chipsets, including analysis of radio and base-band dsp architectures for the physical layer design. Developed signal processing algorithms, channel models, radio system models, and laboratory radios.
- Designed and developed MATLAB and bit accurate C models for the physical layers of 802.11 WLAN chipsets. These included models for equalizers, convolutional coders/decoders, beamforming, nonlinear distortion in radio transceivers, and radio channels.
- Analyzed and debugged first silicon versions of commercially successful 802.11a/b/g integrated circuit products.
- Developed radar detection and dynamic frequency selection hardware and software for 802.11a chipsets to meet ETSI (European) and FCC (U.S.) regulations.

Excess Bandwidth Corporation (now Conexant), Santa Clara, California

Principal Systems Engineer

1998–1999

- System engineering and architecture for HDSL2/G.shdsl digital subscriber line modems, including MATLAB and C code to simulate equalizers, error correcting codes, timing recovery, digital phase locked loops, waiting time jitter, and performance in crosstalk.
- Developed DSP software in C and assembler (TI C6x) for prototype HDSL2/G.shdsl modem. Implemented modules for adaptive equalization, timing recovery, and activation frame handshake.

Amati Communications Corporation (now Texas Instruments)

San Jose, California

Senior Research Engineer

1997-1998

- Developed, analyzed, and implemented advanced equalizer training algorithms for discrete multi-tone (DMT) based asymmetric digital subscriber line (ADSL) models.

AT&T Bell Laboratories, Whippany, New Jersey

Member of Technical Staff

1990-1992

- Developed RF and analog circuit designs for AT&T Autoplex 1000 fiber optic micro-cell radio transceiver.
- Managed testing group and developed test program for high power 900 MHz feed-forward linear amplifier used in cellular telephone base stations.

MIT Lincoln Laboratory, Lexington, Massachusetts

Member of Technical Staff

1989-1990

- Developed signal processing software and RF hardware for experimental X-band and Ka-band radar.
- Conducted radar measurements at Lincoln Laboratory sites in Lexington, MA and Kwajalein Atoll, U.S. Marshall Islands.

III. LITIGATION EXPERIENCE

- NXP B.V. v. Broadcom Corp., No. 5:14-cv-826 (N.D. Cal.). Retained on behalf of Broadcom.
- Linex Techs., Inc. v. Hewlett-Packard Co. et al., No. 4:13-cv-00159 (N.D. Cal.). Retained on behalf of Broadcom.
- TomTom Int'l, B.V. v. Broadcom Corp., No. 8:14-cv-475 (C.D. Cal.). Retained on behalf of Broadcom.
- Certain Electronics Products, Including Products with Near-Field Communication ("NFC") System-Level Functionality and/or Battery Power-Up Functionality, Components Thereof, and Products Containing Same, No. 337-TA-950 (ITC). Retained on behalf of Dell.
- NXP B.V. et al. v. Dell Inc., No. 1:14-cv-00146 (D. Del.). Retained on behalf of Dell.
- California Institute of Tech. v. Broadcom Ltd. et al., No. 2:16-cv-3714 (C.D. Cal.). Retained on behalf of Broadcom. Deposed.
- Nokia Techs. Oy et al. v. Apple Inc., Nos. 2:16-cv-1440, 2:16-cv-1441 (E.D. Tex.). Retained on behalf of Apple Inc.

- Certain Electronic Devices, Including Mobile Phones, Tablet Computers, and Components Thereof, Nos. 337-TA-1038, 337-TA-1039 (ITC). Retained on behalf of Apple Inc.
- Ruckus Wireless, Inc., Belkin International, Inc., Amazon.com, Inc., Netgear, Inc., and Roku, Inc. v. Hera Wireless S.A., U.S. Patent and Trademark Office *Inter Partes Review*. Retained on behalf of Ruckus Wireless (Arris, Inc.).
- Certain Mobile Electronic Devices and Radio Frequency and Processing Components Thereof, Inv. No. 3337-TA-1065; Qualcomm Inc. v. Apple Inc, Civ. Action No. 3:17-cv-01375-JAH-MDD. Retained on behalf of Apple.
- VLSI Technology LLC v. Intel Corporation, No. 1:18-cv-00966 (Delaware). Retained on behalf of Intel Corporation.
- Nokia Techs. Oy v. Lenovo (Shanghai) Elects. Tech. Co. Ltd, et al., No. 5:19-cv-427 (E.D.N.C.) and In re Certain Electronic Devices, Including Computers, Tablet Computers, and Components and Modules Thereof, Inv. No. 337-TA-1208 (U.S.I.T.C). Retained on behalf of Lenovo.
- Koss Corporation v. Apple, Inc, No. 6:20-cv-00665 (W.D. Texas). Retained on behalf of Apple, Inc. Deposed.
- Aegis 11 S.A. v. Hisense Company, Ltd. and Hisense USA Corporation, No. 1:20-cv-03891 (N.D. Georgia). Retained on behalf of Hisense.
- Mediatek, Inc. v. NXP Semiconductors, No. 2:21-cv-04970 (C.D. California), In the Matter of Certain Integrated Circuits And Products Containing Same, Inv. No. 337-TA-1272. Retained on behalf of NXP. Deposed. Testified at evidentiary hearing.
- One-E-Way, Inc. v. Apple Inc., No. 2:20-cv-06339-JAK-PD (C.D. Cal.)
- NXP Semiconductors v. Mediatek, Inc. In the Matter of Certain Integrated Circuits And Products Containing Same, Inv. No. 337-TA-1287. Retained on behalf of NXP. Deposed.
- Intellectual Ventures v. General Motors, No. 6:21-cv-1088 (W.D. Texas). Retained on behalf of General Motors.
- XR Communications, LLC v. Hewlett Packard, 6:21-cv-00694 (W.D. Texas). Retained on behalf of Hewlett Packard.
- American Patents, LLC v. Marvell Semiconductors, 6:22-cv-771 (W.D. Texas). Retained on behalf of Marvell Semiconductors.
- TexasLDPC, Inc. v. Broadcom, C.A. No. 18-1966-SB (Delaware). Retained on behalf of Broadcom.

- Atlas Global Technologies v. OnePlus, 6:21-cv-01217-ADA. Retained on behalf of OnePlus.
- LG Electronics Inc. v. TCL Electronics Holding Ltd., 2:22-cv-122-JRG. Retained on behalf of LG Electronics Inc.
- Atlas Global Technologies v. TP-Link, 2:21-cv-430-JRG. Retained on behalf of TP-Link. Deposed. Testified at Trial.
- Panasonic Automotive Systems Co., Ltd. v. UNM Rainforest Innovations, U.S. Patent and Trademark Office *Inter Partes Review*. Retained on behalf of Panasonic.
- Intellectual Ventures I, LLC v. Ubiquiti, Inc., C.A. No. 23-cv-00865-GBW. Retained on behalf of Ubiquiti.
- Motorola Mobility LLC v. Ericsson AB, Certain Cellular Base Station Communications Equipment Components Thereof, And Products Containing Same. ITC 337-TA-. Retained on behalf of Ericsson.

IV. EDUCATION

Ph.D., Electrical Engineering University of California, Los Angeles Dissertation: <i>Probing Techniques for Multiuser Channels with Power Control</i> Research Area: Wireless and Digital Communications Advisor: Gregory J. Pottie	1997
M.S., Electrical Engineering University of Massachusetts, Amherst Concentration: Signal Processing and Microwave Systems	1989
B.S., Electrical Engineering Rensselaer Polytechnic Institute	1987

V. HONORS AND AFFILIATIONS

- Institute of Electrical and Electronics Engineers (IEEE) Senior Member.
- Member, Society for Industrial and Applied Mathematics.
- Reviewer, IEEE Communications Magazine, 2014 - present.
- Board of Directors, PATCA - Professional and Technical Consultants Association, Silicon Valley, 2007 - present.
- Vice Chair, IEEE 802.11ad Task Group, 2011-2012.
- Secretary, Wireless Gigabit Alliance, 2010-2012.
- Rockwell graduate fellowship recipient, UCLA, 1992-1996.
- Eta Kappa Nu, Electrical Engineering Honor Society, Rensselaer Polytechnic Institute, 1987.

VI. SKILLS

- Architecture and analysis of wireless digital communication systems, including 802.11a/b/g/n/ac/ad/ax/ay, Bluetooth, Wimedia UWB, WirelessHD, and WiGig.

- DSP Programming (TI TMS320C62x and 320C5x) in C and assembler and general programming in C++, C, Matlab, and Python.
- RF/microwave/mmwave laboratory and over-the-air channel measurements.
- Extra class Amateur Radio license (W6COV) and Commercial General Radiotelephone license.

VII. PUBLICATIONS

C. J. Hansen, “Semi-blind Channel Estimation on 802.11 OFDM Data Symbols”, International Conference on Computing, Networking and Communications (ICNC 2024), February 2024.

A. Tompkins, et al, “A 16-Element Phased-Array Transceiver in 130-nm SiGe BiCMOS for Fixed Wireless Access Covering the Full 57-71 GHz Band”, IEEE Radio and Wireless Symposium (RWS), January 2020.

C. J. Hansen, “Internetworking with Bluetooth Low Energy”, ACM GetMobile, Vol 19, Issue #2, April 2015.

C. J. Hansen, “WiGig – Multigigabit Wireless Communication in the 60 GHz Band”, IEEE Communications Magazine, December 2011.

C. J. Hansen and G. J. Pottie, “A Distributed Access Algorithm for Cellular Personal Communication Systems with Channel Partitioning”, IEEE Transactions on Vehicular Technology, January 1999.

C. J. Hansen and G. J. Pottie, “Distributed Access Control in Wireless and Wireline Systems,” International Symposium on Information Theory, Whistler, B.C., 1995.

C. J. Hansen, C. C. Wang, and G. J. Pottie, “Distributed Dynamic Channel Resource Allocation in Wireless Communication Systems”, Asilomar Conference on Signals, Systems, and Computers, 1994.

VIII. PATENTS

Named inventor on the following United States patents:

<i>US Patent Number</i>	<i>Patent Title</i>
11,297,625	Method, system and apparatus for signaling station capabilities to establish wireless connections
11,121,818	Method and apparatus for unsolicited block acknowledgements
10,886,975	Single-carrier wideband beamforming method and system
10,820,328	Method and apparatus for de-centralized spatial reuse in wireless communications systems
10,784,990	Method and apparatus for encoding and modulating data for wireless transmission
10,735,133	Method and apparatus for configurable MIMO processing in wireless communications
10,716,117	Method, system and apparatus for signaling station capabilities to establish wireless connections
10,681,632	System and method for low power signaling in a wireless local area network
10,630,359	Method and apparatus for beamforming training using frames
10,498,419	Method and apparatus for determining direction for transmission to establish wireless connections
10,243,635	Method and apparatus for beamforming training using frames
10,236,964	Method and apparatus for beamforming training in basic service set discovery
10,110,273	Interference mitigation in wireless communication systems
10,015,741	System and method for low power signaling in a wireless local area network
9,960,865	Filtering of Wi-Fi physical layer measurements
9,949,227	Location determination
9,680,563	System and method for partial bandwidth communication
9,596,637	Dynamically adapting wireless communication
9,826,373	WLAN transmitter having high data throughput
9,622,216	Method and system for low rate MAC/PHY for 60 GHz transmission
9,516,483	Wireless communication between stations of differing protocols
9,356,673	Communication device incorporating beamforming handshaking
9,344,535	Multiple protocol wireless communications in a WLAN
9,307,350	Protocol adaptation layer for wireless communications
9,300,368	Method and system for 60 GHz antenna adaptation and user coordination based on base station beacons
9,247,439	High data throughput wireless local area network receiver

9,241,331	Method and system for optimal beamforming in wireless networks
9,198,035	Simple pairing to generate private keys for different protocol communications
9,130,705	Transmitting high rate data within a MIMO WLAN
9,104,569	Method and apparatus for signal detection and decoding
9,037,092	Method, apparatus and computer program for determining whether a received signal comprises a first signal component
9,025,491	High speed data transmission utilizing a high frequency physical layer for a wireless personal area network device
8,996,949	Encoding system and method for a transmitter in wireless communications
8,965,431	Multimode control device for allocating resources to communication devices that use differing protocols and methods for use therewith
8,964,895	WLAN transmitter having high data throughput
8,964,521	Method and system for compromise greenfield preambles for 802.11N
8,929,317	Transmission of wide bandwidth signals in a network having legacy devices
8,917,676	Device and method for transmitting long training sequence for wireless communications
8,909,272	Control device for allocating resources to communication devices that use differing protocols and methods for use therewith
8,897,320	High data throughput WLAN frame format
8,892,056	Protocol adaptation layer for wireless communications
8,891,642	Mixed mode preamble for MIMO wireless communications
8,805,277	Method and system for Bluetooth 802.11 alternate MAC/PHY (AMP) transmit power control (TPC)
8,804,685	Dual mode operation in a wireless network
8,774,327	Adjustable RF receiver
8,750,252	Long training sequence method and device for wireless communications
8,743,994	Feedback of channel information in a closed loop beamforming wireless communication system
8,737,189	Method and system for compromise greenfield preambles for 802.11n
8,725,101	Wireless device and method of operation
8,644,770	Protocol adaptation layer for wireless communications
8,644,284	Dual mode operation in a wireless network
8,638,263	Platform enhancements for planar array antennas
8,634,777	Pairing with directional code sequence
8,630,367	Signaling format for wireless communications

8,620,368	Method and system for 60 GHz antenna adaptation and user coordination based on base station beacons
8,611,821	Communication device that detects and adapts to the presence of other devices and methods for use therewith
8,588,283	Method and system for frame formats for MIMO channel measurement exchange
8,577,416	Transceiver with plural space hopping array antennas and methods for use therewith
8,576,695	Preamble formats for MIMO wireless communications
8,553,659	Method and system for optimal beamforming in wireless networks
8,548,087	Long training sequence for MIMO WLAN systems
8,520,669	High data throughput wireless local area network receiver
8,437,419	Method and system for frame formats for MIMO channel measurement exchange
8,437,362	Asymmetrical MIMO wireless communications
8,407,556	LDPC (low density parity check) coding and interleaving implemented in MIMO communication systems
8,406,204	Transmission of wide bandwidth signals in a network having legacy devices
8,385,844	Transceiver with plural space hopping phased array antennas and methods for use therewith
8,369,784	High speed data transmission utilizing a high frequency physical layer for a wireless personal area network device
8,363,642	High data throughput wireless local area network receiver
8,351,399	MIMO wireless communication greenfield preamble formats
8,345,732	Feedback of channel information in a closed loop beamforming wireless communication system
8,320,877	Method and system for 60 GHz location determination and coordination of WLAN/WPAN/GPS multimode devices
8,284,867	Mixed mode preamble for MIMO wireless communications
8,284,651	Preamble formats for MIMO wireless communications
8,265,185	Method and system for encoding a signal for wireless communications
8,254,407	Asymmetrical MIMO wireless communications
8,233,565	Method and system for high speed wireless data transmission between communication devices
8,213,395	Method and system for dual mode operation in wireless networks
8,195,092	Method and system for utilizing a high frequency PHY layer for high speed data transmission between wireless devices
8,190,162	Radar detection circuit for a WLAN transceiver
8,184,679	RF transceiver having adaptive modulation

8,176,380	Algebraic construction of LDPC (low density parity check) codes with corresponding parity check matrix having CSI (cyclic shifted identity) sub-matrices
8,175,542	Transceiver with plural space hopping phased array antennas and methods for use therewith
8,170,504	Modified preamble for programmable transmitter
8,170,496	Transceiver with space hopping phased array antenna and methods for use therewith
8,170,495	Collaborative pairing transceiver with space hopping phased array antenna and methods for use therewith
8,169,998	Method and system for an AD HOC wireless network with master control of network parameters
8,144,798	Long training sequence for MIMO WLAN systems
8,126,425	Method and system for 60 GHZ location determination based on varying antenna direction and coordination of WLAN/WPAN/GPS multimode devices
8,095,162	Control device for allocating resources to communication devices that use differing protocols and methods for use therewith
8,094,749	Signaling format for wireless communications
8,089,890	Transmitting high rate data within a MIMO WLAN
8,085,871	Adaptive modulation in a multiple input multiple output wireless communication system with optional beamforming
8,081,926	Method and system for multisession communication using multiple physical (PHY) layers
8,081,104	Radar detection circuit for a WLAN transceiver
8,077,810	Apparatus for high data throughput reception in a WLAN
8,059,740	WLAN transmitter having high data throughput
8,041,333	Method and system for 60 GHz antenna adaptation and user coordination based on base station beacons
8,032,167	Multimode control device for allocating resources to communication devices that use differing protocols and methods for use therewith
8,031,806	Mixed mode preamble for MIMO wireless communications
7,995,667	Reduced latency concatenated reed solomon-convolutional coding for MIMO wireless LAN
7,991,056	Method and system for encoding a signal for wireless communications
7,991,009	Preamble formats for MIMO wireless communications
7,978,729	High data throughput WLAN frame format
7,974,591	Modified preamble for programmable transmitter
7,957,450	Method and system for frame formats for MIMO channel measurement exchange
7,940,751	Personal area network data encapsulation in WLAN communications

7,924,943	Method and system for optional closed loop mechanism with adaptive modulations for multiple input multiple output (MIMO) wireless local area network (WLAN) system
7,920,526	Long training sequence method and device for wireless communications
7,912,449	Method and system for 60 GHz location determination and coordination of WLAN/WPAN/GPS multimode devices
7,894,852	Channel reciprocity matrix determination in a wireless MIMO communication system
7,873,022	Multiple input multiple output wireless local area network communications
7,865,142	Method and system for multisession bluetooth communication using multiple physical (PHY) layers
7,840,184	Method and system for utilizing a 60 GHZ PHY layer for high speed data transmission between bluetooth devices
7,826,547	Mixed mode preamble for MIMO wireless communications
7,801,098	Parallel MAC/PHY for enhanced transmission rate in a wireless network
7,796,696	Asymmetrical multiple stream wireless communication using STBC
7,773,565	MIMO wireless communication greenfield preamble formats
7,746,886	Asymmetrical MIMO wireless communications
7,702,291	Radar detection from pulse record with interference
7,701,382	Radar detection circuit for a WLAN transceiver
7,680,059	Multiple protocol wireless communications in a WLAN
7,617,439	Algebraic construction of LDPC (Low Density Parity Check) codes with corresponding parity check matrix having CSI (Cyclic Shifted Identity) sub-matrices
7,593,692	Radar detection circuit for a WLAN transceiver
7,590,429	RF transceiver configuring for a MIMO communication
7,590,189	Signaling format for wireless communications
7,586,881	MIMO wireless communication greenfield preamble formats
7,583,933	Dynamic frequency selection in a wireless communication network
7,570,619	Long training sequence method and device for wireless communications
7,564,914	Method and system for frame formats for MIMO channel measurement exchange
7,558,537	Modified preamble for programmable transmitter
7,555,053	Long training sequence for MIMO WLAN systems
7,539,501	High data throughput wireless local area network receiver
7,516,390	LDPC (Low Density Parity Check) coding and interleaving implemented in MIMO communication systems
7,502,408	RF transceiver having adaptive modulation

7,466,773	WLAN receiver having an iterative decoder
7,444,134	Device and method for transmitting long training sequence for wireless communications
7,423,989	Preamble formats for MIMO wireless communications
7,417,974	Transmitting high rate data within a MIMO WLAN
7,400,643	Transmission of wide bandwidth signals in a network having legacy devices
7,330,501	Orthogonal normalization for a radio frequency integrated circuit
7,324,785	Transmit power control of wireless communication devices
7,269,430	Frame format for high data throughput wireless local area network transmissions
7,242,961	Channel reciprocity matrix determination in a wireless MIMO communication system
7,233,773	Configuring a MIMO communication
7,162,204	Configurable spectral mask for use in a high data throughput wireless communication
7,158,759	Dynamic frequency selection in a wireless communication network
7,020,220	Digital estimation and correction of I/Q mismatch in direct conversion receivers