

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INTEL CORPORATION,

Petitioner

v.

AX Wireless LLC,

Patent Owner.

IPR 2023–01144

U.S. Patent No. 9,614,566

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 9,614,566**

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EXHIBIT LIST

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1001	U.S. Patent No. 9,614,566 (“the ’566 patent”)
1002	File History of the ’566 patent
1003	Declaration of Dr. Thomas La Porta in Support of <i>Inter Partes Review</i> of U.S. Patent 9,614,566
1004	Curriculum Vitae of Dr. Thomas La Porta
1005	IEEE 802.11-05/0149r5, <i>WWiSE Proposal: High Throughput Extension to the 802.11 Standard</i> to Kose, et al, uploaded and publicly available on July 9, 2005 (“WWiSE”)
1006	U.S. Patent Publication No. 2006/0182017 to Hansen et al. (“Hansen”)
1007	Declaration of James L. Lansford, Ph.D.
1008	U.S. Provisional Application 61/235,909 (“the ’909PROV”)
1009	U.S. Patent 8,737,189 to Hansen, et al (“Hansen Patent”)
1010	U.S. Provisional Application 60/653,429 (“Hansen Provisional”)
1011	IEEE 802.11-04/0889r3, <i>TGn Sync Proposal Technical Specification</i> , to Mujtaba, uploaded and publicly available on January 20, 2005 (“TGn Sync”)
1012	IEEE 802.11-04/0886r6, <i>WWiSE Proposal: High Throughput Extension to the 802.11 Standard</i> , to Hansen, et al, uploaded and publicly available on January 6, 2005 (“January 2005 WWiSE”)
1013	IEEE Std. 802.11a-1999, <i>Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications: High-Speed Physical Layer in the 5 GHz Band</i> , approved September 16, 1999 (“802.11a”)
1014	Declaration of David Ringle
1015	Heiskala, et al., <i>OFDM Wireless LANs: A Theoretical and Practical Guide</i> (Sams Publishing 2002) (“Heiskala”)
1016	Tse, et al., <i>Fundamentals of Wireless Communication</i> (Cambridge University 2005) (“Tse”)

Exhibit	Reference
1017	U.S. Publication No. 2010/0260159 to Zhang et al. (“Zhang”)
1018	U.S. Patent No. 7,349,436 to Maltsev et al. (“Maltsev”)
1019	U.S. Provisional Application 61/229,900 (“the ’900PROV”)
1020	<i>IEEE 100: The Authoritative Dictionary of IEEE Standard Terms</i> (IEEE 7th ed., 2000)
1021	R. Van Nee, et al., <i>OFDM for Wireless Multimedia Communications</i> , Artech House Publishers (2000) (“Van Nee”)
1022	B. Sklar, <i>Digital Communications: Fundamentals and Applications</i> (2d ed. 2001) (“Sklar”)
1023	M. Gast, <i>802.11 Wireless Networks: The Definitive Guide</i> (O’Reilly, 2002) (“Gast”)
1024	Aware, <i>G.hn: PHY-Frame Header Extension</i> , 09CC-046, Concord, CA, as filed in file wrapper of the ’566 patent
1025	CopperGate Communication, <i>G.hn: Using Two Symbols for the Header of a PHY frame on Coax</i> , ITU-T SG15/Q4, 09XC-100, Xian, China July 2009, as filed in file wrapper of the ’566 patent
1026	Intellon Corporation, <i>G.hn: Extended PHY frame header</i> , ITU-T SG15/Q4, 09XC-119, Xian, China, July 2009, as filed in file wrapper of the ’566 patent
1027	B. O’Hara et al., <i>802.11 Handbook: A Designer’s Companion</i> (IEEE 1999) (“O’Hara”)
1028	Editor for G.9960, <i>ITU-T Recommendation G.9960 Next Generation Wire-line Based Home Networking Transceivers-Foundation</i> , ITU-T SG15/Q4, January 2009, as filed in file wrapper of the ’566 patent
1029	IEEE 802.11-04/422r4, <i>New Participant Orientation</i> , presentation submission (July 2004) (Appendix A to Lansford Declaration, IEEE 802wirelessworld website, “New Participant Orientation” slides, available at https://mentor.ieee.org/802.11/dcn/04/11-04-0422-04-0000-new-participantorientation.ppt (Appendix A to INTEL-1007)
1030	IEEE 802.11-04/736r1, <i>Approved Minutes of the IEEE P802.11 Full Working Group</i> , Minutes (July 2004) (Appendix B to

Exhibit	Reference
	Lansford Declaration, INTEL-1007) IEEE 802wirelessworld website, July 2004 Meeting Minutes, available at http://grouper.ieee.org/groups/802/11/Minutes/Cons_Minutes_July-2004.pdf (Appendix B to INTEL-1007).
1031	U.S. Patent 7,415,074 (Appendix C to INTEL-1007)
1032	A. Stephens, <i>802.11 “Decrypted”</i> , ACM SIGCOMM Computer Communication Review, Vol. 35, No. 2 (April 2005) (“Stephens Paper”) (Appendix D to Lansford Declaration, INTEL-1007).
1033	Lörincz, et al, <i>Physical Layer Analysis of Emerging IEEE 802.11n WLAN Standard</i> , 8th International Conference Advanced Communication Technology (February 20-22, 2006); added to IEEE Xplore May 8, 2006
1034	Cox, <i>Stage Set for Compromise on IEEE High-Speed Wireless</i> , Network World (March 21, 2005)
1035	Kay, <i>Sidebar: The Battle for 11n</i> , ComputerWorld (March 13, 2006)
1036	“WWiSE” Consortium, <i>Motorola Team on Proposal for IEEE 802.11n</i> , Wireless Design Online (February 24, 2005)
1037	WWiSE Industry Organization press release, “ <i>WWiSE” Consortium and Motorola Team to Offer Enhanced Proposal for IEEE 802.11n</i> (February 24, 2005); <i>archived</i> on April 6, 2005 at https://web.archive.org/web/20050406073808/http://www.wwise.org/presreleasefeb23.htm .
1038	Bahai, et al., <i>Multi-Carrier Digital Communications theory and Applications of OFDM</i> , (Springer 2004)

TABLE OF ABBREVIATIONS

Abbreviation	Meaning
AP	access point
BSS	basic service set
ER	extended range
FFT	fast Fourier transform
GHz	gigahertz
HT	high throughput
IEEE	Institute of Electrical and Electronics Engineers
IFFT	inverse fast Fourier transform
MAC	media access control
MCS	modulation and coding scheme
MHz	megahertz
MIMO	multiple-input multiple-output
NR	normal range
OFDM	orthogonal frequency division multiplexing
PHY	physical layer
PLCP	PHY layer convergence protocol
PPDU	physical layer protocol data unit
PSDU	PLCP Service Data Unit
RX	receive
STA	station
TX	transmit
WLAN	wireless local area network

APPENDIX OF CHALLENGED CLAIMS

Challenged Claim	Limitation
[1Pre]	<i>A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:</i>
[1A]	<i>a modulator operable to modulate a first number of OFDM symbols to transmit a first plurality of header bits in a first packet, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;</i>
[1B]	<i>a wireless OFDM communications transmitter, connected to and in communication with the modulator, operable to transmit in a first narrower frequency band, the first packet comprising the first number of OFDM symbols;</i>
[1C]	<i>the modulator further operable to modulate a second number of OFDM symbols to transmit a second plurality of header bits in a second packet, wherein the second number of OFDM symbols is less than the first number of OFDM symbols and wherein the second plurality of header bits is different than the first plurality of header bits; and</i>
[1D]	<i>the wireless OFDM communications transmitter further operable to transmit in a second wider frequency band, the second packet comprising the second number of OFDM symbols,</i>
[1E]	<i>wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.</i>
2	<i>The wireless transceiver of claim 1, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.</i>

Challenged Claim	Limitation
3	<i>The wireless transceiver of claim 1, wherein the at least one repeated header bit provides diversity to increase a likelihood of correctly communicating header information of the first packet in the first narrower frequency band.</i>
4	<i>The wireless transceiver of claim 1, wherein the second wider frequency band is two times wider than the first narrower frequency band.</i>
5	<i>The wireless transceiver of claim 1, wherein the second wider frequency band is four times wider than the first narrower frequency band.</i>
6	<i>The wireless transceiver of claim 1, wherein the second wider frequency band is eight times wider than the first narrower frequency band.</i>
7	<i>The wireless transceiver of claim 1, wherein a first OFDM symbol in the first packet contains different header bits than a second OFDM symbol in the first packet.</i>
8	<i>The wireless transceiver of claim 1, wherein a first OFDM symbol in the first packet contains the first plurality of header bits and a second OFDM symbol in the first packet contains the first plurality of header bits.</i>
10	<i>The wireless transceiver of claim 1, wherein the wireless transceiver supports one or more wireless standards.</i>
[11Pre]	<i>A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:</i>

Challenged Claim	Limitation
[11A]	<i>a modulator operable to modulate a first number of OFDM symbols to transmit a first header portion of a first packet, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;</i>
[11B]	<i>a wireless OFDM communications transmitter, connected to the modulator, operable to transmit the first packet in a first narrower frequency band, wherein the first packet comprises the first header portion transmitted on the first number of OFDM symbols;</i>
[11C]	<i>the modulator further operable to modulate a second number of OFDM symbols to transmit a second header portion of a second packet; and</i>
[11D]	<i>the wireless OFDM communications transmit further operable to transmit the second packet in a second wider frequency band, wherein the second number of OFDM symbols is less than the first number of OFDM symbols and wherein the second header portion is different than the first header portion,</i>
[11E]	<i>wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.</i>
12	<i>The wireless transceiver of claim 11, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.</i>
13	<i>The wireless transceiver of claim 11, wherein the at least one repeated header bit provides diversity to increase a likelihood of correctly communicating header information of the first packet in the first narrower frequency band.</i>
14	<i>The wireless transceiver of claim 11, wherein the second wider frequency band is two times wider than the first narrower frequency band.</i>

Challenged Claim	Limitation
15	<i>The wireless transceiver of claim 11, wherein the second wider frequency band is four times wider than the first narrower frequency band.</i>
16	<i>The wireless transceiver of claim 11, wherein the second wider frequency band is eight times wider than the first narrower frequency band.</i>
17	<i>The wireless transceiver of claim 11, wherein a first OFDM symbol in the first packet contains different header bits than a second OFDM symbol in the first packet.</i>
18	<i>The wireless transceiver of claim 11, wherein a first OFDM symbol in the first packet contains the first plurality of header bits and a second OFDM symbol in the first packet contains the first plurality of header bits.</i>
20	<i>The wireless transceiver of claim 11, wherein the wireless transceiver supports one or more wireless standards.</i>
[21Pre]	<i>A method of operating a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:</i>
[21A]	<i>modulating, by a modulator, a first number of OFDM symbols to transmit a first plurality of header bits in a first packet, wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers;</i>
[21B]	<i>transmitting, in a first narrower frequency band, by a transmitter using wireless OFDM communications, the transmitter connected to and in communication with the modulator, the first packet comprising the first number of OFDM symbols;</i>

Challenged Claim	Limitation
[21C]	<i>modulating, by the modulator, a second number of OFDM symbols to transmit a second plurality of header bits in a second packet, wherein the second number of OFDM symbols is less than the first number of OFDM symbols and wherein the second plurality of header bits is different than the first plurality of header bits; and</i>
[21D]	<i>transmitting, in a second band wider frequency band, by the transmitter using wireless OFDM communications, the second packet comprising the second number of OFDM symbols,</i>
[21E]	<i>wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.</i>
22	<i>The method of claim 21, wherein a first OFDM symbol of the first packet contains different header bits than a second OFDM symbol of the first packet.</i>
23	<i>The method of claim 21, wherein a first OFDM symbol of the first packet contains the first plurality of header bits and a second OFDM symbol of the first packet contains the first plurality of header bits.</i>
25	<i>The method of claim 21, wherein the wireless transceiver supports one or more wireless standards.</i>
26	<i>The method of claim 21, wherein the second wider frequency band is two times wider than the first narrower frequency band.</i>
27	<i>The method of claim 21, wherein the second wider frequency band is four times wider than the first narrower frequency band.</i>

Challenged Claim	Limitation
28	<i>The method of claim 21, wherein the second wider frequency band is eight times wider than the first narrower frequency band.</i>
29	<i>The method of claim 21, the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.</i>
30	<i>The method of claim 21, wherein the at least one repeated header bit provides diversity to increase a likelihood of correctly communicating header information of the first packet in the first narrower frequency band.</i>
[31Pre]	<i>A method in a wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:</i>
[31A]	<i>modulating, by a modulator, a first number of OFDM symbols to transmit a first header portion of a first packet, wherein at least one header bit of the first header portion in the first packet is repeated on a plurality of OFDM subcarriers;</i>
[31B]	<i>transmitting, by a wireless OFDM communications transmitter, connected to the modulator, the first packet in a first narrower frequency band, wherein the first packet comprises the first header portion transmitted on the first number of OFDM symbols;</i>
[31C]	<i>modulating, by the modulator, a second number of OFDM symbols to transmit a second header portion of a second packet; and</i>
[31D]	<i>transmitting, by the wireless OFDM communications transmit, the second packet in a second wider frequency band, wherein the second number of OFDM symbols is less than the first number of OFDM symbols and wherein the second header portion is different than the first header portion,</i>

Challenged Claim	Limitation
[31E]	<i>wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.</i>
32	<i>The method of claim 31, wherein the at least one repeated header bit increases reliability of the first packet in the first narrower frequency band.</i>
33	<i>The method of claim 31, wherein the at least one repeated header bit provides additional diversity to increase a likelihood of correctly communicating header information of the first packet in the first narrower frequency band.</i>
34	<i>The method of claim 31, wherein the second wider frequency band is two times wider than the first narrower frequency band.</i>
35	<i>The method of claim 31, wherein the second wider frequency band is four times wider than the first narrower frequency band.</i>
36	<i>The method of claim 31, wherein the second wider frequency band is eight times wider than the first narrower frequency band.</i>
37	<i>The method of claim 31, wherein a first OFDM symbol in the first packet contains different header bits than a second OFDM symbol in the first packet.</i>
38	<i>The wireless method of claim 31, wherein a first OFDM symbol in the first packet contains the first plurality of header bits and a second OFDM symbol in the first packet contains the first plurality of header bits.</i>

Challenged Claim	Limitation
40	<i>The method of claim 31, wherein the wireless transceiver supports one or more wireless standards.</i>

I. INTRODUCTION

Intel Corporation (“Intel” or “Petitioner”) petitions for *inter partes* review (“IPR”) of claims 1–8, 10–18, 20–23, 25–38, and 40 of U.S. Patent No. 9,614,566 (“the ’566 patent”; INTEL-1001).

II. GROUNDS FOR STANDING

Petitioner certifies the ’566 patent is available for IPR, and Petitioner is not barred or estopped from requesting IPR on the grounds herein.

III. IDENTIFICATION OF CHALLENGE

A. Prior Art

The ’566 patent claims the benefit of Provisional Application 61/235,909, filed August 21, 2009. Petitioner does not acquiesce that the ’566 patent is entitled to the priority date of the ’909 provisional, but regardless, each applied reference qualifies as prior art that predates August 21, 2009.

1. **U.S. Patent Publication No. 2006/0182017 to Hansen et al.** (“Hansen”; INTEL-1006), published on August 17, 2006, is prior art under pre-AIA §102(b).

2. **Kose & M. Fischer, *WWiSE Proposal: High throughput extension to the 802.11 Standard (IEEE 2005)*** (“WWiSE”; INTEL-1005) is prior art under 35 U.S.C. pre-AIA §102(b) because the document was available and accessible to the public on July 9, 2005. (*See* INTEL-1007, ¶24.) WWiSE was a submission made to Task Group n (“TGn”) of the IEEE 802.11 Wireless Local Area Networks

(“WLAN”) Working Group. During the 2004-2005 timeframe, IEEE Working Group members could provide submissions. (INTEL-1007, ¶15.) Members made these submissions through the IEEE 802 Wireless World website, <http://802wirelessworld.com>. (INTEL-1007, ¶16; INTEL-1029 (New Participant Orientation Slides), 35–37; INTEL-1030 (July 2004 Meeting Minutes), 5.) All submissions were accessible to any member of the public after free registration through the Wireless World website. (INTEL-1007, ¶18; INTEL-1029 (New Participant Orientation Slides), 25-30 (describing process of becoming a member).) After creating an account, an individual could view the “Working Group Document Listing” and download any submissions that had been uploaded. (INTEL-1029 (New Participant Orientation Slides), 35; INTEL-1007, ¶18.) Submissions were also publicly available to any member of the public via FTP at [ftp.wirelessworld.com](ftp://ftp.wirelessworld.com). (INTEL-1007, ¶19; INTEL-1029 (New Participant Orientation Slides), 35 (describing process for creating a free account).) The FTP server’s address and login credentials were also publicly available. (INTEL-1007, ¶19, *citing* INTEL-1031 and INTEL-1032)).

In mid-2007, the IEEE’s current Mentor website (“Mentor”) replaced the Wireless World website. (INTEL-1007, ¶21.) Prior submissions uploaded to the Wireless World server were added to Mentor shortly after its creation. (INTEL-1007, ¶21.) The uploaded documents retained their original submission upload dates.

(INTEL-1007, ¶21.) Mentor and all its documents have been freely available to members of the public since soon after its creation in 2007 and before August 21, 2009. (INTEL-1007, ¶21.) Entries in Mentor were and remain searchable by year, task group, title, or other parameters. (INTEL-1007, ¶22.)

WWiSE was uploaded to the IEEE database on July 9, 2005, at which time it would have been available to interested members of the public through the Wireless World website or by FTP. (INTEL-1007, ¶¶18-29, 24.) After mid-2007 and before August 21, 2009, WWiSE would have been available to interested members of the public through Mentor. (INTEL-1007, ¶¶18-18, 21, 24.) Interested members of the public would have been aware of the proposals made to IEEE by WWiSE because they were frequently discussed in 2004 and 2005 in industry publications. (*See, e.g.*, INTEL-1033–1037.)

For at least these reasons, WWiSE was publicly accessible prior to the earliest priority date of the '566 patent to a person of ordinary skill in the art (“POSITA”) exercising reasonable diligence. *See GoPro, Inc. v. Contour IP Holding LLC*, 908 F.3d 690, 693 (Fed. Cir. 2018).

3. **U.S. Publication No. 2010/0260159 to Zhang et al.** (“Zhang”; INTEL-1017), filed on April 12, 2010, claims priority to a series of provisional applications filed between April 13, 2009 and March 31, 2010, and is prior art under pre-AIA §102(e).

4. U.S. Patent No. 7,349,436 to Maltsev et al. (“Maltsev”; INTEL-1018), issued March 25, 2008, is prior art under pre-AIA §102(b).

None of the applied references were cited in or discussed during prosecution of the ’566 patent, weighing heavily against discretionary denial under 35 U.S.C. §325(d).

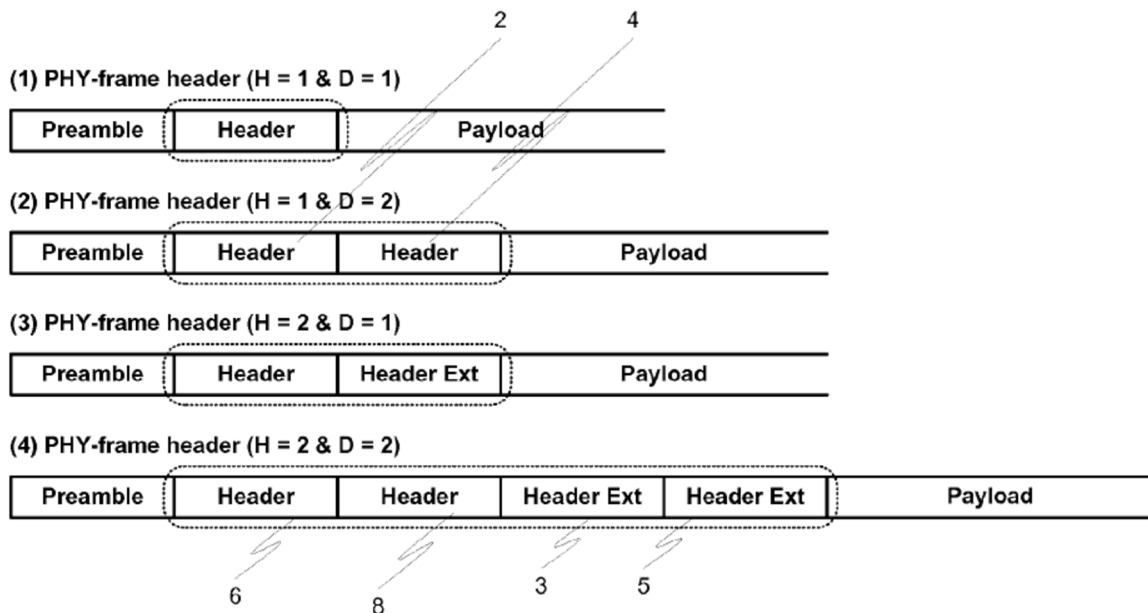
B. Grounds For Challenge

Ground		Claims	Prior Art
1	§103	1–8, 10–18, 20–23, 25–38, and 40	Hansen and WWiSE
2	§103	1–8, 10–18, 20–23, 25–38, and 40	Zhang and Maltsev

IV. ’566 PATENT OVERVIEW

The ’566 patent relates to “exemplary methods [and] systems . . . directed toward header repetition in a communications environment.” (INTEL-1001, 1:22–26.) According to the specification, “[t]he header contains important control information for the receiver to decode the payload properly, and also provides information about the packet length for virtual carrier sensing,” so “it is essential to decode the header reliably.” (INTEL-1001, 1:45–48.) The specification further acknowledges that by August 2009, a document concerning G.9960 wireline networking already disclosed that a “header containing PHY_H bits (header information block) is carried over one or two OFDM symbols (D=1 or 2), and within

each symbol, multiple header information blocks are repeated over the entire frequency band.” (INTEL-1001, 1:51–54.) And the specification also acknowledges that by August 2009, G.hn documents discussed “[t]he possibility of carrying more than PHY_H bits in the header ($H=1$ or 2).” (INTEL-1001, 1:66–67.) Both of these existing concepts are illustrated in Figure 1 from the ’566 patent below, including situations where: (1) a header ($H=1$) is contained within one symbol ($D=1$); (2) a header ($H=1$) is carried in two symbols ($D=2$), where the second symbol repeats the first; (3) a header and a header extension ($H=2$) are each carried in a single symbol ($D=1$); and (4) a header and a header extension ($H=2$) are each carried in two symbols ($D=2$), where the second symbol repeats the first. (INTEL-1001, 5:46–59, Fig. 1.)



The ’566 patent discusses “allowing different values of D in a single domain

where nodes are operating in different portions of frequency bands” and “the level of frequency diversity is different depending on the bandplan.” (INTEL-1001, 2:8–18.) For example, setting $D=2$ “increases reliability for the narrowband devices” because “each additional OFDM header symbol provides additional diversity thereby increasing the likelihood of decoding the header information correctly”; however, it “may also unnecessarily increase overhead for the wideband devices.” (INTEL-1001, 2:16–21, 2:67–3:2.) The patent therefore purports to teach “techniques to accommodate different repetition[] schemes ... in a single domain” while “still allow[ing] devices to communicate with one another.” (INTEL-1001, 2:23–26.) A “transceiver” is illustrated in Figure 2, including a “modulation module” (in red) and “transmitter” (in pink).

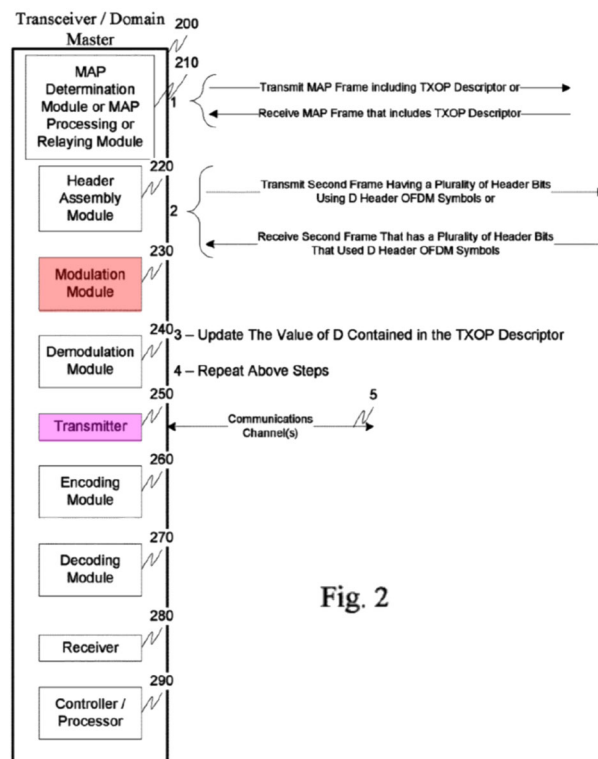


Fig. 2

A. Prosecution History

The '566 patent issued from U.S. Application No. 15/350,418, which was a continuation of U.S. Application No. 13/376,856 that issued as U.S. Patent number 9,584,262 (“the '262 patent”). The claims of the '566 patent were allowed without substantive rejection, and the Examiner’s “Reason for Allowance” noted that “[t]he only difference between the instant and continuation applications is that the instant relates to modulator/transmitter whereas the continuation deals with demodulator/receiver. Therefore, same reason for allowance applies to the instant application except ‘demodulator/receiver’ of the continuation application is replaced with ‘modulator/transmitter’ in the instant application.” (INTEL-1039, 13.) When allowing the '262 patent, the Examiner stated that “[p]rior art of record fails to disclose demodulating the first number of OFDM symbols to determine the first header bits of the first packet that is received at a first narrower frequency band and demodulating the second number of OFDM symbols that is less than the first number of OFDM symbols to determine the second header bits of the second packet that is received at a second wider frequency band.” (INTEL-1039, 516.)

B. Level Of Ordinary Skill In The Art

A POSITA at the time of the purported invention would have had at least a master’s degree in electrical engineering or similar discipline, and/or two to three years of experience working or conducting research in wireless communication

protocols, or an equivalent combination of education and experience. (INTEL-1003, ¶70.)

C. Claim Construction

Claim terms are typically given their ordinary and customary meanings as understood by a POSITA at the time of the invention. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312-16 (Fed. Cir. 2005) (en banc). Petitioner does not believe it is necessary for the Board to expressly construe any term for the purpose of this IPR proceeding. *See Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

V. GROUND 1: Claims 1–8, 10–18, 20–23, 25–38, and 40 are Obvious Based on the Combination of Hansen and WWiSE

The proposed combination involves programming Hansen's 802.11-compliant, wireless OFDM transceivers to support WWiSE's packet formats—including extended range (ER) packets—within WWiSE's WLAN.

A. Combination Overview

1. Hansen

Hansen is the publication of U.S. Patent Application 11/151,772, which matured into U.S. Patent 8,737,189 (INTEL-1009; “Hansen Patent”). Hansen relates “to a method and system for compromise greenfield preambles for 802.11n.” (INTEL-1006, ¶7, 1:24–25.)

The IEEE 802.11 task group N (TGn) was “chartered to develop a standard to

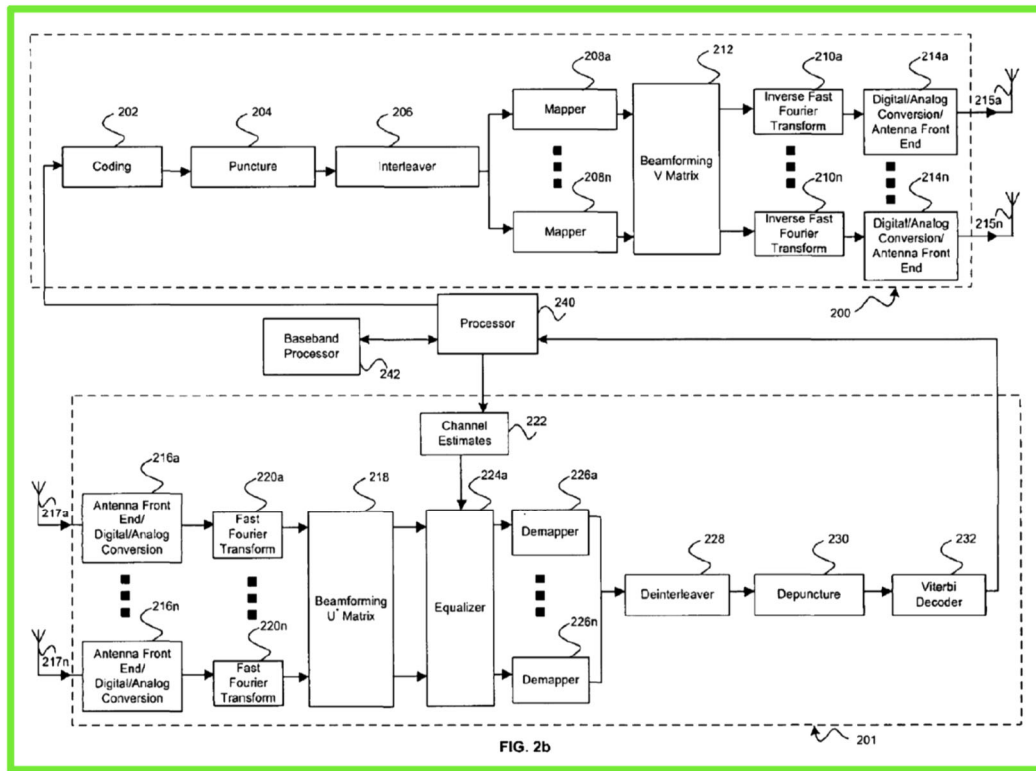
enable WLAN devices to achieve throughput rates beyond 100 Mbits/s” to “be documented in IEEE resolution 802.11n.” (INTEL-1006, ¶9.) The task group was “to develop a standard that will enable WLAN devices compatible with IEEE 802.11n to also interoperate with IEEE 802.11 devices that are not compatible with IEEE 802.11n” (“legacy” devices). (See INTEL-1009, 1:41–44; INTEL-1010, 13; INTEL-1006, ¶¶1, 6, 32 (incorporating the Hansen Provisional).) This “backward compatible” access is referred to as “mixed mode access.” (INTEL-1006, ¶32.) In mixed mode access, a communication packet/frame (PHY layer PPDU) includes “legacy” information for non-802.11n devices and 802.11n information for 802.11n devices. (INTEL-1006, ¶¶32, 59, 61, 111.) The TGn task group also recognized that 802.11n-compatible devices that communicate in a WLAN having no legacy devices can operate in a “greenfield” mode in which a communication packet/frame does not need the “legacy” information. (INTEL-1006, ¶¶32, 59, 77, 87.)

Two proposals emerged as “candidates for incorporation in IEEE 802.11n.” (INTEL-1006, ¶9.) The first, from TGn Sync industry group, supported mixed-mode access but did “not provide a mechanism to support greenfield access.” (INTEL-1009, 4:42-43; INTEL-1006, ¶33.) The second, from WWiSE industry group, supported both greenfield and mixed-mode access. (INTEL-1006, ¶33.) Hansen sought a compromise by combining aspects of the mixed-mode TGn Sync preambles and headers with greenfield preambles and headers proposed by the WWiSE

industry group during development of 802.11n. (INTEL-1006, ¶¶7, 11, 27, Fig. 4a, Fig. 5a, Fig. 6a; Hansen Provisional, 14; *see also* INTEL-1006, ¶¶1, 6 (incorporating the Hansen Provisional by reference); INTEL-1003, ¶76.) In the corresponding Hansen Patent, Hansen submitted the WWiSE proposal from January 2005 (“January 2005 WWiSE”) and the TGn Sync proposal from January 2005 in an Information Disclosure Statement. (*See* INTEL-1009, (56) OTHER PUBLICATIONS.) Petitioner refers to the WWiSE proposal discussed in Hansen as “January 2005 WWiSE” to distinguish it from the March 2005 version of the WWiSE proposal applied in this ground (INTEL-1005).

Hansen describes transceiver hardware, illustrated in Figure 2b, that “may be utilized in accordance with an embodiment of the invention.” (INTEL-1009, 2:12-13; INTEL-1006, ¶¶15, 29, 41, 57.)

Wireless OFDM Transceiver



2. WWiSE

WWiSE proposed HT extensions to the existing 802.11 standard to double the bandwidth from previous versions of 802.11 by providing a 40MHz frequency band—which WWiSE refers to as a “channel”—for HT device communications or two 20MHz frequency bands for devices that did not support the 40MHz channel (e.g., legacy 802.11 devices). (See INTEL-1005, 13-14, 48-49, 55, 84.)

WWiSE also added specifications for “Extended Range (ER) capable devices ... which support the optional ER MCS [Modulation and Coding Scheme], in addition to the Normal Range (NR) MCS,” and where “[a] characteristic of ER MCS is that they have a longer range than NR MCS.” (See INTEL-1005, 50:9–10,

15.) In the ER configuration, “SIG-N is composed of two consecutive MIMO-OFDM symbols: The SIG-N MIMO-OFDM symbol is followed by a second MIMO-OFDM symbol, denoted as ER-SIG-N.” (INTEL-1005, 69:16-18.) To support ER capability, the SIG-N field includes a REXT bit field indicating whether standard or extended range communication is being used for transmission. (INTEL-1005, 69-70.)

The following figure illustrates a mixed-mode ER PPDU for two spatial streams ($N_{TX}=2$) in a 20MHz frequency band. (INTEL-1005, 60, 65–66) The gray shaded field “indicates the optional duplicate SIG-N for extended range communication.” (INTEL-1005, 67.)

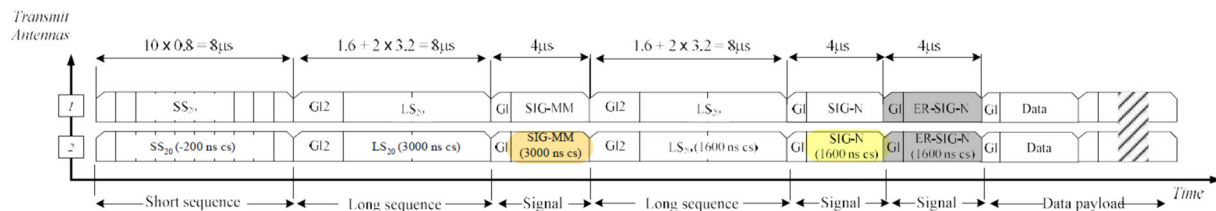


Figure 008 – MIMO-OFDM Training structure for $N_{TX}=2$, 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.

The figure below illustrates a mixed-mode NR PPDU for one (40MHz) or two (20/40MHz) transmit antenna modes. (INTEL-1005, 55.)

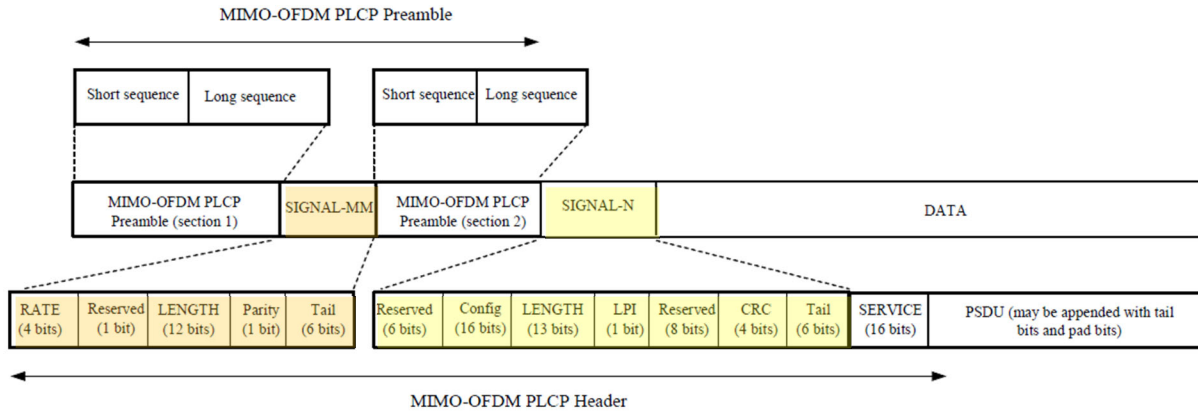
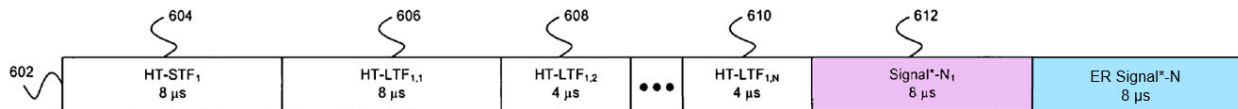


Figure 003 – PPDU frame format: Mixed-mode access in the 1TX (40 MHz) and 2TX (20 and 40 MHz) modes

B. Motivation to Combine

A POSITA would have been motivated to combine Hansen and WWiSE to included support for WWiSE’s ER communication in Hansen’s transceiver. (INTEL-1003, ¶81.) For example, a POSITA would have understood the advantages in duplicating header fields for improved diversity and would have been motivated to program Hansen’s processors to generate duplicate (*i.e.*, repeated) header fields such as Signal*-N of Hansen’s Fig. 6a during ER communications, as taught by WWiSE. (INTEL-1003, ¶81) The duplicated header is referred to herein as “ER-Signal*-N”, consistent with the terminology used by WWiSE.



Hansen’s “Compromise” PPDU with WWiSE’s duplicate SIG-N field for ER communication

A POSITA would have been motivated to include support for the fields (or

subfields) necessary to support ER in Hansen's transceiver and would have had a reasonable expectation of success since programming such fields would have been well within the level of skill of ordinary artisans based on WWiSE's disclosure that is commensurate with other 802.11 wireless standards documents. (INTEL-1003, ¶82.) For example, a POSITA would have used one of the reserved bits in Hansen's Signal*-N header field or to extend Hansen's Signal*-N header field to incorporate WWiSE's REXT bit indicating whether a device is operating in NR or ER configuration. (INTEL-1003, ¶82.) A POSITA would have understood that the added bit(s) could be used for the REXT field. (INTEL-1003, ¶82; INTEL-1006, ¶¶67, 97.) When the REXT field indicates the device is operating in NR mode, the repeated header ER-Signal*-N is not included in the PPDU, and when the REXT field indicates the device is operating in ER mode, the repeated header is included in the PPDU. (INTEL-1003, ¶82.) A POSITA would have had several reasons to make this proposed combination.

First, Hansen provides an express teaching that would have led a POSITA to the combination with WWiSE. Hansen describes the earlier January 2005 WWiSE and TGn Sync proposals submitted to the TGn working group. (INTEL-1006, ¶33.) Both the January 2005 and March 2005 WWiSE proposals include support for greenfield access. (See, e.g., INTEL-1006, ¶¶21-23, 77, 79, 82.) Hansen notes however that TGn Sync did "not provide a mechanism to support greenfield access."

(INTEL-1006, ¶33.) Hansen therefore sought to define a compromise proposal based on the WWiSE and TGN Sync January 2005 proposals. (INTEL-1006, Title (“Method and system for compromise greenfield preambles for 802.11n”), ¶7 (“certain embodiments of the invention relate to a method and system for compromise greenfield preambles for 802.11n”); INTEL-1010 (Hansen Provisional), 14 (“Embodiments of this invention may comprise a plurality of proposals that seek to define a compromise proposal to TGN which is based on aspects of current proposals from WWiSE and TGN sync”); INTEL-1006 ¶6 (incorporating Hansen Provisional by reference) Based on the suggestion to bridge the gap between the WWiSE and TGN Sync industry groups, a POSITA would have been motivated to combine the teachings of WWiSE with Hansen to support the newly introduced aspects of the March WWiSE proposal, including support for WWiSE’s ER features. (INTEL-1003, ¶83.)

Second, this combination involves use of a known technique to improve similar devices in the same way. (*See KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007).) In particular, WWiSE’s ER capability is based on repeating the SIGNAL-N header field (a known technique), which would improve Hansen’s transceiver by providing additional diversity. (INTEL-1003, ¶84.) Diversity is a known technique to improve system performance over fading channels. (INTEL-1015, 130; INTEL-1003, ¶84.) Fading is generally the time variation of received

signal power due to changes in transmission medium or paths that occurs from numerous sources including reflections from the ground and surrounding buildings, as well as scattered signals from trees, people and towers present in the larger area. (INTEL-1022; INTEL-1003, ¶84.) Large-scale fading occurs when an obstacle comes in-between the transmitter and receiver. (INTEL-1022, 947.) Small-scale fading is concerned with rapid fluctuations of received signal strength over a very short distance and short time period. (INTEL-1022, 947.)

The three main forms of diversity that are “traditionally exploited in communication systems for fading channels: temporal, spectral, and spatial diversity.” (INTEL-1015, 130.) By repeating the header (Signal-N) in the time domain, WWiSE’s ER capability introduces temporal diversity. (See INTEL-1005, ¶¶67–69.) Each repeated symbol provides additional diversity, which increases the likelihood of decoding the information correctly at the receiver. (INTEL-1003, ¶85.) This introduction of diversity improves the decodability of the header (Signal-N) in noisy environments or at a greater distance for a given signal power—extending the range of communication, and improving the receiver gain. (INTEL-1003, ¶85.) A POSITA thus would have been motivated to include WWiSE’s ER capability to improve robustness of communication in noisy or otherwise degraded channel conditions. (INTEL-1003, ¶85.)

Third, this combination applies a known technique (WWiSE’s ER capability)

to a known device (Hansen's transceiver) that was ready for improvement. *See KSR*, 415–421. The addition of support for WWiSE's ER capability to Hansen's transceiver would extend the range of reliable communication between devices by providing diversity when environmental conditions (fading and/or noise) adversely affect communication. (INTEL-1003, ¶86.) A POSITA would have applied the known improvement (ER capability of WWiSE) in the same way to Hansen, which already uses a PPDU based on the one disclosed in WWiSE. (INTEL-1003, ¶86.)

Fourth, this combination is of prior art elements according to known methods to yield predictable results (*i.e.*, extended range for devices in a WLAN). *See KSR*, 550 U.S. at 416. (INTEL-1003, ¶87.) For example, as explained above, the combination adds a repeated data field (known method) to the PPDU frame (prior art element) and adds a one-bit sub-field (or reassign existing reserved bit if available) to the header field. A POSITA would have known how to make these modifications because the addition of fields/sub-fields to network packets was commonly done to implement enhanced features or otherwise support modifications to standards such as 802.11. (INTEL-1003, ¶87.) Indeed, reserved bits are provided for this specific purpose. (*See, e.g.*, INTEL-1008, 30 (“... define two one-bit fields which are assigned to bits in the PHY frame header that are currently reserved.”).) For example, both Hansen and WWiSE discuss modifications to existing 802.11 PDUs by the addition of fields and sub-fields. (INTEL-1003, ¶87.)

The results of this combination would have been predictable, and a POSITA would have had a reasonable expectation of success. (INTEL-1003, ¶87.) Both Hansen and WWiSE describe PPDU's for use in the 802.11n standard under development. And the existing 802.11 standards upon which both Hansen and WWiSE build, would have been well-known to a POSITA before the '566 patent. (INTEL-1003, ¶87.) And as discussed above, the combination adds fields/sub-fields to an existing packet structure. (INTEL-1003, ¶87.) Because such modifications were commonplace when dealing with evolving communications technologies, the results would have been predictable, and a POSITA would have had a reasonable expectation that the combination would operate successfully. (INTEL-1003, ¶87.)

C. Independent Claims 1, 11, 21, and 31¹

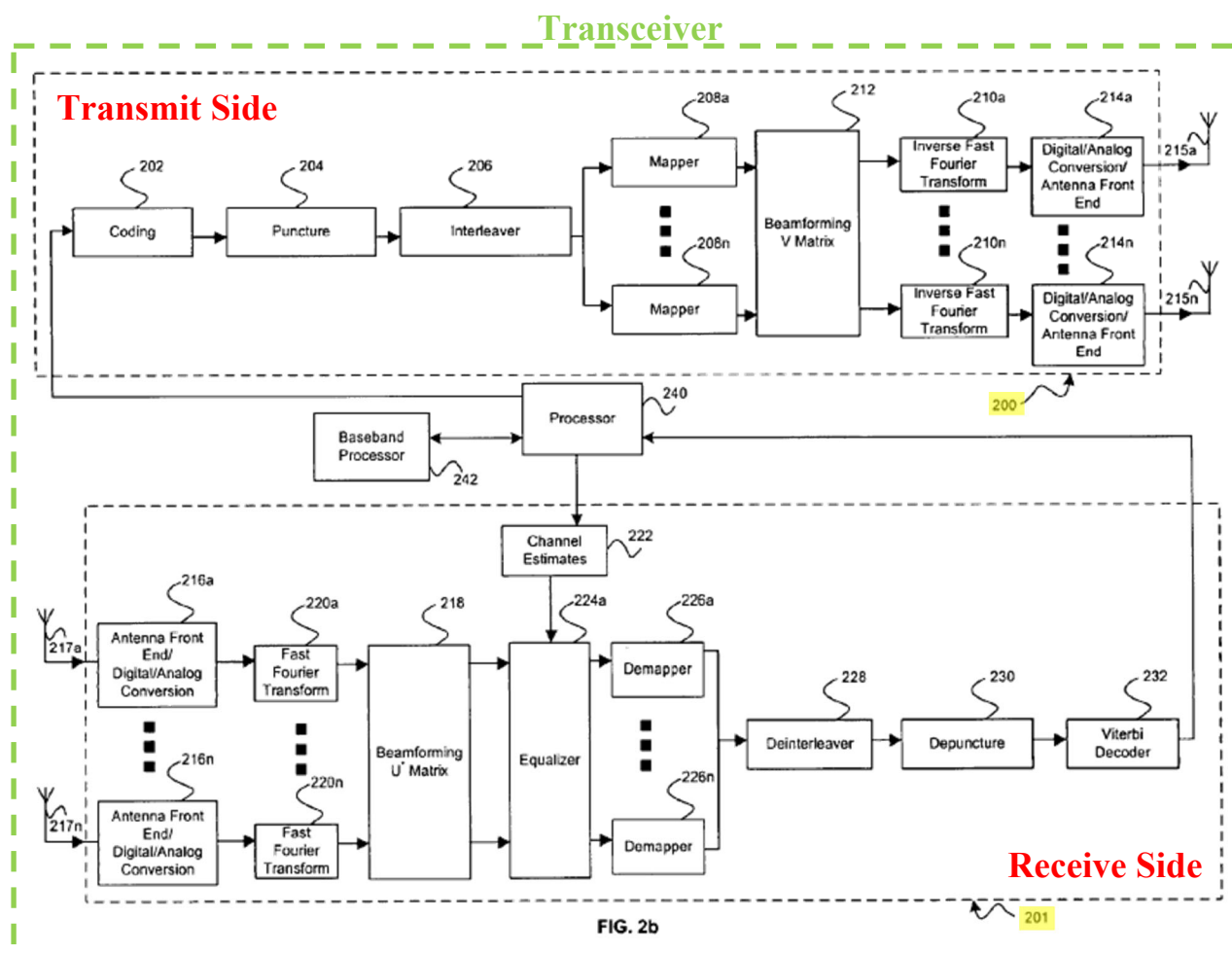
WWiSE in combination with Hansen renders these claims obvious, as set forth below.

1. Preamble [1Pre], [11Pre], [21Pre], and [31Pre]

Petitioner does not acquiesce that the preamble is limiting. Nevertheless, the

¹ Given the repeated subject-matter among the claims—including between the apparatus claims (claims 1 and 11) and the corresponding method claims (claims 21 and 31)—this petition addresses overlapping claims together. Any substantive differences between claims or the analysis is noted herein.

combination of Hansen and WWiSE discloses the preamble. (INTEL-1003, ¶89.) Hansen—which expressly refers to WWiSE (*e.g.*, INTEL-1006, ¶¶34, 36, 77, 79)—discloses “a transceiver comprising a transmitter and a receiver in a MIMO system.” (INTEL-1006, ¶15, Figure 2b (below); *see also* INTEL-1006, ¶57 (structure of Figure 2b is a “wireless communications transceiver”).)



The “Fast Fourier Transform” (FFT, 220a-n) and “Inverse Fast Fourier Transform” (IFFT, 210a-n) blocks within the transceiver, “implement orthogonal frequency division multiplexing (OFDM)” as recited in the preamble. (*See, e.g.*, INTEL-1006, ¶¶48, 51.)

Hansen's transceiver is compatible with the packets of WWiSE, which similarly describes a "multiple input multiple output orthogonal frequency division multiplexing (MIMO-OFDM) system" that "provides a wireless LAN" with HT communications among 802.11-compliant APs and STAs that have transmitting and receiving capabilities. (See INTEL-1005, 13–14, 30 55.) WWiSE further describes "mandatory" transmitting and receiving capabilities (*e.g.*, INTEL-1005, 27 (describing "the bitmap size in bytes between the *transmitter* and *receiver* STAs with HT Capability"), 55 (explaining that "support for *transmitting and receiving* data using the MIMO-OFDM PHY defined in this Clause is *mandatory*"), 58 (explaining how "PSDUs are converted to and from PPDU's at the *transmitter* and *receiver*"), 83 ("The *transmitter (receiver)* shall initiate the modulation constellation, code rate, code type, and other configuration parameters according to the CONFIG indicated in the SIG-N field.")) that a POSITA would understand could be performed by a transceiver like the one Hansen discloses. (INTEL-1003, ¶90.) A POSITA would therefore have had a reasonable expectation of success in implementing WWiSE's PPDU's using Hansen's transceiver. (INTEL-1003, ¶90.)

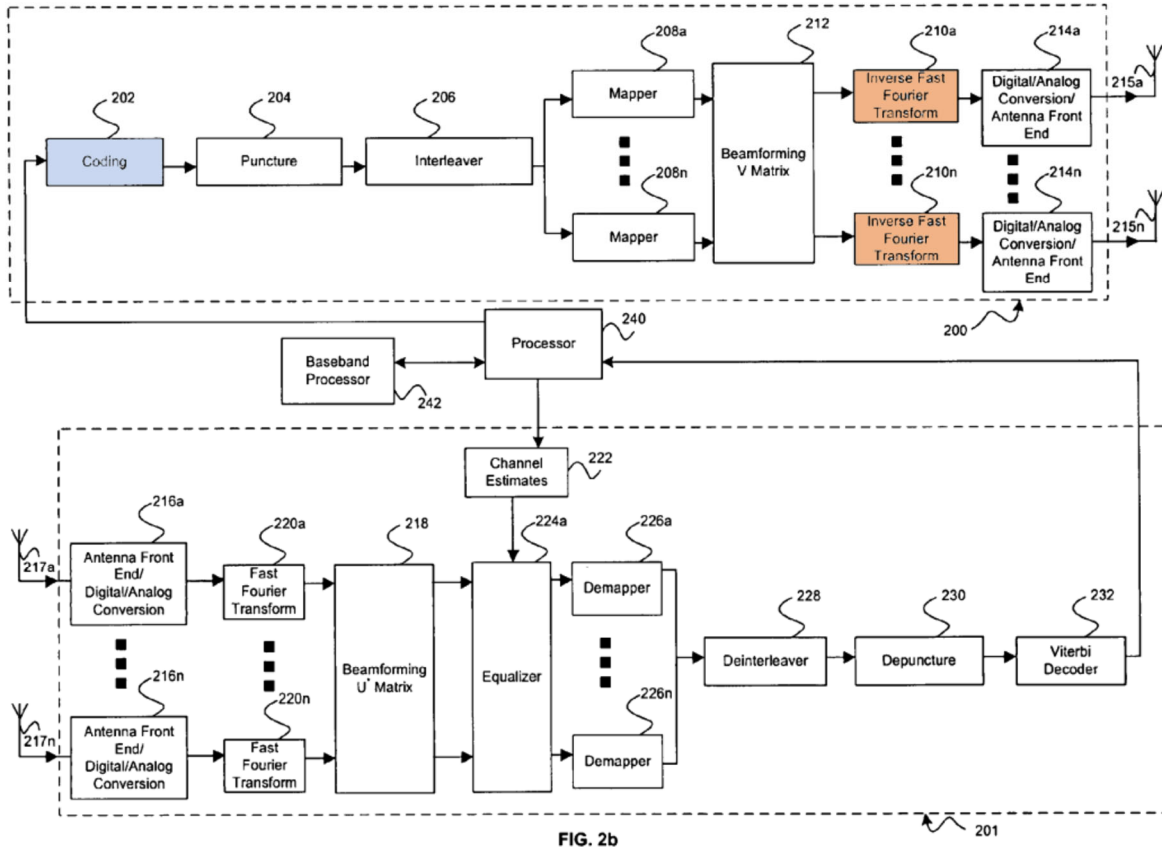
2. Claim Limitations [1A], [11A], [21A], and [31A]

The combination of Hansen and WWiSE discloses this limitation.

a. Modulator operable to modulate ... OFDM symbols

In Hansen's transceiver, illustrated in annotated Figure 2b below, an input bitstream associated with the PPDU to be transmitted is received at coding block 202 (shaded blue) from processor 240 and baseband processor 242. (INTEL-1006, ¶56 (processor "generate[s] a plurality of bits that are communicated to the coding block 202"), ¶44.) The PPDU input bit stream at this point in the transmission pipeline includes the header and data (payload)² bits associated with the PPDU to be transmitted. (INTEL-1003, ¶92; *see also* INTEL-1006, ¶59; INTEL-1005, 60:14–24 ("Produce the PLCP header field" and "Extend the data bit string ... so that the resulting length will be a multiple of the number of data bits per OFDM symbol").)

² The preamble is not added until after modulation which completes the PPDU ("packet"). (*See* INTEL-1005, 61:37–39.)



Hansen, Annotated Figure 2b

The output of mapper block 208 is provided to IFFT 210³, which “subdivide[s] the bandwidth of the RF channel into a plurality of n sub-band frequencies to implement orthogonal frequency division multiplexing (OFDM),

³ Although Hansen describes beamforming after the mapper, beamforming is not performed on the header because the header is repeated on each transmit antenna. (INTEL-1003, ¶93.) Instead, the same data would be provided to each IFFT when the header is being processed. (*Id.*)

buffering a plurality of received signals.” (INTEL-1006, ¶48; INTEL-1003, ¶93.) Each buffered signal is “modulated by a carrier signal whose frequency is based on [] one of the sub-bands.” (INTEL-1006, ¶48.) IFFT block 210 then independently sums its “respective buffered and modulated signals across the frequency sub-bands to perform an n-point IFFT, thereby generating a composite OFDM signal.” (*Id.*) (INTEL-1003, ¶93; *see also* INTEL-1005, 61:32–35.) For a multiple antenna system, because the header is provided in parallel to each mapper and then to a corresponding IFFT, each IFFT receives the same data and outputs the same header symbols. (*See* INTEL-1005, 70:18–21; INTEL-1012, 121:1–122:2; INTEL-1003, ¶93.) IFFT 210 (shaded orange above) is therefore a “modulator” that generates OFDM symbols. (INTEL-1003, ¶93.)

Should PO contend that an OFDM symbol includes the IFFT output plus a guard interval (GI), WWiSE discloses prepending a GI to the IFFT output to generate an OFDM symbol. (*See* INTEL- 1005, 61:32–35, 83:21–25 (TX Block Diagram showing “add cyclic extension (guard)”); INTEL-1003, ¶94 (citing INTEL-1038, 260–262).) Accordingly, the combination of WWiSE and Hansen discloses a “*modulator*” that generates an OFDM symbol. (INTEL-1003, ¶94.) Thus, the combination discloses “*a modulator operable to generate*” an OFDM symbol corresponding to a set of bits in the PPDU input stream. (INTEL-1003, ¶95.)

b. A first number of OFDM symbols to transmit a first plurality of header bits in a first packet

WWiSE discloses transmitting a first packet comprising a first number of OFDM symbols that carry a first plurality of header bits. Included among the APs and STAs described in WWiSE are “Extended Range (ER) capable devices” that “support the optional Extended Range MCS [modulation and coding scheme], in addition to the Normal Range (NR) MCS.” (INTEL-1005, 15, 50, 69.) “A characteristic of ER MCS is that they have a longer range than NR MCS” (INTEL-1005, 50), meaning that ER MCS provides improved reliability when, for example, a STA operates farther away from an AP. (INTEL-1003, ¶96.) WWiSE further explains that ER-capable devices can communicate using “the long SIG-N field format”—or “[t]he SIG-N MIMO-OFDM symbol, followed by a second MIMO-OFDM symbol, denoted as ER-SIG-N” that repeats SIG-N. (INTEL-1005, 50, 67, 69, Fig. 008 (below; shaded field indicates the optional duplicate SIG-N for ER communication).) “SIG-N is composed of a single MIMO-OFDM symbol that provides all length and configuration parameters associated with a MIMO-OFDM PPDU” packet, including “bandwidth, modulation, code rate, code type, number of TX antennas, and number of spatial streams.” (INTEL-1005, 58–59, 69–70, 83.) An example is shown in Figure 008 for a device in “mixed-mode operation.” (INTEL-1005, 13–14, 58; INTEL-1003, ¶96.)

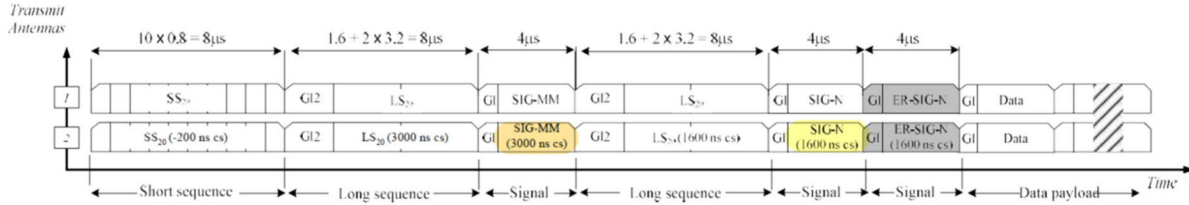


Figure 008 – MIMO-OFDM Training structure for $N_{TX} = 2$, 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.

As also shown, mixed-mode includes “another [OFDM] symbol, denoted SIGNAL-MM (SIG-MM)” that provides additional information in mixed-mode communications. (INTEL-1005, 67, 70–71.) Collectively, SIG-N, ER-SIG-N, and SIG-MM correspond to the claimed “first number of OFDM symbols” in “a first packet.” (INTEL-1003, ¶97.)

c. “Header” bits/portion

WWiSE discloses that the “SIG-N” (or “SIGNAL-N”) field appears within the “MIMO-OFDM PLCP header” and “consists of 54 bits that specify all configuration and length related parameters associated with [packet] transmission.” (INTEL-1005, 58–59, 69–70, Fig. 003.) This likewise describes the ER-SIG-N field, which repeats the SIG-N field. (*Supra* §V.C.2.b; INTEL-1005, 50, 67, 69, Fig. 008; INTEL-1003, ¶98.) The SIG-MM (or SIGNAL-MM) field includes additional bits, appears in the mixed-mode packet header and, as WWiSE further explains, is “sent in the PLCP header.” (INTEL-1005, 69–71, Fig. 008; INTEL-1003, ¶98.) Each of WWiSE’s SIG-N, ER-SIG-N, and SIG-MM header fields (*e.g.*, in the packet in Figure 008) appear before the payload, carry a plurality of header bits, and include

packet length and control information. (INTEL-1005, 58–59, 70, 92, 95; INTEL-1006, ¶¶59, 79–81; INTEL-1003, ¶¶98.)

- d. **At least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers**

WWiSE applies a frequency permute function when transmitting bits in the ER-SIG-N header field (shaded gray in Figure 008 below), which is a “duplicate SIG-N for extended range communication.”

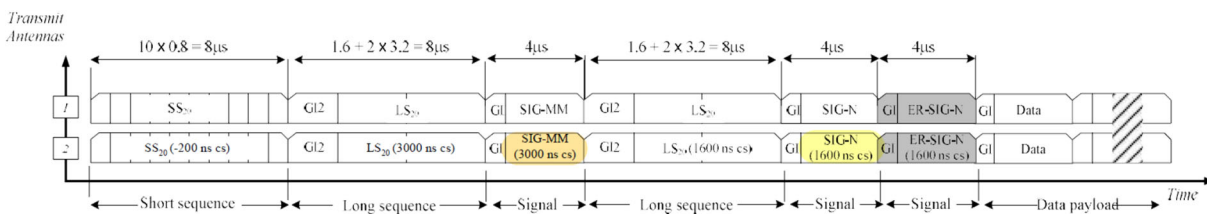


Figure 008 – MIMO-OFDM Training structure for $N_{Tx} = 2$, 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.

Each ER-SIG-N bit is indexed to a distinct OFDM subcarrier from the corresponding SIG-N bit, as described in the following excerpt from WWiSE.

In the extended communication range configuration (ER), SIG-N is composed of two consecutive MIMO-OFDM symbols: The SIG-N MIMO-OFDM symbol is followed by a second MIMO-OFDM symbol, denoted as ER-SIG-N. The frequency domain MIMO-OFDM symbol ER-SIG-N is derived from MIMO-OFDM symbol SIG-N by applying the following permutation on the subcarrier indices (as described in subclause 20.3.2.4) of the OFDM data symbols composing SIG-N:

- For 20MHz data transmissions: With SIG-N=(0, s(1), s(2)...., s(28), 0, ..., 0, s(-28), s(-27), ..., s(-1)), ER-SIG-N is specified as ER-SIG-N=(0, s(-28), s(-27), ..., s(-1), 0, ..., 0, s(1), s(2)...., s(28));
- For 40MHz data transmissions: With SIG-N=(0, 0, 0, s(3), s(4)...., s(58), 0, ..., 0, s(-58), s(-57), ..., s(-3), 0, 0), ER-SIG-N is specified as ER-SIG-N=(0, 0, 0, s(-58), s(-57), ..., s(-3), 0, ..., 0, s(3), s(2)...., s(58), 0, 0).

(INTEL-1005, 69.) For example, the above excerpt indicates that a SIG-N bit indexed to subcarrier s(1) in a 20MHz data transmission would correspond to an ER-SIG-N bit indexed to s(-28) in that the next symbol transmission. This means

that a given header bit from SIG-N is repeated (in ER-SIG-N) on more than one OFDM subcarrier (“*a plurality of OFDM subcarriers*”) when Hansen’s transceiver modulates and transmits a mixed-mode ER packet. (INTEL-1003, ¶99.)

WWiSE and Hansen thus disclose a “*modulator operable to modulate a first number of OFDM symbol to transmit a first plurality of header bits*” (e.g., Hansen’s IFFT modulating OFDM symbols carrying header bits of SIG-N, ER-SIG-N and SIG-MM) “*in a first packet*” (Figure 008’s mixed-mode ER packet) “*wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers*” (WWiSE’s frequency permute function places the bits of SIG-N and ER-SIG-N on subcarriers that are different subcarriers) (INTEL-1003, ¶100.)

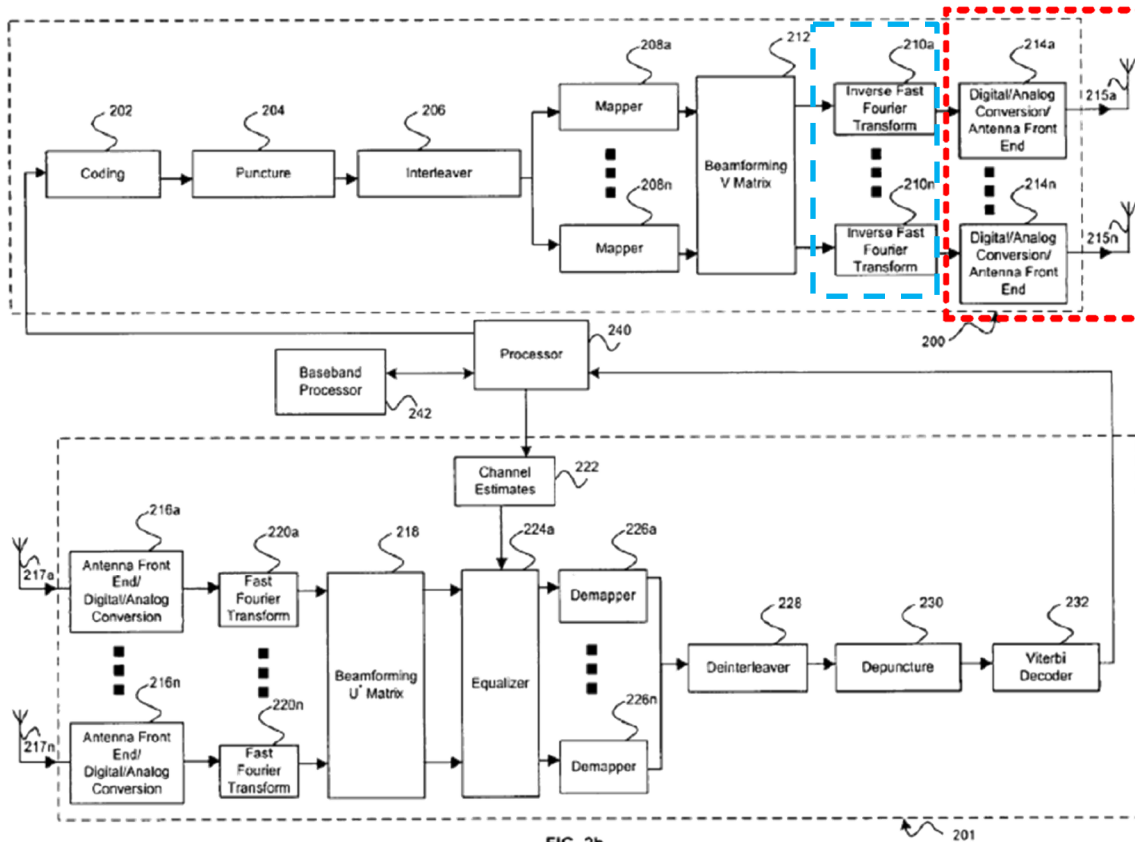
3. Claim Limitations [1B], [11B], [21B], and [31B]

The combination of Hansen and WWiSE discloses this limitation.

a. Wireless OFDM communications transmitter, connected to and in communication with the modulator

Hansen discloses an 802.11-compliant transceiver that includes a transmitter capable of wireless OFDM communications. Referring to Figure 2b (reproduced below), Hansen identifies “a plurality of transmitter antennas 215a, ... 215n” connected to a “plurality of digital (D) to analog (A) conversion and antenna front end blocks 214a, ..., 214n” that “receive the plurality of signals generated by the plurality of IFFT blocks 210a, ..., 210n.” (INTEL-1006, ¶¶41, 49.) “The digital

signal representation received from each of the plurality of IFFT blocks 210a, ..., 210n may be converted to an analog RF signal that may be amplified and *transmitted* via an antenna.” (INTEL-1006, ¶ 49.) The transmitter components are in the dashed red box shown below and are connected to and in communication with the IFFT blocks (in the blue box), as indicated by the black arrows between them.



A POSITA would have understood the antennas and “Digital/Analog Conversion Antenna Front End” blocks collectively correspond to a transmitter for transmitting wireless packets. (INTEL-1003, ¶102.)

- b. Operable to transmit in a first narrower frequency band, the first packet comprising the first number of OFDM symbols

As discussed above (*see supra* § VC.2b), WWiSE’s ER packets include SIG-N, ER-SIG-N, and SIG-MM fields as illustrated in Figure 8 below for the case of two transmit antennas operating in the 20MHz frequency band. These ER packets include a plurality of OFDM header symbols of 4 μ s each in duration as shown below.

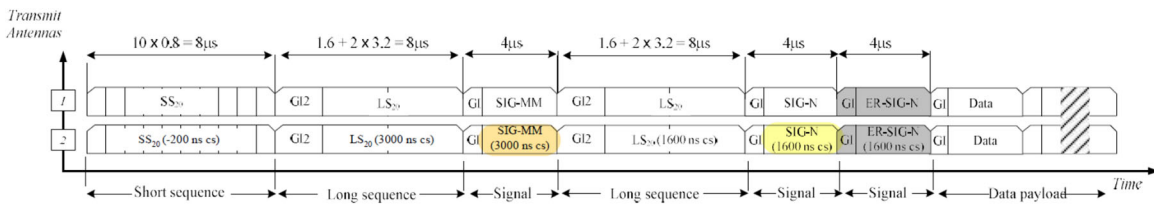


Figure 008 – MIMO-OFDM Training structure for $N_{Tx} = 2$, 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.

(WWiSE, 67.)

Hansen similarly describes an 802.11 PPDU—a type of packet—that is analogous to 802.11 PPDU in WWiSE (which WWiSE also calls “frames”) and is also transmitted in mixed-mode operation in the 20MHz frequency band. (INTEL-1005, ¶¶59, 67; INTEL-1003, ¶104 (citing INTEL-1013, 7, 13, 33 (referring to “packet” structure and contents))). Hansen’s transceiver thus supports communications over the 20MHz frequency band, including communications based on WWiSE’s proposal. (INTEL-1006, ¶¶67–68 (“20 MHz or 40 MHz bandwidth field 494 may indicate whether the PPDU was transmitted utilizing a 20 MHz RF

channel, or a 40 MHz RF channel”), 79 (“BW field 560 may represent a bandwidth, for example, 20 MHz, or 40 MHz”). The 20MHz frequency band corresponds to the claimed “*narrower frequency band.*” (INTEL-1003, ¶104.)

To the extent Hansen’s transceiver would require modification to be capable of transmitting the ER packets of WWiSE, that modification (*e.g.*, to transmit the additional ER-SIG-N header symbol) would have been well within the ability of a POSITA (INTEL-1003, ¶105), who would have been motivated to make the modification for the reasons discussed above (*see supra* §V.B.).

4. Claim Limitations [1C], [11C], [21C], and [31C]

The combination of WWiSE and Hansen discloses this limitation.

a. Modulator operable to modulate ... OFDM symbols

As discussed in §V.C.2.a., *supra*, the combination of WWiSE and Hansen discloses a “modulator operable to modulate” OFDM symbols.

b. A second number of OFDM symbols to transmit a second plurality of header bits in a second packet, less than the first number of OFDM symbols

As discussed above, WWiSE discloses ER packets for improved reliability when, for example, a STA operates far away from an AP. (*See supra* §V.C.2.b.) In addition, WWiSE discloses NR mixed-mode packets transmitted/received in 40MHz, as illustrated in Figure 003 below. (INTEL-1003, ¶108.)

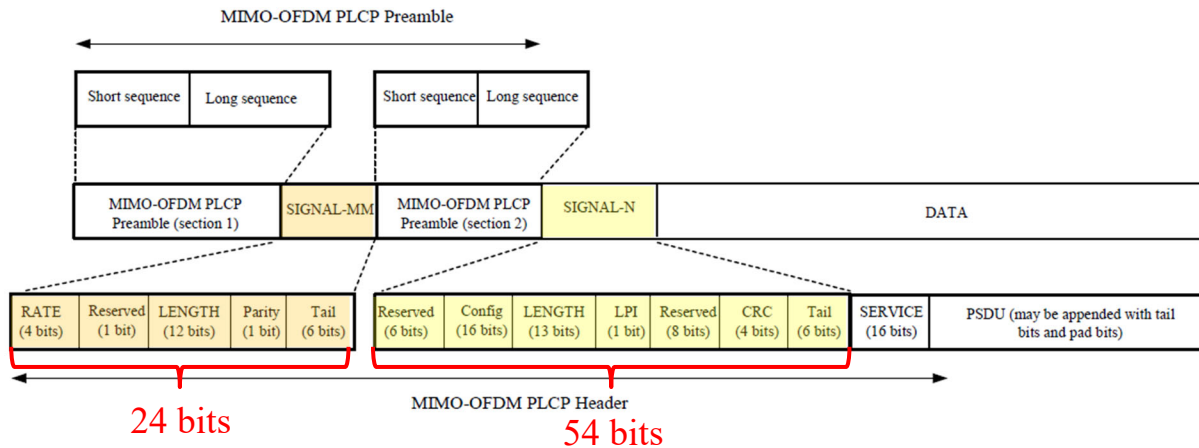


Figure 003 – PPDU frame format: Mixed-mode access in the 1TX (40 MHz) and 2TX (20 and 40 MHz) modes

This packet includes SIGNAL-MM (or “SIG-MM”) and SIGNAL-N (or “SIG-N”) OFDM symbols—consisting of 24 bits and 54 bits, respectively—but does not include the ER-SIG-N symbol discussed above for ER operation. (*See supra* §V.C.2b; INTEL-1005, 58, 68–70, Figs. 11, 12, 13, 14.) The non-ER packet is thus a “second packet comprising a second number of OFDM symbols” (two for SIG-MM and SIG-N) that is “less than the first number of OFDM symbols” discussed above for ER mode (three for SIG-MM, SIG-N, and ER-SIG-N). (INTEL-1003, ¶108.)

c. “Header” bits/portion

As discussed above, SIG-MM and SIG-N are part of the MIMO-OFDM packet header that comprises a plurality of “header bits” or a “header portion.”⁴

⁴ Claims 11 and 31 recite a “header portion” rather than “plurality of header

(See *supra* §V.C.2.c; INTEL-1003, ¶108.) This is further illustrated in the non-ER (i.e., the NR) packet of Figure 003 of WWiSE, where the SIG-MM and SIG-N fields are within the “MIMO-OFDM PLCP Header.” (INTEL-1005, 58–59, 70–71, Fig. 003.)

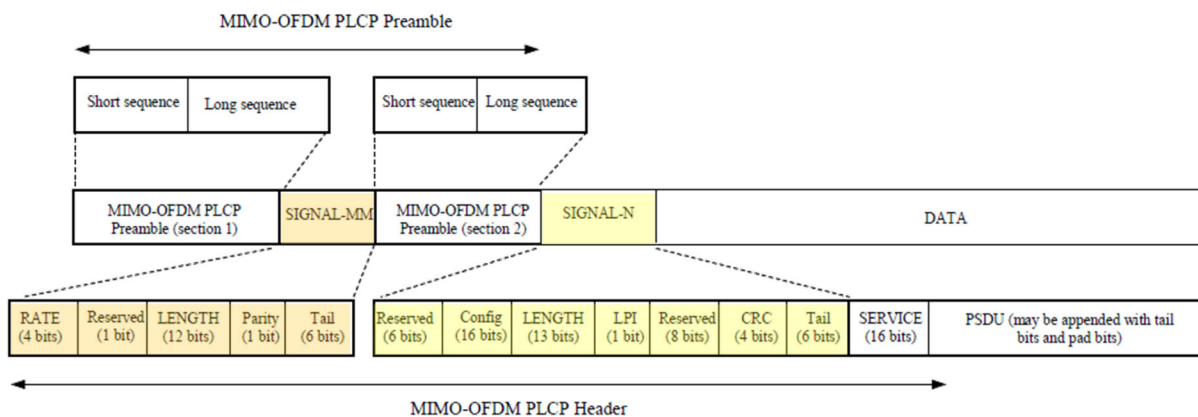


Figure 003 – PPDU frame format: Mixed-mode access in the 1TX (40 MHz) and 2TX (20 and 40 MHz) modes

Each field includes control information that precedes the payload and is used on the receive side to decode the packet payload. (INTEL-1005, 69, 83; INTEL-1003, ¶109.)

d. The second header bits are different than the first header bits

The header fields of WWiSE’s first (Figure 008) and second (Figure 003) packets appear below. The header bits of the “*second packet*” (i.e., the non-ER,

bits” (as in claims 1 and 21). The analysis in this section applies equally to both claim terms.

mixed-mode packet) do not include the ER-SIG-N field that appears in the “*first packet*” (i.e., the ER, mixed-mode packet). (INTEL-1005, 58–59, 67–71, 83.)

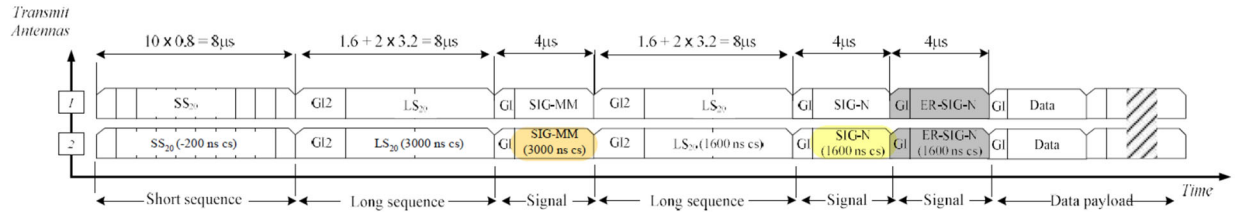


Figure 008 – MIMO-OFDM Training structure for $N_{TX} = 2$, 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.

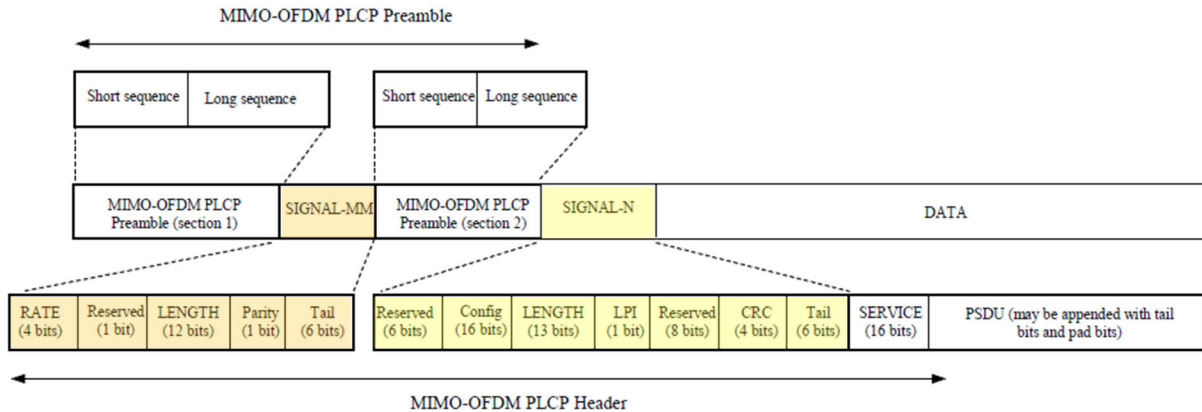


Figure 003 – PPDU frame format: Mixed-mode access in the 1TX (40 MHz) and 2TX (20 and 40 MHz) modes

Furthermore, the SIG-N field of WWiSE’s ER packet includes different bit values from the SIG-N field of a NR packet. For example, an ER packet “shall be transmitted with ... the REXT bit set to value 1” in the SIG-N field (and therefore also the ER-SIG-N field that repeats the SIG-N field), whereas in non-ER packets, the REXT bit in SIG-N is set to zero. (INTEL-1005, 50, 69–70.) And other bits would similarly be different, including LEN and CRC since an ER packet is longer than an NR packet. (INTEL-1003 ¶110.) This is shown in Table 011 of WWiSE:

Table 011—SIG-N field bit assignment

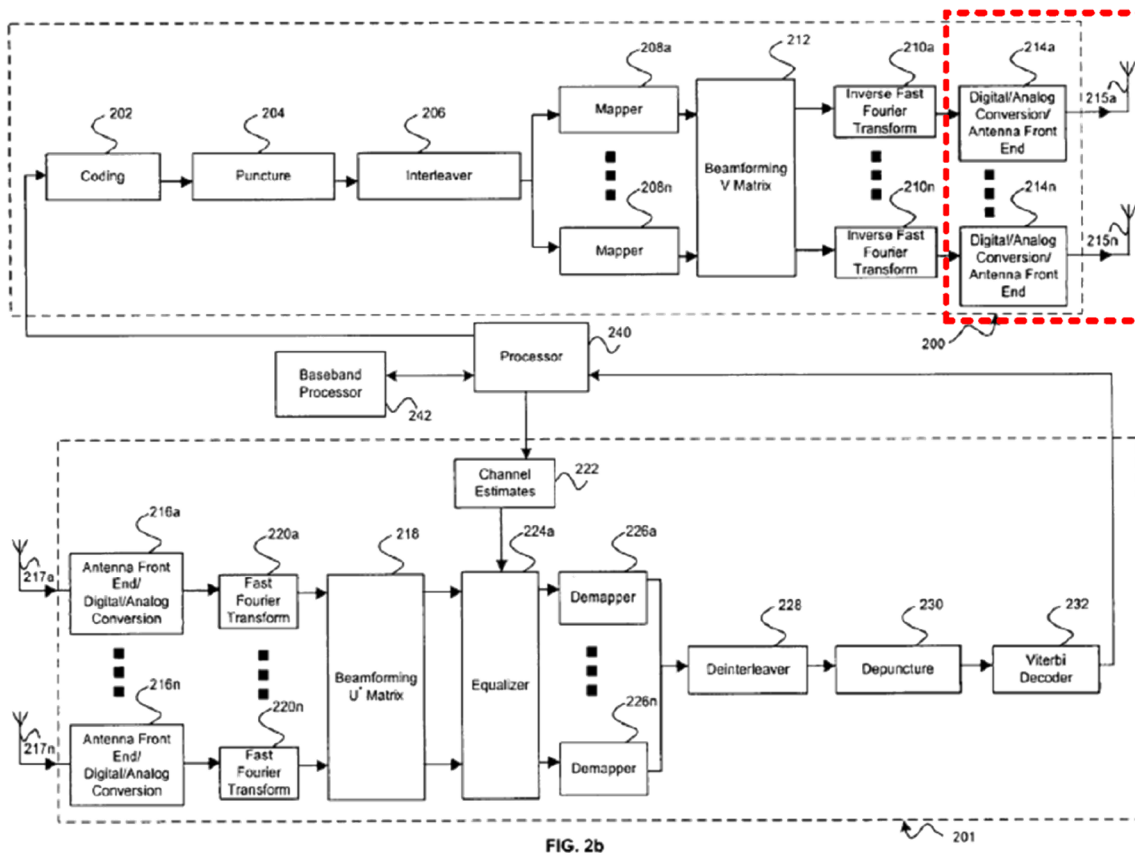
Bits	Field	Subfield	Parameter	Values
B0 : b5	RSVD		Reserved bits	111111, Bits shall be ignored at the receiver
B6 : b21	CONFIG		Configuration	
B6 : b8		NSS	Number of spatial streams	000: 1, 001: 2, 010: 3, 011: 4
B9 : b11		NTX	Number of transmit antennas	000: 1, 001: 2, 010: 3, 011: 4
B12 : b13		BW	Bandwidth	00: 20 MHz, 01: 40 MHz
B14: b16		R	Code rate	000: 1/2, 001: 2/3, 010: 3/4, 011: 5/6
B17 : b18		CT	ECC type	00 : convolutional, 01 : LDPC
B19 : b21		CON	Constellation type	000: BPSK, 001: QPSK, 010: 16-QAM, 011: 64-QAM
B22 : b34	LEN		Length	Number of bytes in the payload. The value of 0 is allowed.
b35	LPI		Last PSDU indicator	1 indicates that this is the last PSDU to be aggregated into the current PPDU. LPI shall have the value of 1 when the value of the LEN field is 0.
b36	REXT		Standard or extended communication range configuration	0 indicates the standard configuration, 1 indicates the extended communication range configuration
b37 : b43	RSVD		Reserved	0000000, bits shall be ignored at the receiver
b44 : b47	CRC		Cyclic Redundancy Check	CRC calculated on bits 0-43 using generator polynomial x^4+x+1
b48 : b53	TAIL			000000

(INTEL-1005, 70.) WWiSE thus discloses that the “*second plurality of header bits*” from the second packet is “*different than the first plurality of header bits*” of the first packet in at least two ways: (1) the second packet header includes fewer bits than the first packet, and (2) several bit values in the second packet header are different than in the first packet header. (INTEL-1003, ¶111.)

5. Claim Limitations [1D], [11D], [21D], and [31D]

As discussed in §V.C.3.a., *supra*, the combination of WWiSE and Hansen discloses an 802.11-compliant transceiver that includes a “*wireless OFDM transmitter*” for transmitting wireless OFDM packets like WWiSE’s mixed-mode packets in the 20MHz and 40MHz frequency bands. (*See supra*, §V.C.3.b; INTEL-

1006, ¶¶65, 67–68 (“20 MHz or 40 MHz bandwidth field 494 may indicate whether the PPDU was transmitted utilizing a 20 MHz RF channel, or a 40 MHz RF channel”), 79.) Hansen’s transmitter (in the red dashed box) is illustrated in Figure 2b below.



WWiSE further teaches that the 40MHz band is for communications among devices with HT capability or can be divided into two 20MHz bands for communications among devices that do not support the 40MHz band. (INTEL-1005, 14 (referring to “primary” and “secondary” 20 MHz channels within the 40 MHz bandwidth), 32, 41, 48, 84.) Similarly, Hansen teaches that “the plurality of subcarrier frequencies within a 20 MHz or 40 MHz RF channel, may be utilized for

transmission,” and Hansen describes transmission over the 40MHz frequency band. (INTEL-1006, ¶¶65, 68, 79.) Hansen’s transceiver thus transmits packets in the 40MHz “*wider frequency band.*” (INTEL-1003, ¶113.) This includes, for example, WWiSE’s NR mixed-mode packets that can be transmitted in the 40MHz band, as illustrated in Figure 003 below. (INTEL-1003, ¶114.)

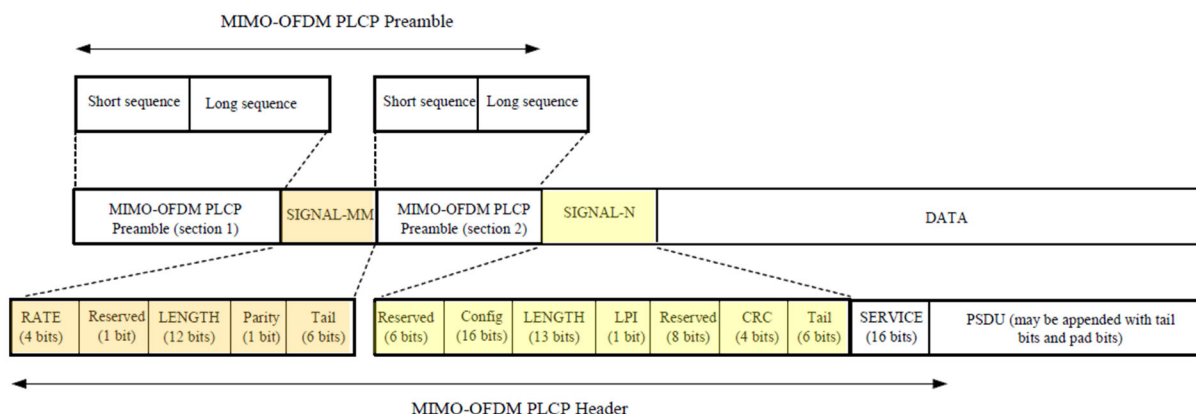


Figure 003 – PPDU frame format: Mixed-mode access in the 1TX (40 MHz) and 2TX (20 and 40 MHz) modes

The NR packet is “*the second packet comprising a second number of OFDM symbols*” because it includes SIG-MM and SIG-N OFDM header symbols, but not the ER-SIG-N symbol that is in an ER packet. (See *supra* §V.C.2.b; (INTEL-1003, ¶114.)

6. Claim Limitations [1E], [11E], [21E], and [31E]

As discussed above, Hansen and WWiSE each disclose the use of 20/40MHz frequency bands for transmission. (See *supra* §V.C.3.b.) WWiSE further explains that the 40MHz frequency band (“*the second wider frequency band*”) comprises a primary 20MHz band (“*the first narrower frequency band*”)—which WWiSE also

calls a “channel”—with frequency regions that overlap the 40MHz band. (INTEL-1005, 14; INTEL-1003, ¶115.) For example, WWiSE explains that the “primary channel ... will be used for 20 MHz transmissions as well as being *part of the 40 MHz channel for 40 MHz transmissions.*” (INTEL-1005, 14.) And WWiSE further notes that a “40 MHz channel pair consists of two 20 MHz channels, on each of which there could be 20 MHz transmissions” (INTEL-1005, 49, 84.) This is consistent with Hansen’s disclosure of transmission over “20 MHz channels with an optional utilization of 40 RF MHz channels.” (INTEL-1006, ¶34.) Hansen and WWiSE thus teach that “*the first narrower*” (20MHz) and “*second wider*” (40MHz) frequency bands “*have one or more overlapping frequency regions*” (the primary 20MHz channel). (INTEL-1003, ¶115.)

D. Claims 2, 12, 29, and 32

The “wherein” clauses of claims 2, 12, 29, and 32 should not be afforded any patentable weight because each merely recites the intended result of the recited function. *See, e.g., Hoffer v. Microsoft Corp.*, 405 F.3d 1326, 1329 (Fed. Cir. 2005). For this reason, claims 2, 12, 29, and 32 are obvious for the same reasons as independent claims 1, 11, 21, and 31. The combination of Hansen and WWiSE discloses a transceiver that transmits an ER, mixed-mode packet in 20MHz (“*the first narrower frequency band*”), like the one in Figure 008 below. (*See supra* §V.C.2.b.)

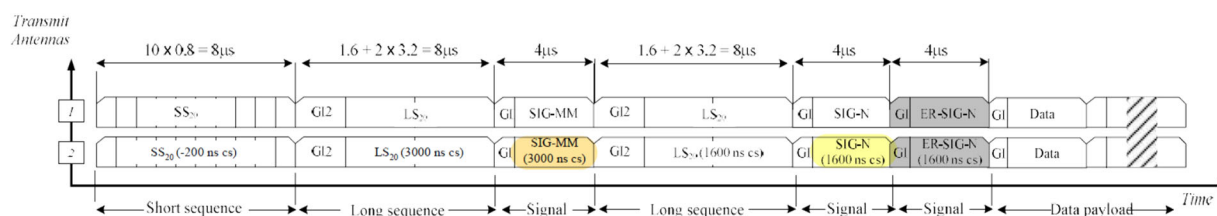


Figure 008 – MIMO-OFDM Training structure for $N_{TX} = 2$, 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.

(INTEL-1005, 67.) As shown, the ER packet includes SIG-N and ER-SIG-N, where ER-SIG-N is a “duplicate [of] SIG-N for extended range communication.” (See *supra* §V.C.2.b.) Additionally, WWiSE discloses repeating the SIG-N header bits by transmitting bits of ER-SIG-N using distinct OFDM subcarriers from those that transmit the bits of SIG-N. (See *supra* §V.C.2.d; INTEL-1005, 69.) Thus, SIG-N’s header bits are repeated in time and frequency.

A POSITA would have understood that repetition of transmitted information at different times and frequencies results in increased time/frequency diversity for the transmitted signal, which makes transmissions more reliable. (See INTEL-1003, ¶117 (citing Tse, et al., *Fundamentals of Wireless Communication* (Cambridge University (2005)) (INTEL-1016, 59, 64 (explaining that diversity improves performance by “ensur[ing] that the information symbols pass through multiple signal paths,” and “[t]here are many way to obtain diversity,” including diversity over time and over frequency).) A POSITA reading WWiSE thus would have understood it to disclose that “the at least one repeated header bit” (ER-SIG-N

repeats SIG-N bits in time and frequency) “*increases reliability of the first packet in the first narrower frequency band*” (e.g., 20MHz). (INTEL-1003, ¶117.)

E. Claims 3, 13, 30, and 33

The “wherein” clauses of claims 3, 13, 30, and 33 should not be afforded any patentable weight because each merely recites the intended result of the recited function. *See, e.g., Hoffer*, 405 F.3d at 1329. For this reason, claims 3, 13, 30, and 33 are obvious for the same reasons as independent claims 1, 11, 21, and 31.

The combination of Hansen and WWiSE discloses a transceiver that transmits an ER, mixed-mode packet where the header bits from the SIG-N symbol are repeated in the ER-SIG-N symbol—both in time and frequency. (*See supra* §§V.C.2.b, V.C.2.d.) A POSITA would have understood that repetition of the bits of SIG-N (in ER-SIG-N) in time/frequency results in increased diversity for the transmitted signal, which makes the transmission more reliable and increases the likelihood that transmitted header information is correctly communicated. (*See* INTEL-1003, ¶118 (citing INTEL-1016, 49 (“By sending signals that carry the same information through different paths, multiple independently faded replicas of data symbols are obtained at the receiver end and *more reliable detection can be achieved.*”); 59 (“diversity ... can dramatically improve the performance over fading channels”).))

A POSITA would thus understand the combination of Hansen and WWiSE to disclose that “*at least one repeated header bit*” (ER-SIG-N repeats SIG-N header bits in time/frequency) “*provides additional diversity to increase a likelihood of correctly communicating header information of the first packet*” (increased temporal and frequency diversity, which makes it more likely that the header will be properly detected and decoded) “*in the first narrower frequency band*” (e.g., 20MHz). (INTEL-1003, ¶119.)

F. Claims 4, 14, 26, and 34

As discussed above, Hansen and WWiSE disclose a 40MHz frequency band, and WWiSE further explains that the 40MHz band “consists of two 20 MHz channels, on each of which there could be 20 MHz transmissions” for devices (e.g., APs) communicating over 20MHz. (See *supra* §V.C.6; INTEL-1005, 49, 84.) WWiSE further explains that one of the 20MHz channels is the “primary channel” and is “in a 40 MHz channel pair that will be used for 20 MHz transmissions as well as being part of the 40 MHz channel for 40 MHz transmissions.” (INTEL-1005, 14.) The 40MHz band (“*the second wider frequency band*”) is thus two times as wide as the 20MHz “primary channel” (“*the first narrower frequency band*”). (INTEL-1003, ¶120.)

G. Claims 5, 15, 27, 35

As discussed above, Hansen and WWiSE disclose the use of a 40 MHz

frequency band that is twice as wide as the 20 MHz frequency band. (*See supra* §V.C.4.b.) It would have been obvious to a POSITA that the wider frequency band could be extended further—for example, to 80MHz, four times the width of the 20MHz “*narrower frequency band*”—to further increase the available bandwidth and thereby increase transmission speed. The benefits of wideband communications for higher throughput were well known in the art at the time of Hansen and WWiSE, and once WWiSE made clear the benefit of a doubled frequency band, a POSITA would have recognized the benefits of even wider (4x or 8x) frequency bands, particularly since WWiSE did not limit the bandwidth increase to 2x. (INTEL-1003, ¶121.) In fact, WWiSE discloses two bits for designating transmission bandwidth in the SIG-N header field of a packet, which can have four possible values (00, 01, 10, and 11), yet WWiSE only addresses two of the four values in Table 11 (below). A POSITA would have recognized that other bit values could be used to designate higher transmission bandwidths—*e.g.*, 80MHz transmission. (INTEL-1003, ¶121.)

Table 011—SIG-N field bit assignment

Bits	Field	Subfield	Parameter	Values
B0 : b5	RSVD		Reserved bits	111111, Bits shall be ignored at the receiver
B6 : b21	CONFIG		Configuration	
B6 : b8		NSS	Number of spatial streams	000: 1, 001: 2, 010: 3, 011: 4
B9 : b11		NTX	Number of transmit antennas	000: 1, 001: 2, 010: 3, 011: 4
B12 : b13		BW	Bandwidth	00: 20 MHz, 01: 40 MHz

(WWiSE, 70.)

H. Claims 6, 16, 28, 36

Hansen and WWiSE disclose the use of a 40 MHz frequency band that is twice as wide as the 20 MHz frequency band. (*See supra* §V.C.5.) It would have been obvious to a POSITA that the wider frequency band could be extended further—for example, to 160MHz, eight times the width of the 20MHz “*narrower frequency band*”—to further increase the available bandwidth and thereby increase transmission speed for the same reasons discussed in §V.G. above.

I. Claims 7, 17, 22 and 37

As discussed above, the combination of Hansen and WWiSE discloses a transceiver that transmits mixed-mode, ER packets with header symbols SIG-N, ER-SIG-N, and SIG-MM, as illustrated, for example, in Figure 008. (*See supra* §V.C.2.b; INTEL-1005, 67.)

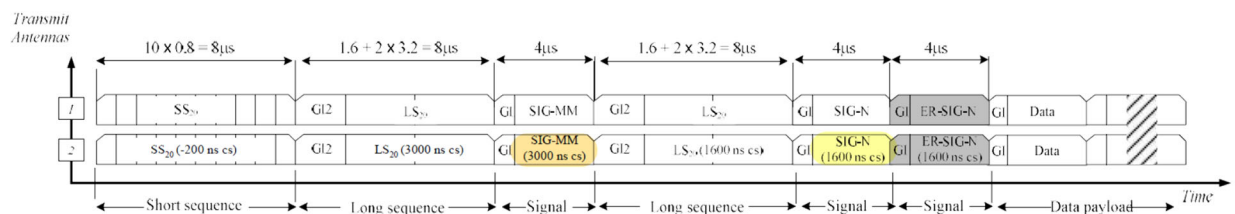


Figure 008 – MIMO-OFDM Training structure for $N_{Tx} = 2$, 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.

WWiSE explains that in the “PLCP Header,” “SIG-N is composed of a single MIMO-OFDM symbol that provides all length and configuration parameters associated with a MIMO-OFDM PPDU” packet—including “bandwidth, modulation, code rate, code type, number of TX antennas, and number of spatial

streams” (INTEL-1005, 58–59, 69–70, 83)—whereas “another symbol, denoted SIGNAL-MM (SIG-MM) is sent in the PLCP header” and provides additional information in mixed-mode communications. (INTEL-1005, 59, 67, 71.) Figure 003 of WWiSE—which is for NR, mixed-mode packets but is nevertheless instructive here—further illustrates the bit differences between the SIG-N and SIG-MM fields, including the fields and the numbers of bits:

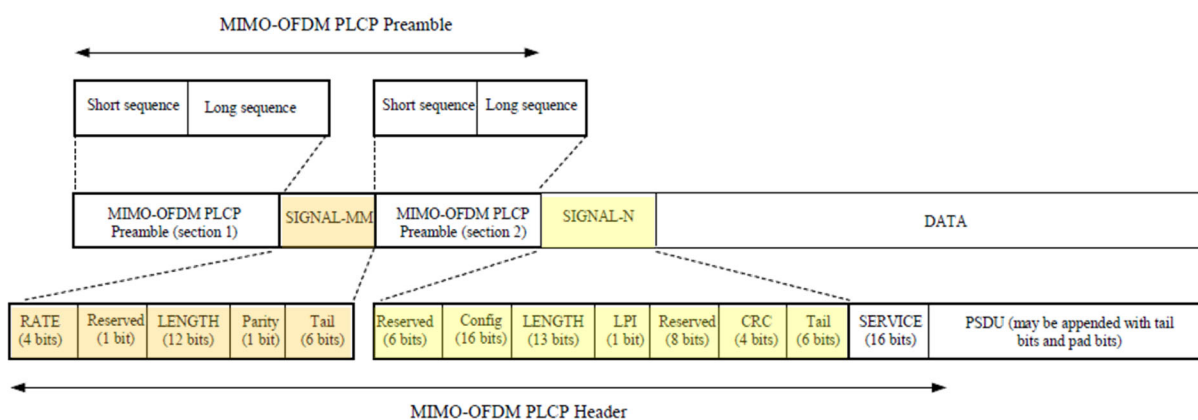


Figure 003 – PPDU frame format: Mixed-mode access in the 1TX (40 MHz) and 2TX (20 and 40 MHz) modes

Header symbol SIG-N (“*a first OFDM symbol*”) thus contains different bits than header symbol SIG-MM (“*a second OFDM symbol*”) in a mixed-mode packet (“*the first packet*”).

J. Claims 8, 18, 23, and 38

As discussed above, the combination of Hansen and WWiSE discloses a transceiver that transmits ER mixed-mode packets with OFDM header symbols SIG-N, ER-SIG-N, and SIG-MM, as illustrated in Figure 008 below. (*See supra* §V.C.2.b; INTEL-1005, 67, 69.)

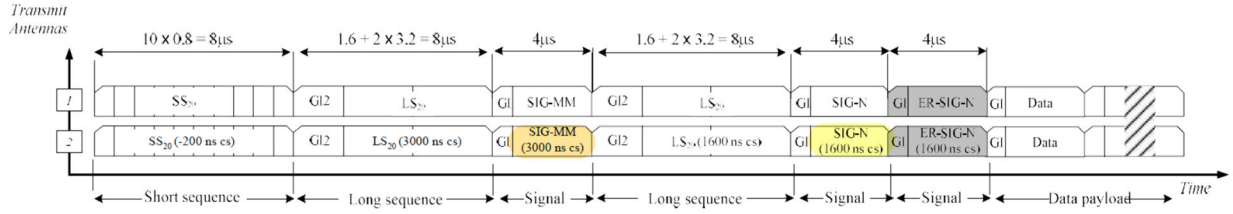


Figure 008 – MIMO-OFDM Training structure for $N_{TX} = 2$, 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.

The ER-SIG-N symbol is a “duplicate [of] SIG-N for extended range communication” and repeats the 54-bit contents of SIG-N. (See *supra* §V.C.2.d.; INTEL-1006, Fig. 008.) Accordingly, SIG-N (“a first OFDM symbol”) and ER-SIG-N (“a second OFDM symbol”) contain the same header bits (“the first plurality of header bits”).

K. Claims 10, 20, 25, and 40

Hansen and WWiSE expressly support multiple versions of IEEE 802.11. WWiSE proposes “[c]hanges and additions to IEEE Std. 802.11-1999 ... as amended by published amendments IEEE802.11a, IEEE802.11g, IEEE802.11h and IEEE802.11i” (INTEL-1005, 1 and 13.) Accordingly, WWiSE builds upon existing 802.11 standards that must be supported by a transmitter in Hansen’s transceiver. (See, e.g., INTEL-1005, 56, 71–72; see also INTEL-1003, ¶127.)

Likewise, Hansen’s wireless transceiver supports mixed-mode access for interoperating with legacy devices that support versions of 802.11 (e.g., 802.11a/b/g). (See, e.g., INTEL-1006, ¶¶9, 32, 41, 61-62, 66, 111-112; INTEL-1006, ¶57 (transceiver supports “the invention”).) Hansen also expressly references

WWiSE's support for "legacy IEEE 802.11 WLAN devices." (INTEL-1006, ¶34.)

Thus, the combined system of WWiSE and Hansen "*supports one or more wireless standards*" (*e.g.*, 802.11a/g). (INTEL-1003, ¶128.)

VI. GROUND 2: Claims 1–8, 10–18, 20–23, 25–38, and 40 Are Obvious Based On the Combination of Zhang and Maltsev.

A. Combination Overview

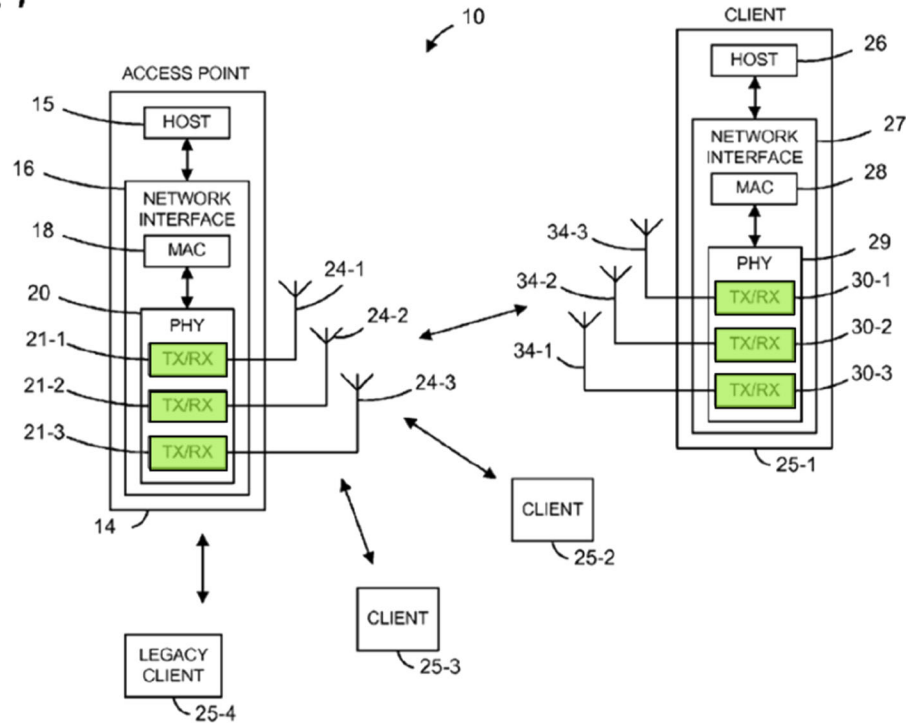
The proposed combination involves the use of Zhang's packet formats and hardware for communicating with 802.11-compliant devices in different frequency bandwidths with Maltsev's flexible channel-width capability for communicating with narrowband devices in a narrower frequency band and wideband devices in a wider frequency band within the same network.

1. Zhang

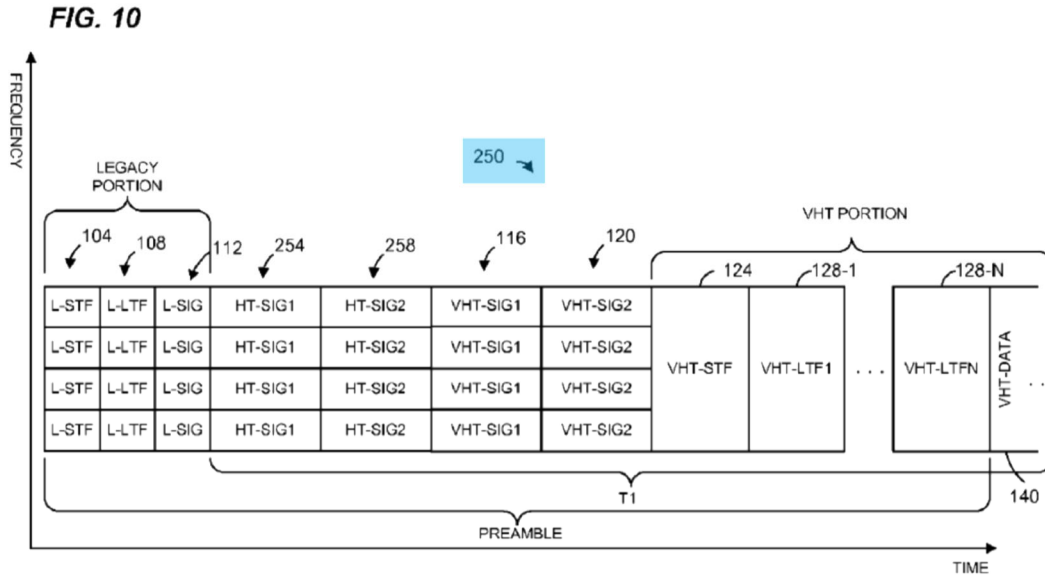
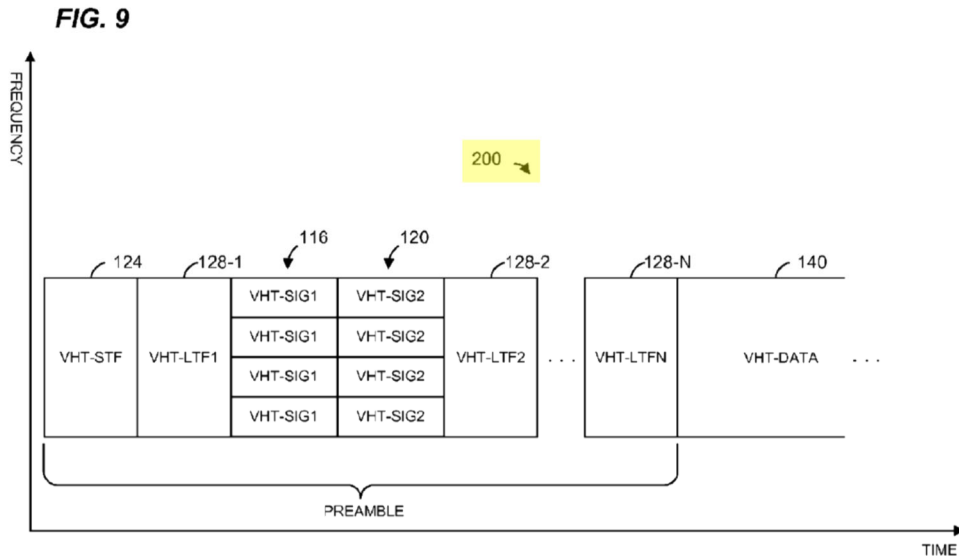
a. Overview

Zhang discloses "wireless local area networks that utilize orthogonal frequency division multiplexing (OFDM)" (INTEL-1017, ¶17) and that include wireless network devices "such as an access point (AP) ... [that] transmits data streams to one or more client stations" (INTEL-1017, Fig. 1 (below), ¶62). Zhang's devices (*e.g.*, APs) each include a wireless OFDM transceiver operable to transmit/receive packets in a wireless network. (*See* INTEL-1017, Fig. 1, ¶¶64, 66, 69-70.)

FIG. 1



Zhang provides multiple physical layer (PHY) packet frames—referred to as “data units”—that are formatted to facilitate communications among devices compliant with different 802.11 standard communication protocols in the same WLAN (INTEL-1017, Abstract, ¶¶62–63), including “legacy” devices such as those that support 802.11a (INTEL-1017, ¶¶31–32). For example, Zhang discloses (1) a “mixed mode” packet format such as “data unit 250” of Figure 10 for situations “when the WLAN [] includes at least one ... legacy client station” that supports an older version of 802.11 (e.g., 802.11a) (INTEL-1017, ¶102, Fig. 10), and (2) a “Greenfield” format such as “data unit 200” of Figure 9 for situations “when the WLAN [] does not include any ... legacy client station[s]” (INTEL-1017, ¶100, Fig. 9).



Zhang further discloses transmitting packets in frequency bands of different sizes, such as 20MHz, 40MHz, and 80MHz, and provides bit(s) in the VHT-SIG header fields to indicate which 20/40/80MHz bandwidth is being used. (See INTEL-1017, ¶¶83, 85, 95, 100, 102).

b. Zhang Is Prior Art

Zhang claims priority to multiple provisional applications, including

application 61/229,900 (“the ’900PROV”), filed on July 30, 2009 (before the earliest claimed priority date of the ’566 patent). Zhang is entitled to priority based on the ’900PROV under 35 U.S.C. §119(e) because Zhang was filed not later than 12 months after the filing date of the ’900PROV and contains a specific reference to the provisional application.⁵

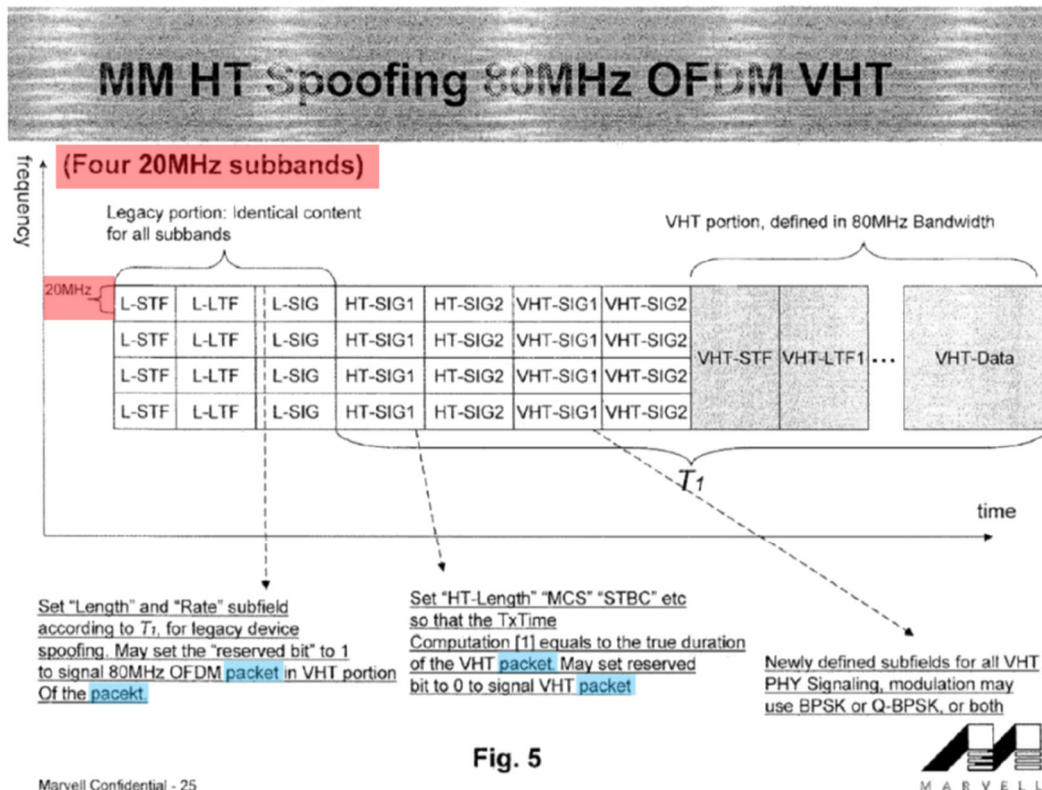
Furthermore, a nonprovisional patent application publication is prior art as of the earlier filing date of a provisional application if the disclosure of the provisional provides 35 U.S.C. § 112 support for at least one claim in the publication. *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1381–82 (Fed. Cir. 2015); *see also Amgen Inc. v. Sanofi*, 872 F.3d 1367, 1380 (Fed. Cir. 2017) (holding that *Dynamic Drinkware* applies to published patent applications); *Medtronic, Inc. v. Niazi Licensing Corp.*, IPR2018-00609, Paper 8 at 11 (PTAB Aug. 20, 2018) (holding §112 support only needed for one claim in the publication); *Benitec Biopharma Ltd. v. Cold Spring Harbor Lab.*, IPR2016-00014, Paper 7 at 7 (PTAB Mar. 23, 2016) (same). Here, the ’900PROV supports at least claim 1 of Zhang, as explained below.

⁵ Petitioner provides supporting citations from both Zhang and the ’900PROV for each claim limitation analyzed in Ground 2.

'900PROV Claim 1	
[1PRE]	A method for generating a data unit for transmission via a communication channel, the data unit conforming to a first communication protocol, the method comprising:
[1A]	generating a preamble of the data unit, wherein the preamble includes a first field having information that indicates a duration of the data unit, the first field being formatted such that the first field is decodable by a receiver device that conforms to a second communication protocol but does not conform to the first communication protocol to determine the duration of the data unit based on the first field,
[1B]	the preamble is formatted such that a portion of the preamble is decodable by a receiver device that conforms to a third communication protocol but does not conform to the first communication protocol, and
[1C]	the preamble is formatted such that a receiver device that conforms to the first communication protocol can determine that the data unit conforms to the first communication protocol; and
[1D]	generating a data portion of the data unit that conforms to the first communication protocol and does not conform to either (i) the second communication protocol or (ii) the third communication protocol.

(i) Preamble [1Pre]

The '900PROV discloses an 80MHz mixed-mode (MM), HT spoofing, very high-throughput (VHT) wireless OFDM “packet” as shown in Figure 5.



(INTEL-1019, 25 (Fig. 5).) A POSITA would understand a “packet” to be a “data unit” as the terms are used interchangeably in 802.11 wireless communications. (INTEL-1003, ¶134.) For example, the 802.11-1999 standard refers to network packets/frames as protocol *data units* (PDUs). (See INTEL-1013, at 7.) Zhang also uses the terms “data unit” and “packet” interchangeably. (INTEL-1017 ¶110 (“[T]he current *packet* could be either an IEEE 802.11a *data unit* or a *data unit* that conforms to the first communication protocol.”); see also INTEL-1019, 4 (referring to legacy 11a/n frame formats as PPDU’s).) The packet in Figure 5 of the ’900 provision is thus a “data unit.” (INTEL-1003, ¶134.)

The data unit of Figure 5 contains very high-throughput fields “VHT-SIG1”

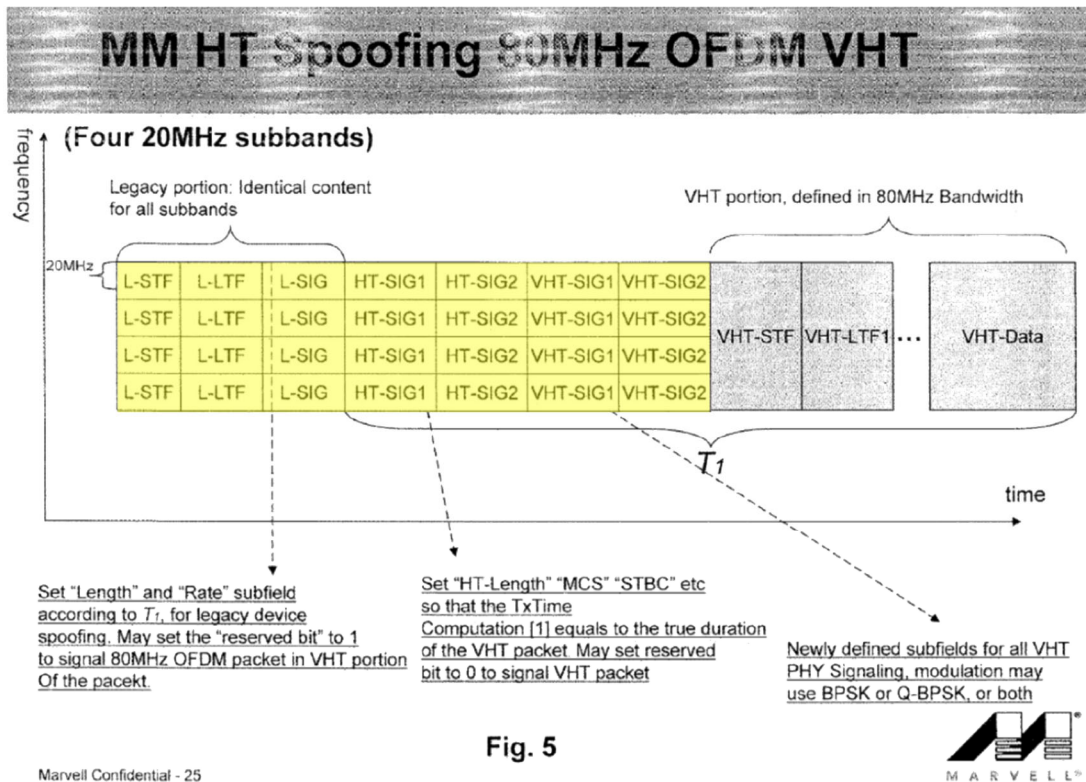
and “VHT-SIG-2” which a POSITA would recognize as conforming to the then-forthcoming IEEE 802.11ac standard (“*first communication protocol*”). (INTEL-1019, Figure 5; INTEL-1003, ¶135); *see also* INTEL-1019, slide 1 (“Thoughts on 802.11ac Preamble”).)

Further, as shown in Figure 5, the VHT data unit is transmitted in an 80MHz communications channel comprising four 20MHz subbands. (INTEL-1019, 2, 5, Fig. 5; INTEL-1003 ¶136.) Thus, the ’900PROV discloses “*generating a data unit*” (e.g., 80MHz VHT data unit) “*for transmission via a communications channel*” (e.g., 80MHz channel comprising four 20MHz subbands), “*the data unit conforming to a first communication protocol*” (e.g., 802.11ac). (INTEL-1003 ¶136.)

(ii) Claim Limitation [1A]

Figure 5 of the ’900PROV below discloses generating a VHT data unit with preamble fields (shaded yellow). (INTEL-1019, 25, 43 (“Preamble Design” of a short mixed-mode packet); INTEL-1003 ¶137).) The preamble includes a legacy signal field “L-SIG” (“*first field*”) that is compatible with legacy devices (e.g., devices that support 802.11a). (See ’INTEL-1019, 5 (“Legacy 20/40MHz OFDM device **is at least able to receive the preamble and/or signal field** of the 80MHz OFDM signal, in one of the PHY modes (‘mixed mode’).”).) L-SIG includes a “length” subfield that indicates the duration “T” of the VHT data unit. (INTEL-1003, ¶138.)

- For backward compatibility, set “rate” and “length” field in L-SIG according to the true length (T) of the VHT packet, so “spoofing” is possible for 11a device.
 - 11a device will see data error from “VHT-SIG1” field, according to the 11a receiver state machine [2], the 11a receiver should hold CCA until the end of the L-SIG-computed packet duration.



(INTEL-1019, 10, 25.)

A legacy receiver that conforms to 802.11a (“*second communication protocol*”) will not conform to subsequent versions of 802.11—including 802.11ac (“*first communication protocol*”)—without additional hardware and/or software development. (INTEL-1003, ¶139.) Accordingly, 802.11ac provides a VHT packet structure with VHT fields that are not decodable by 802.11a devices. (INTEL-1003 ¶141.) In addition, VHT packets are transmitted in wider frequency bands beyond the 20MHz at which an 802.11a receiver operates. (INTEL-1003, ¶139.)

As discussed in §VI.A.1.b.(ii)(a), *supra*, the L-SIG (“*first field*”) includes the true length (or duration) T of the VHT data unit, and 802.11a devices determine the duration of the VHT data unit by decoding L-SIG to learn the value of T . (INTEL-1003, ¶140.) L-SIG thus “spoofs” legacy 802.11a devices on the WLAN by telling them not to use the communication channel for the duration of the data unit. (INTEL-1003, ¶140.)

(iii) Claim Limitation [1B]

The preamble of the VHT data unit of Figure 5 also includes signal fields “HT-SIG” (shaded pink in Fig. 5 below).

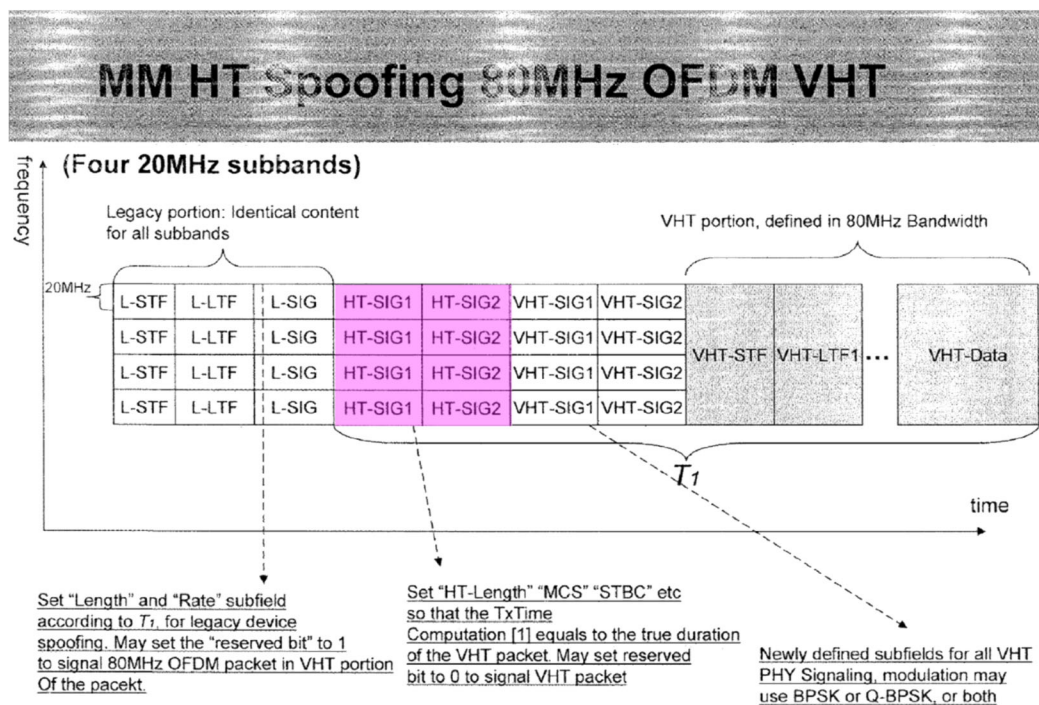


Fig. 5

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(INTEL-1019, 25 (Fig. 5).) A POSITA would have known that HT-SIG fields are decodable by 802.11n receivers (“*third communication protocol*”)—as

the '900PROV explains, the fields are formatted and modulated “for a 11n receiver.” (INTEL-1019, 11 (“The subfields format may be the same as HT-SIG of 11n.”), 28 (below); INTEL-1003, ¶141.)

Discussions

- L-SIG in Fig 5 may set the reserved bit to “1” to signal 11ac receiver the presence of VHT packet (i.e. VHT-SIG1,2 will follow HT-SIG2).
- HT-SIG Fields in Fig 5,6, are formatted/modulated the same way as in 11n [1].
- “HT-LENGTH”, “MCS”, “STBC” subfields in HT-SIG fields should be set such that the TXTIME computation for a 11n receiver equals to the true packet duration of the VHT packet.
 - See 20.4.3 of [1] for the detailed way of computing TXTIME.
 - So 11n Spoofing is achieved: 11n receiver will see “carrier lost” after decoding HT-SIG2, so according to its state machine in [1], it will hold CCA until the end of TXTIME.

But HT-SIG fields decodable by 802.11n devices (“*third communication protocol*”) do not conform to 802.11ac (“*first communication protocol*”) because the formats are “completely different” and the modulation “may be defined differently.” (INTEL-1019, 11–12; INTEL-1003, ¶142.)

- Alternatively, the subfields format may be completely different from HT-SIGs in [1], for VHT packet PHY information signaling.
 - E.g. the subfield in HT-SIG “BW20/40” may not be needed, or combined with the reserved bit to select 20/40/80; the subfield “aggregated” may not be used, etc
 - Since modulation of VHT-SIG may be different from HT-SIG (next slide), so 11n device may not correctly decode VHT-SIG as HT-SIG (CRC error), this allows completely redefinition of VHT-SIG.
 - All different arrangement of the new VHT-SIG subfields should be covered by this disclosure.

- To differentiate VHT-SIG from HT-SIG, the modulation of VHT-SIG may be defined differently from HT-SIG in [1].
- VHT-SIG1 is modulated using 90-deg rotated BPSK (Q-BPSK) in each data tone of the OFDM symbol, and VHT-SIG is modulated using normal BPSK in each subcarrier:
 - HT-SIG2 in 11n [1] also modulated using Q-BPSK.
 - For backward compatibility, a 11n receiver will not decode VHT-SIG2 as HT-SIG2 correctly, and the CRC check for both HT-SIG1 and 2 will fail. According to [1], the 11n receiver state machine will wait (hold CCA) until the energy of the packet drops out, before switching to CCA idle mode. On the other hand, a 11a device will see data error from “VHT-SIG1” field (as for 11n MM HT packet [1]), according to [2], the receiver should hold CCA until the end of the LSIG-computed packet duration (spoofing).

(iv) Claim Limitation [1C]

The '900PROV discloses VHT signal fields “VHT-SIG” decodable by forthcoming 802.11ac devices (“*first communication protocol*”). (INTEL-1019, slide 1 (“Thoughts on 802.11ac Preamble”), 2, 42.) The preamble is formatted by setting a “reserved bit in VHT-SIG2 to 0 ... to signal [to] VHT device[s] that the current packet is a VHT packet.” (INTEL-1019, 11.) 802.11ac-compliant devices can thus determine data unit conforms to 802.11ac when the reserved bit in VHT-SIG2 is set to 0. (INTEL-1003, ¶143.)

(v) Claim Limitation [1D]

As shown in Figure 5 below, the '900PROV discloses generating the VHT data unit's data portion (shaded red) that conforms to 802.11ac (“*first protocol*”) but does not conform to 802.11a (“*second protocol*”) or 802.11n (“*third protocol*”). (INTEL-1003, ¶144.)

MM HT Spoofing 80MHz OFDM VHT

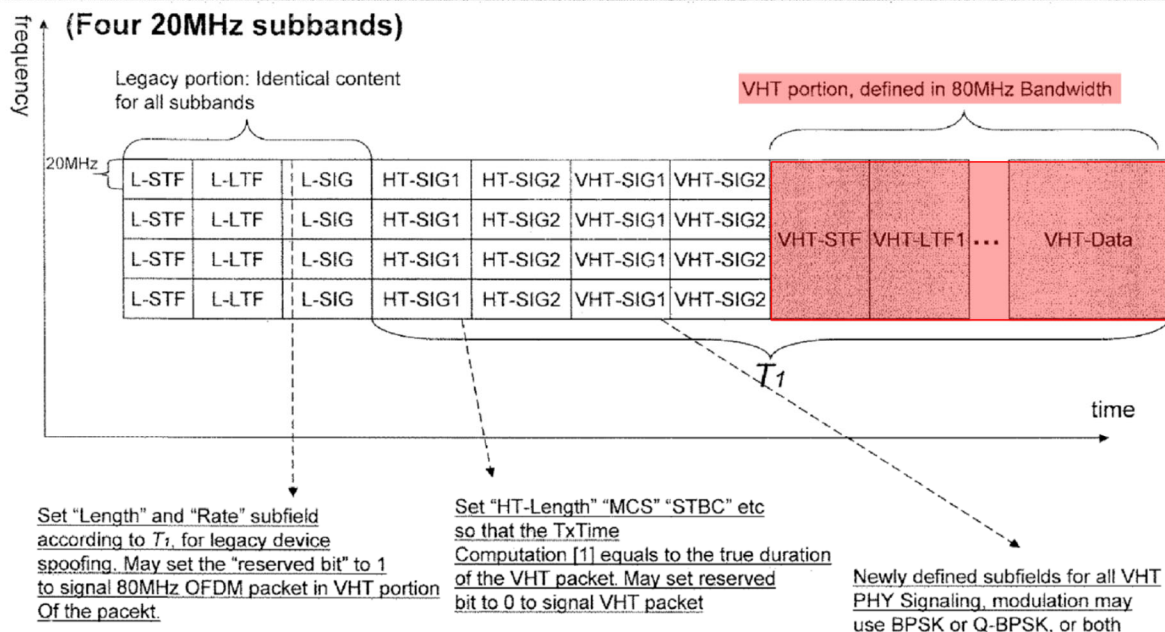


Fig. 5



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(INTEL-1019, 25.) As shown, the data portion is defined over the entire 80MHz channel, which is not compatible with either of the legacy 802.11a/n standards.

(INTEL-1003, ¶144)

Mixed Mode: VHT Portion

- VHT-STF, VHT-LTFs, and VHT-Data OFDM symbols are defined similar to HT-STF, HT-LTFs and HT-Data as in 11n [1], except that each OFDM symbol is defined over 80MHz bandwidth.

The '900PROV thus supports claim 1 of Zhang, confirming that Zhang is prior art to the challenged '566 patent. (INTEL-1003, ¶145.)

2. Maltsev

Maltsev was filed on September 30, 2003 and also discloses communicating different packet formats among wireless OFDM devices with different capabilities in different channel bandwidths within the same WLAN. (INTEL-1018, Abstract, Fig. 1, 2:3–29.)

Maltsev teaches communicating with HT devices in a wider frequency band while also communicating with “narrower-band” devices (*e.g.*, 802.11a/g legacy devices) in a narrower frequency band. (INTEL-1018, 2:18–22, 3:29–55, 4:37–41, 5:58–63, 8:25–27.)

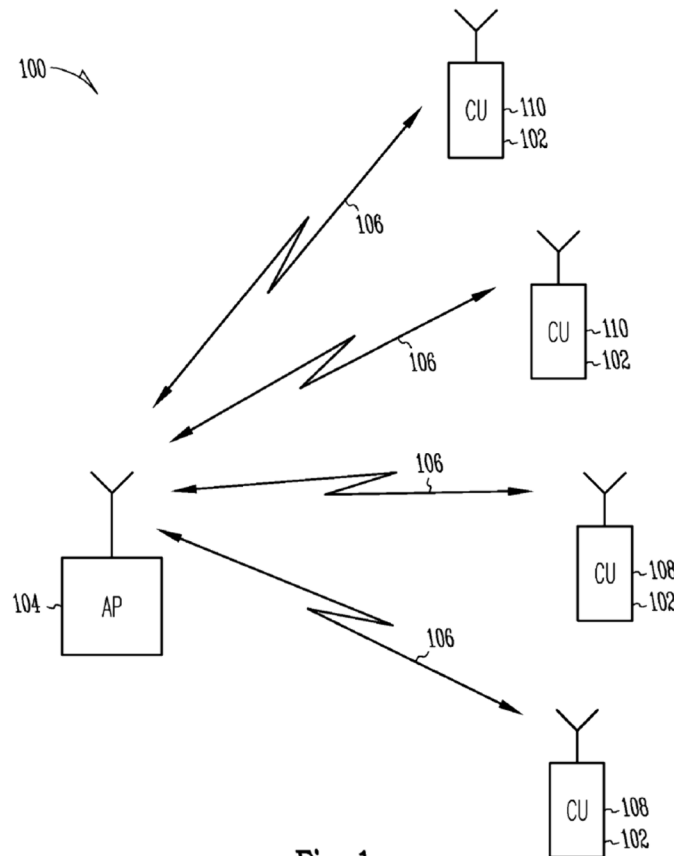


Fig. 1

Maltsev also explains that “packets” carry “data units.” (See INTEL-1018, 4:16–18.) And Maltsev provides OFDM packets with a “predetermined frame structure” for “sharing of channels among narrow-band CUs [communication units] and wider-band CUs ...” (INTEL-1018, 3:51–55; *see also* INTEL-1018, 4:27–31, 8:25–27.) Maltsev’s channels—like the ones disclosed in Zhang—are “20 MHz channels” within an “80 MHz portion of the spectrum” (INTEL-1018, 4:47–49.)

Maltsev teaches scanning the communications channels to detect the presence of narrower-band CUs, and then using that information to select the “operating channels as well as the type of physical layer packet format to be used.” (INTEL-1018, 4:27–31.) These frame formats are the mechanism Maltsev uses “to adapt dynamically to channel conditions by measuring the state of a channel and providing feedback on channel state.” (INTEL-1018, 7:43–45.)

B. Motivation to Combine

It would have been obvious to a POSITA for Zhang’s network packets to be communicated to newer 802.11 devices in a wideband and to legacy devices in a narrowband in the same network, as taught by Maltsev.

First, Zhang teaches communicating with devices compliant with one or more 802.11 communication protocols in different-sized frequency bandwidths in the same WLAN, and providing a 20/40/80MHz bit in the VHT-SIG header field to indicate the transmission bandwidth to be used. (INTEL-1017, ¶¶74–75, 83, 85.)

Similarly, Maltsev—which is in the same field as Zhang—discloses scanning the network to determine the presence of narrowband devices and using that information to vary communication bandwidth by selecting the “operating channels as well as the type of physical layer packet format to be used.” (INTEL-1018, 4:27–31.) Both references thus teach the use of different-sized frequency bandwidths for communications with mixed-mode 802.11 devices in a single WLAN. (INTEL-1003, ¶150)

A POSITA would have recognized that combining the disclosures would give Zhang’s devices greater flexibility and efficiency by using less bandwidth (narrower channels) for communicating with legacy devices, while reserving wider bandwidths for communications with newer 802.11 devices. This would reduce the system’s overall bandwidth usage and provide an accompanying reduction in inter-channel interference. (*See* INTEL-1018, 3:1–15; EX1003, ¶151.) Furthermore, allowing flexible channel-width transmission in different bandwidths increases overall system capacity by allowing a given station to communicate with legacy and newer devices in different bandwidths in parallel. (EX1003, ¶151.)

Second, the combination involves a simple substitution of one known element (Maltsev’s communication with both new and legacy 802.11-compliant devices in different-sized frequency bands in the same WLAN) for another (Zhang’s communication with both new and legacy 802.11-compliant devices in different-

sized frequency bands (*e.g.*, one after another)) to obtain predictable results (improving system efficiency and capacity). Zhang discloses “an AP that is configured to operate with client stations according to a plurality of different communication protocols and/or WLANs in which a plurality of client stations operate according to a plurality of different protocols.” (INTEL-1017, ¶63.) And Zhang teaches using “mixed mode” packet formats for communicating among both new and legacy 802.11 devices. (*See* INTEL-1017, ¶¶31–32, 64, 74, 102.) Zhang further teaches communicating mixed-mode packets among devices of different 802.11 protocols in different-sized frequency bands such as 20 MHz, 40 MHz, and 80 MHz, and describes encoding bits in the packet header to indicate the transmission bandwidth for the WLAN. (*See, e.g.*, INTEL-1017, ¶¶74, 83, 85.) It would have been obvious to a POSITA that Maltsev’s method of communicating with network devices in different-sized frequency bands in the same WLAN (INTEL-1018, 3:29–40, 4:37–49, 5:58–63, 8:25–27) is substitutable for Zhang’s use of different-sized transmission bandwidths for, *e.g.*, communications with new and legacy devices. (INTEL-1003, ¶152.) This would have improved the efficiency and capacity of Zhang’s system, especially when legacy 802.11 devices are in the WLAN. (INTEL-1003, ¶152.)

Third, the combination involves applying a known technique (Maltsev’s flexible channel-width communications with 802.11-compliant devices in different-

sized frequency bands) to a known device (Zhang's 802.11-compliant OFDM transceiver) that was ready for improvement (improved capacity and efficiency). Zhang's wireless OFDM transceiver, like the systems taught by Maltsev, is part of a wireless communications system that conforms to one or more versions of 802.11. (INTEL-1017, ¶¶31–32, 64; INTEL-1018, 2:18–32, 3:29–40, 5:43–49, 6:8–18.) In addition, Zhang's transceivers communicate in different-sized frequency bands like the ones disclosed in Maltsev, but Maltsev expressly teaches a “flexible channel-width capability” for communicating in those different frequency bandwidths based on the capabilities of the receiving devices. (INTEL-1018, 3:29–55.) Zhang already provided a mechanism to change the frequency bandwidth based on the 20/40/80MHz frequency bandwidth selection bit in VHT-SIG (INTEL-1017, ¶¶83, 85), and nothing in Zhang suggests that the transceiver would have been incapable of using Maltsev's flexible channel-width capability for transmitting in different-sized frequency bandwidths. (INTEL-1003, ¶153.)

Fourth, Zhang and Maltsev teach two ways to communicate with new and legacy 802.11 devices over different bandwidths: one at a time or in parallel. It would have been obvious to a POSITA reading Zhang to try Maltsev's parallel communication approach to improve WLAN efficiency and capacity as discussed above.

In addition, a POSITA would have had a reasonable expectation of success in

making the combination based on Maltsev's teaching of how to implement such a WLAN system. (INTEL-1003, ¶155.) As discussed above, both Zhang and Maltsev disclose transmitting header bits in different OFDM packet formats over different frequency bandwidths. (INTEL-1017, Figs 2A, 3-6, 9-11, 13-15, 17-21, ¶¶74-75, 82, 83, 85, 95, 102; INTEL-1018, Figs. 4-6, 3:29-55, 5:26-57.) Additionally, both Zhang and Maltsev disclose operating in a WLAN that supports one or more versions of 802.11. (INTEL-1017, ¶¶31-32, 64; INTEL-1018, 2:18-32, 3:29-40, 5:43-49, 6:8-18.) Thus, Maltsev's method of providing flexible channel-width communications with both narrowband and wideband devices operating in different frequency bandwidths would be compatible with Zhang's packets, which are designed to operate in 802.11 networks and already provide bits in VHT-SIG to indicate the transmission bandwidth for the WLAN. (INTEL-1017, ¶¶74-75, 83, 85.) And because Maltsev's methods can be deployed in the type of 802.11 WLAN described in Zhang, a POSITA would have expected Maltsev's technique to provide the benefits and functionality that Maltsev describes to Zhang's network. (INTEL-1003, ¶155.) This includes the improved efficiency and capacity and reduced interference described above. (*See* INTEL-1018, 3:1-15; INTEL-1003, ¶155.)

C. Independent Claims 1, 11, 21, and 31

Zhang in combination with Maltsev renders these claims obvious, as set forth below.

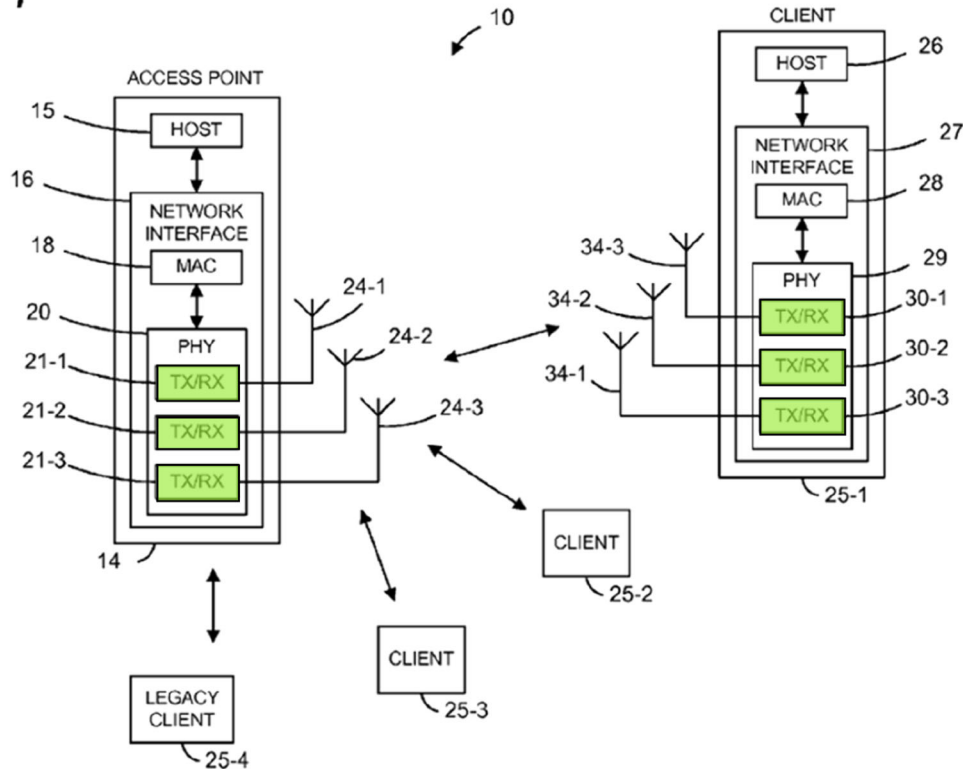
1. Preamble [1Pre], [11Pre], [21Pre], and [31Pre]

Petitioner does not acquiesce that the preamble is limiting. Nevertheless, the combination of Zhang and Maltsev discloses the preamble. (INTEL-1003, ¶157.) Zhang describes “wireless local area networks that utilize orthogonal frequency division multiplexing (OFDM)” (INTEL-1017, ¶17) and “a wireless network device such as an access point (AP) ... [that] transmits data streams to one or more client stations” (INTEL-1017, ¶¶62, 69; INTEL-1019, 1–3, 5–6, 10.) As shown in Figure 1 below, Zhang’s devices include a wireless OFDM transceiver (shaded green) coupled to an antenna for transmitting/receiving wireless packets.⁶ (INTEL-1017, Fig. 1, ¶¶64, 66, 69–70; INTEL-1019, 3, 5–6, 49.)⁷

⁶ In Zhang, a “packet” is a “data unit.” (*E.g.*, INTEL-1017 ¶110, Figs. 5–6, 9–11 (depicting data unit formats); INTEL-1019, 1–6, 8–9, 12, 26, 28, 33, 42, Figs. 1–2, 3, 5–6; INTEL-1003, ¶157.)

⁷900PROV does not use the term “transceiver,” but it describes 802.11-compliant APs and STAs with both transmitting and receiving capabilities (*e.g.*, INTEL-1019, 3 (“40MHz, or 20MHz bandwidth **OFDM signal is transmitted from transmitter to receiver** ... multiple spatial streams may be **transmitted/received** over multiple antennas ...”)) that a POSITA would understand to be performed by a transceiver in each device in Zhang’s WLAN. (*See* INTEL-1003 ¶157 (citing *IEEE*

FIG. 1



Furthermore, Maltsev discloses transceivers capable of “(HT) wideband (WB) communications with wireless local area networks (WLANs).” (INTEL-1018, 1:10–12.) Maltsev’s WLAN includes “one or more communications units (CUs)” which “communicate with one or more access points (AP) ... over wireless communication links” like those described in Zhang. (INTEL-1018, 2:5–14, Fig. 1; INTEL-1017, ¶19; INTEL-1019, 2–3.) Each of Maltsev’s 802.11-compliant devices (i) comprise a “transmitting unit, a receiving unit, **or both**” with “transmitting and receiving

100: *The Authoritative Dictionary of IEEE Standard Terms*, 1198 (IEEE 7th ed., 2000)).)

capability to establish duplex communications therebetween” (INTEL-1018, 2:18–25, 60–67), and (ii) communicate with each other “using a multi-carrier transmission technique, such as ... OFDM” (INTEL-1018, 2:22–28).

2. Claim Limitations [1A], [11A], [21A], and [31A]

The combination of Zhang and Maltsev discloses these limitations.

a. Modulator operable to modulate ... OFDM symbols

Zhang discloses modulating the L-SIG, HT-SIG and VHT-SIG header fields. (INTEL-1017, ¶¶86–89, Figs. 7A–7C.) Each of these fields is modulated by one OFDM symbol. (INTEL-1017, ¶91; INTEL-1019, 11, 15, 25.) Zhang further discloses using a 256-point Inverse Fast Fourier Transform (IFFT) functional unit, which a POSITA would understand is an OFDM system’s modulator to modulate the incoming data stream and produces OFDM symbols at the output for transmission over the channel. (INTEL-1017, 95; INTEL-1019, 16; INTEL-1003, ¶¶47, 49–51 (citing INTEL-1021, 48–49), 160.)

b. A first number of OFDM symbols to transmit a first plurality of header bits in a first packet

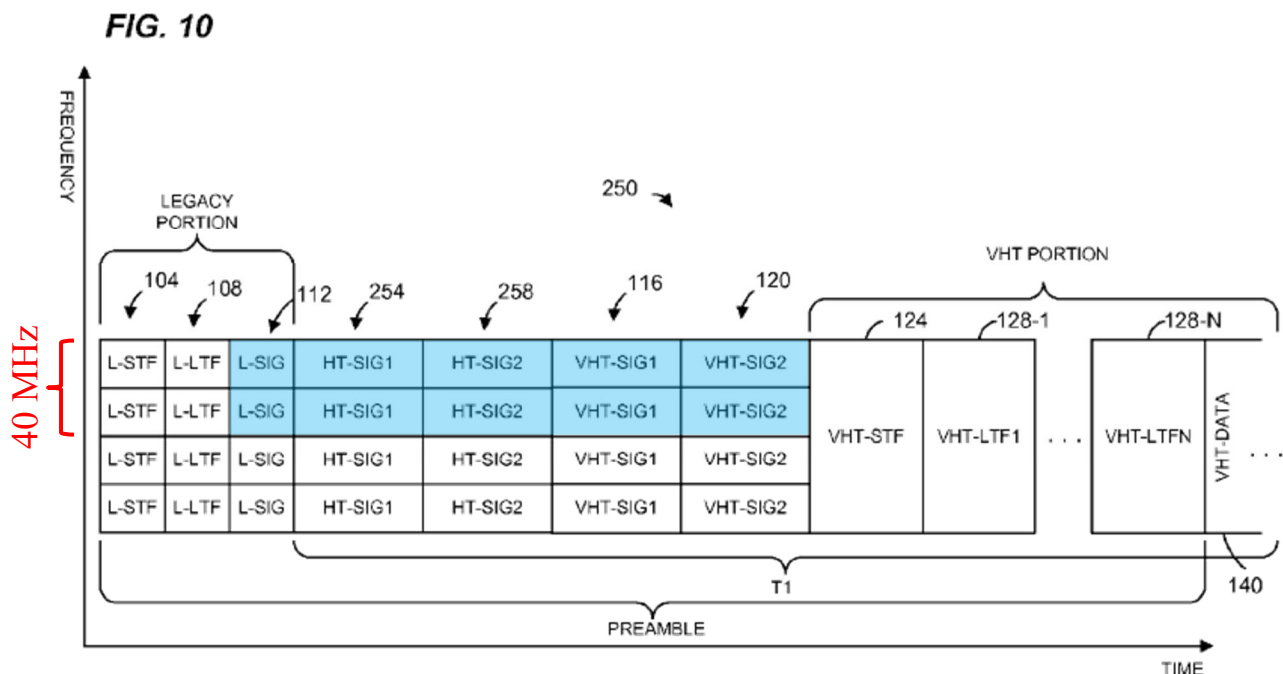
OFDM data unit 250 shown in Zhang’s Figure 10 below is an example of a first packet with a first number of OFDM symbols. (INTEL-1017, ¶102, Fig. 10; INTEL-1019, 25 (Fig. 5).) Data unit 250 “conforms to the first communication protocol” and “occupies an 80 MHz band.” (INTEL-1017, ¶102; INTEL-1019 25.) “In other embodiments, data units ... occupy different bandwidths such as 20 MHz,

40 MHz” (INTEL-1017, ¶102; INTEL-1019, 5–6, 10–11, 15, 30.) Zhang explains that data unit 250 is “suitable for ‘mixed mode’ situations, i.e., when the WLAN 10 includes at least one ... legacy client station ... that conforms to the IEEE 802.11a Standard and/or the IEEE 802.11n Standard.” (INTEL-1017, ¶102, Fig. 10; INTEL-1019, 2, 5, 25.)

“The data unit 250 is similar to the data unit 100 of FIG. 5, but includes HT-SIG1s [] and HT-SIG2s” (INTEL-1017, ¶103; INTEL-1019, 8, 25.) Each VHT-SIG header field in data unit 250 is ‘modulated by one OFDM symbol’ and “occup[ies] a 20 MHz band” (INTEL-1017 ¶¶75, 91, 103; INTEL-1019, 11, 15, Fig. 1) and is “repeated in four 20MHz subbands” of the 80MHz frequency band. (INTEL-1019, 6.) But Zhang also describes 802.11 data units that “have a bandwidth less than 80 MHz (e.g., 40 MHz or 20 MHz)” and “utilize a similar preamble.” (INTEL-1017, ¶108; INTEL-1019, 30 (“Figs1~7 may be redrawn for 40MHz, or 20MHz BW VHT signals.”).)

As a result, the number of OFDM symbols transmitted in a packet depends on the transmission bandwidth used—*i.e.*, “**one of each** ... for an OFDM data unit occupying 20 MHz, **two of each** of the fields for a 40 MHz bandwidth OFDM data unit,” etc. (INTEL-1017, ¶75; INTEL-1019, 5–6, 10–11, 15, 30.) For example, as shown in the diagram below, when data unit 250 is communicated over a 40MHz frequency band (which is a narrower frequency band), the packet includes two of

each of the header fields (shaded blue) and the number of OFDM header symbols is equal to ten based on counting one symbol per header field. (See INTEL-1017, ¶91; INTEL-1019, 11, 15 (“Each VHT-SIG is modulated by one OFDM symbol.”); INTEL-1003, ¶162.)



(INTEL-1017, Fig. 10, INTEL-1019, 25.)

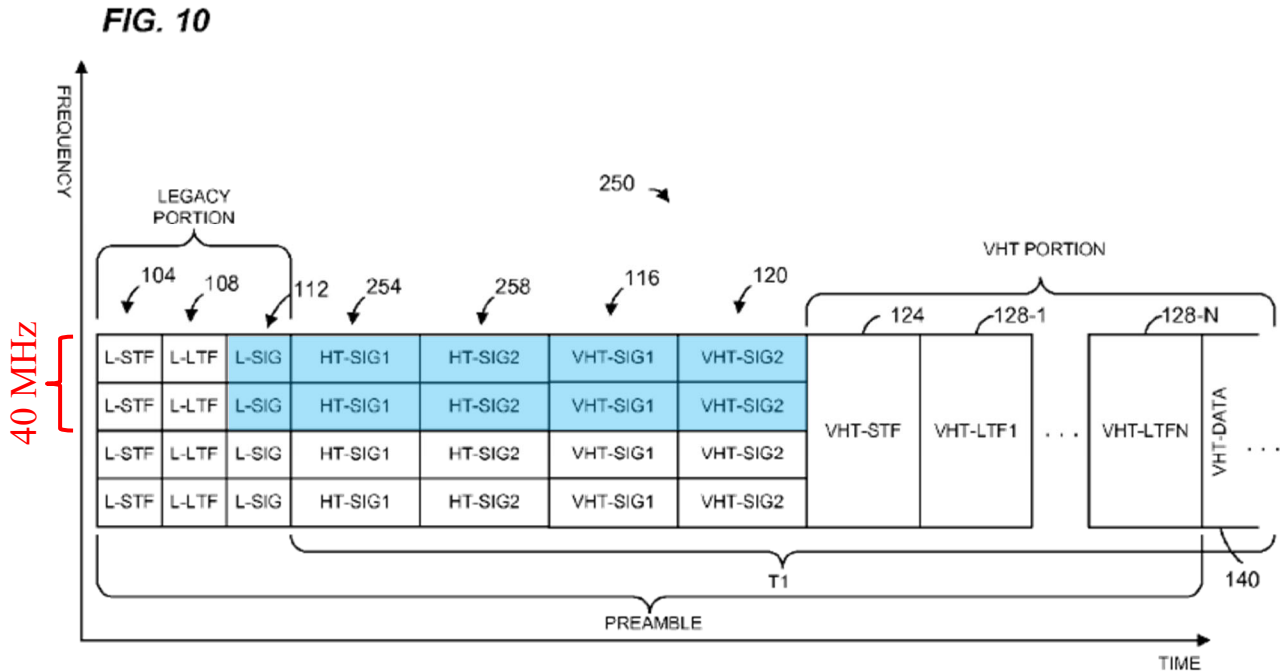
c. “Header” bits/portion

Each of L-SIG, HT-SIG1, HT-SIG2, VHT-SIG1 and VHT-SIG2 are fields of header bits because, like the “header” described in the ’566 patent, they “contain[] important control information for the receiver to decode the payload properly” and “provide[] information about the packet length for virtual carrier sensing.” (INTEL-1001, 1:45–48.) For example, these fields include “a modulation and coding scheme (MCS) field” that provides information to enable the receiver to properly decode the

payload. (INTEL-1017, ¶¶79, 104, 135–136, 143; INTEL-1019, 11–15, 28); INTEL-1003, ¶163.) L-SIG and VHT-SIG also include a reserved bit which is used to identify the packet format so the receiver can properly decode the payload. (INTEL-1017, ¶82; INTEL-1019, 11; INTEL-1003, ¶163.) And these fields further include “length and rate subfields” that are “set to indicate the duration T corresponding to remainder of the data unit ... for **carrier sense** multiple access/collision avoidance ... purposes.” (INTEL-1017, ¶¶76, 103–104, 120; INTEL-1019, 10, 22, 24–25, 28, 42.) This describes “virtual carrier sensing” and is done “so the receiver should hold CCA for appropriate amount of time (e.g. according to the duration as indicated in the length field” (INTEL-1017, ¶120; INTEL-1019, 10, 12, 22.); INTEL-1003, ¶163.)

d. At least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers

Zhang discloses repeating (*i.e.*, sending more than once) at least one header bit of data unit 250 on a plurality (*i.e.*, more than one) of OFDM subcarriers. As discussed in §VI.C.2.b, *supra*, Zhang teaches transmitting a different number of OFDM symbols depending on the transmission bandwidth. In the examples shown below for data unit 250 transmitted in a 40MHz band, header symbols L-SIG, HT-SIG1, HT-SIG2, VHT-SIG1 and VHT-SIG 2 (shaded blue) are repeated on two 20MHz subcarriers.



(INTEL-1017, Fig. 10.)

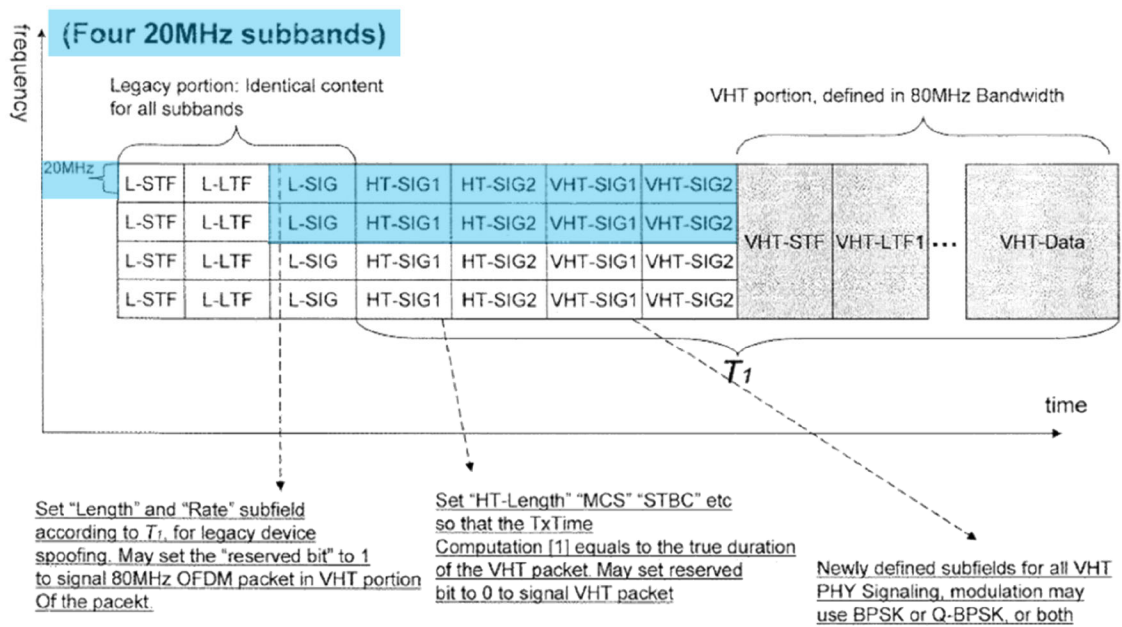


Fig. 5



(INTEL-1019, Fig. 5.)

Zhang therefore discloses "*a modulator operable to modulate*" (e.g., IFFT to

modulate L-SIG, HT-SIGs, and VHT-SIGs) “*a first number of OFDM symbols to transmit a first plurality of header bits*” (e.g., ten symbols for transmitting L-SIGs, HT-SIGs, and VHT-SIGs) “*in a first packet*” (e.g., data unit 250) “*wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers*” (bits of data unit 250’s header fields are repeated in two 20 MHz sub carriers).

3. Claim Limitations [1B], [11B], [21B], and [31B]

The combination of Zhang and Maltsev discloses these limitations.

a. Wireless OFDM transmitter connected to and in communication with the modulator

Zhang’s devices each include wireless transceivers for communicating packets over a WLAN using OFDM. (§VI.C.1., *supra*). Each of these transceivers includes a transmitter to transmit wireless OFDM packets. “The transceiver(s) ... is/are configured to transmit the generated data units via the antenna(s)” (INTEL-1017, ¶69.) A POSITA would understand that Zhang’s transmitter is electrically connected to and in communication with the modulator (IFFT) to receive the modulated OFDM symbols for transmission over the channel. (INTEL-1017, ¶95; INTEL-1019, 16; INTEL-1003, ¶167 (*citing* INTEL-1022, at 4–5, Fig. 1.2 (depicting a “typical digital communication system” that includes a modulator communicating with the transmitter antenna front end” for transmission over the channel)).)

b. Operable to transmit the first number of OFDM symbols of the first packet in a first narrower frequency band

As discussed in §VI.C.2.b, *supra*, Zhang discloses modulating a first number of OFDM symbols in a first packet (data unit 250) to transmit its header bits. Zhang discloses transmitting data unit 250 over different-sized frequency bands such as 20/40/80MHz, or “any suitable bandwidth.” (INTEL-1017, ¶102, Fig. 10; INTEL-1019, 5–6, 10–11, 15, 30.) Therefore, the first packet is operable for transmission over a narrower frequency band (e.g., 40MHz) as opposed to a wider one (e.g., 80MHz). (INTEL-1003, ¶168.) Zhang also provides bits in VHT-SIG to indicate/select the 20/40/80MHz frequency bandwidth for communications over the WLAN. (INTEL-1017, ¶¶83, 85; INTEL-1019, 13–15.)

4. Claim Limitations [1C], [11C], [21C], and [31C]

The combination of Zhang and Maltsev discloses these limitations.

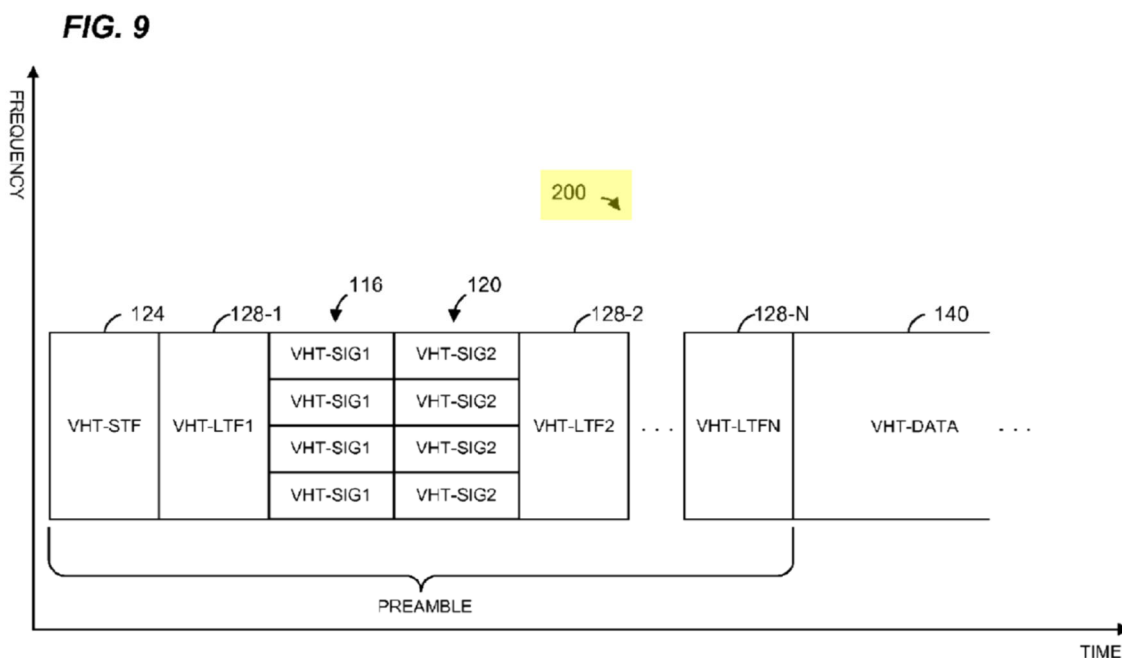
a. Modulator operable to modulate ... OFDM symbols

As discussed in §V.C.2.a., *supra*, the combination of Zhang and Maltsev discloses a “modulator operable to modulate” OFDM symbols.

b. A second number of OFDM symbols to transmit a second plurality of header bits in a second packet, less than the first number of OFDM symbols

OFDM data unit 200 shown in Zhang’s Figure 9 below is a second packet with a second number of OFDM symbols. (INTEL-1017, ¶100, Fig. 9; INTEL-1019, 20 (Fig. 3).) Data unit 200 “conforms to the first communication protocol” and

“occupies an 80 MHz band.” (INTEL-1017, ¶100; INTEL-1019, 20.) Zhang explains that data unit 200 is “suitable for ‘Greenfield’ situations, i.e., when the WLAN 10 does not include any ... legacy client station[s]” (INTEL-1017, ¶100, Fig. 9; INTEL-1019, 5, 20.) “The data unit 200 is similar to the data unit 100 of FIG. 5, but omits the legacy portion.” (INTEL-1017, ¶101; INTEL-1019, 8, 20.)



As discussed in §VI.C.2.b., *supra*, each of the VHT-SIG fields “occup[ies] a 20 MHz band” and is “repeated in four 20MHz subbands” of the 80MHz frequency band. (INTEL-1017, ¶75; INTEL-1019, Fig. 1, 6, 8.)

Figure 9 below shows that four of each of data unit 200’s VHT-SIG header fields (shaded yellow) are transmitted over the wider 80MHz frequency bandwidth comprising four 20MHz subbands. (INTEL-1017, ¶¶77, 100, Fig. 9; INTEL-1019, 6, 8, 10, 20 (Fig. 3); INTEL-1003, ¶172.) As a result, the number of OFDM symbols

in data unit 200 is equal to eight (counting one symbol per field). (INTEL-1017, Fig. 9, ¶¶91, 113; INTEL-1019, 11, 15 (“Each VHT-SIG is modulated by one OFDM symbol.”), 20 (Fig. 3 below); INTEL-1003, ¶172.)

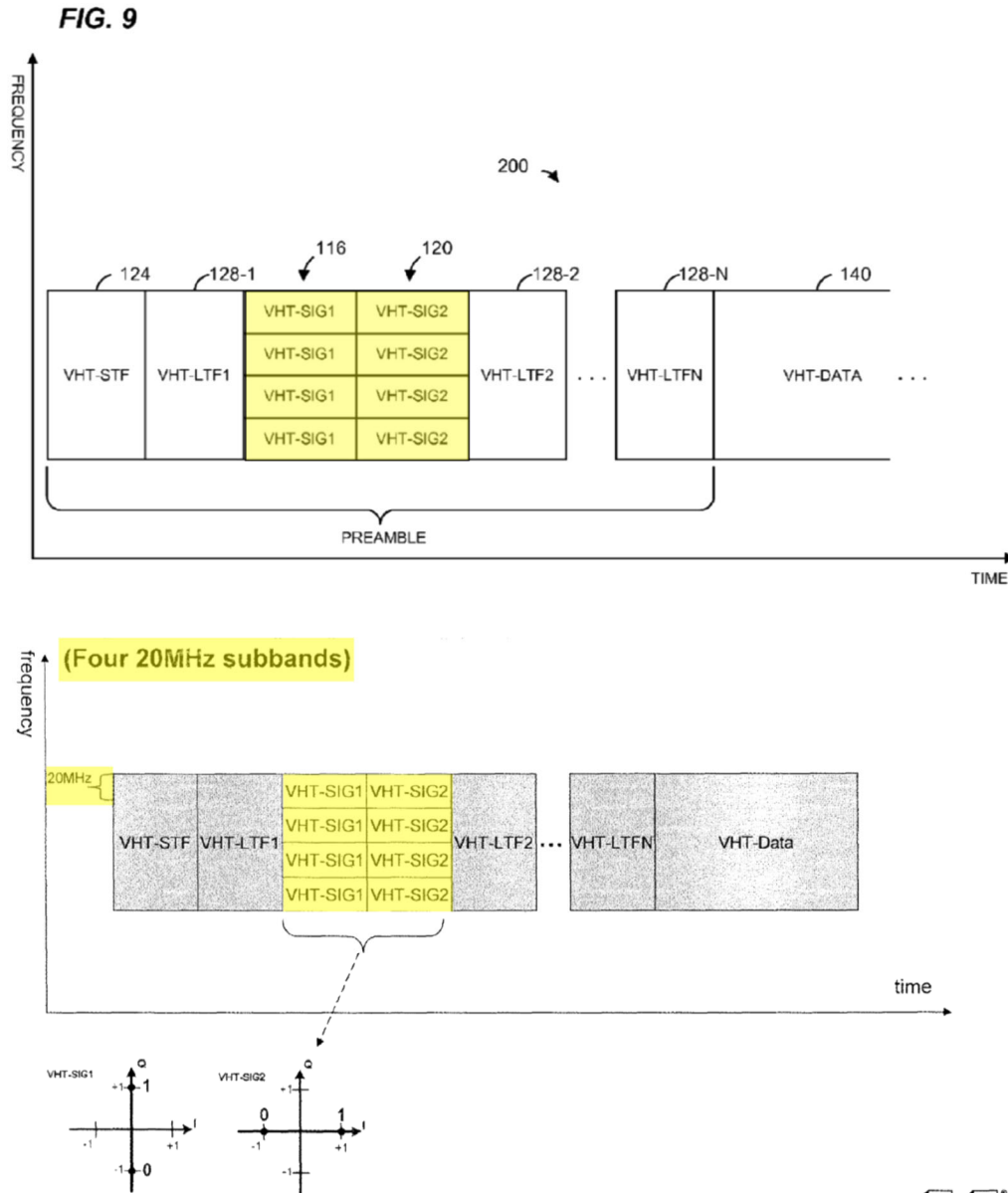


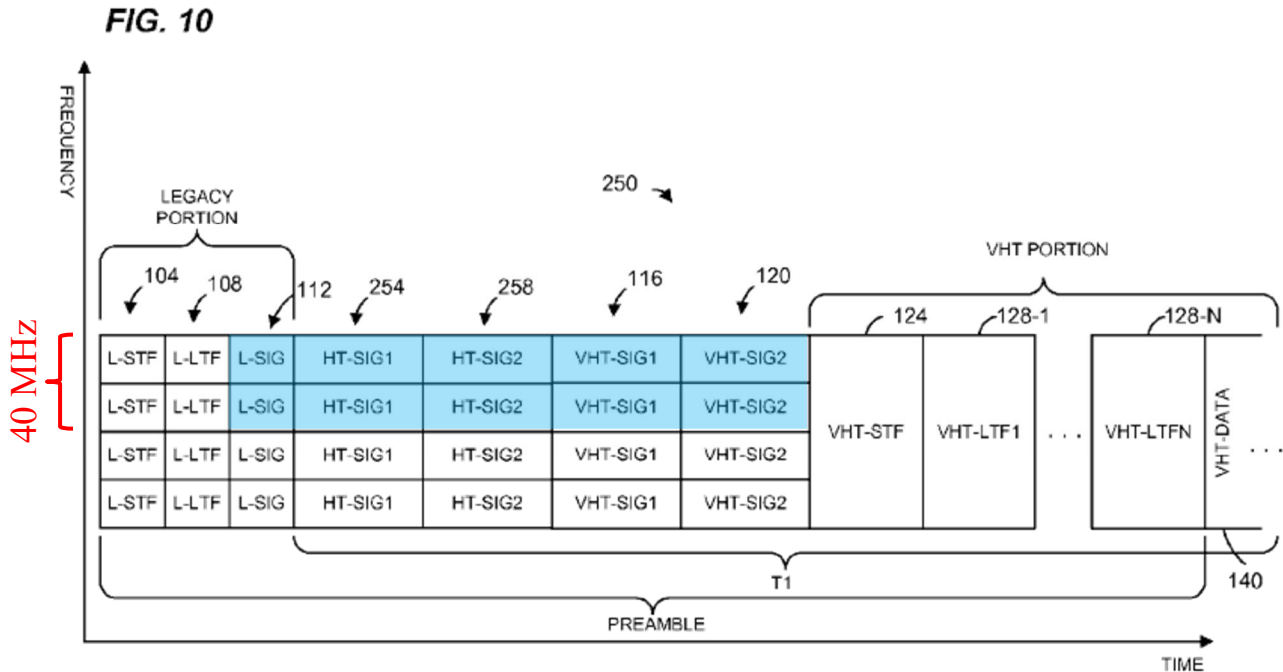
Fig. 3

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Zhang therefore discloses a “*second packet*” (data unit 200) with a “*second number of OFDM symbols*” (e.g., eight), less than the first number of OFDM

symbols of the first packet (e.g., ten in data unit 250 transmitted in 40 MHz, shown below).



c. “Header” fields/bits/portion

As discussed above in §VI.C.2.c., *supra*, VHT-SIG is part of the OFDM packet header that comprises a plurality of header bits because it contains important control information for properly decoding the packet payload and packet length information for virtual carrier sensing consistent with the description in the ’566 patent. (See INTEL-1001, 1:45–48; INTEL-1017, ¶¶79 (modulation and coding scheme), 82 (reserved bit indicating VHT packet), 85 (20/40/80MHz bandwidth selection bits), 120 (length field for virtual carrier sensing); INTEL-1019, 11; INTEL-1003, ¶174.)

d. The second header bits are different than the first header bits

The header fields of Zhang’s first (Figure 10) and second (Figure 9) packets appear below. The header bits of the “*second packet*” (*i.e.*, greenfield packet) do not include the L-SIG, HT-SIG1 and HT-SIG2 header fields of the “*first packet*” (*i.e.*, mixed-mode packet). (INTEL-1017, Figs. 9–10, ¶¶100, 102.)

FIG. 9

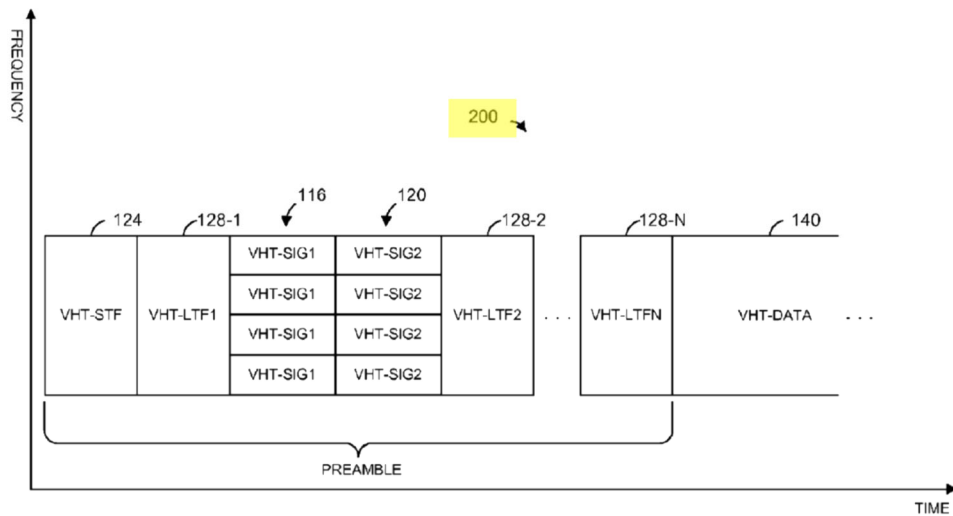
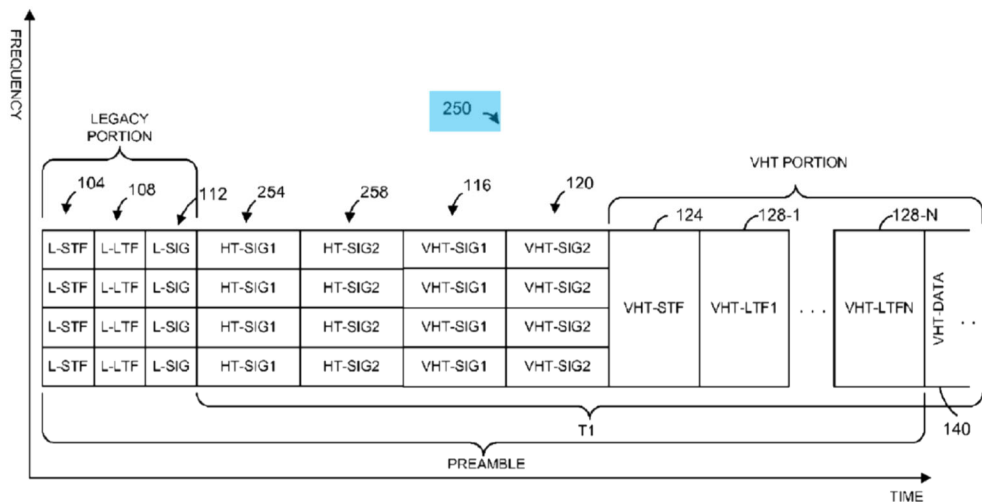


FIG. 10



(INTEL-1017, Figs. 9–10; INTEL-1019, 20, 25.) A POSITA would understand that

these different packet formats with different header fields carried over different numbers of OFDM symbols include different sets of header bits. (See INTEL-1003, ¶175; INTEL-1017, ¶107 (VHT-SIG fields “have different format” than HT-SIG fields); INTEL-1019, 11–12.)

5. Claim Limitations [1D], [11D], [21D], and [31D]

The combination of Zhang and Maltsev discloses this limitation.

a. Wireless OFDM Transmitter further operable to transmit the second number of OFDM symbols of the second packet in a second wider frequency band

As discussed in §§ VI.C.4.a–b and VI.C.3.a., *supra*, the combination of Zhang and Maltsev discloses a modulator (IFFT) operable to modulate a second number of OFDM symbols in data unit 200 and a wireless OFDM transmitter. Zhang’s transmitter is further operable to transmit the second number of OFDM symbols of data unit 200 (“*second packet*”) over the wireless channel in a wider frequency bandwidth. Zhang teaches that data unit 200 is transmitted in different-sized frequency bands such as 20/40/80MHz, or “any suitable bandwidth.” (INTEL-1017, ¶100, Fig. 9; INTEL-1019, 5–6, 10–11, 15, 20 (Fig. 3), 30.) Therefore, the second packet is operable for transmission in a wider frequency band (*e.g.*, 80MHz) as opposed to a narrower one (*e.g.*, 40Hz). (INTEL-1003, ¶177.) Further, Zhang provides bandwidth selection bits in VHT-SIG to indicate/select the 20/40/80MHz frequency band for communications over the WLAN. (INTEL-1017, ¶¶83, 85;

INTEL-1019, 13–15.)

6. Claim Limitations [1E], [9E], [17E], and [25E]

Zhang discloses transmitting packets in a 40MHz narrowband and an 80MHz wideband. (*See supra* §§VI.C.3.a–b., VI.C.5.a.) Zhang also provides a 20/40/80MHz frequency bandwidth selection subfield in VHT-SIG that enables selection from 20MHz, 40MHz or 80MHz in the same manner that the “BW20/40” subfield in the HT-SIG fields of 802.11n packets enable selection between 20MHz and 40MHz. (INTEL-1017, ¶83, 85; INTEL-1019, 11, 13–14.) A POSITA would therefore expect Zhang’s 20/40/80MHz frequency bands to be overlapping in the same manner as the 20/40MHz frequency bands in 802.11n, with the only difference being the extra bit needed to select among three overlapping frequency bands instead of two. (INTEL-1003, ¶178.)

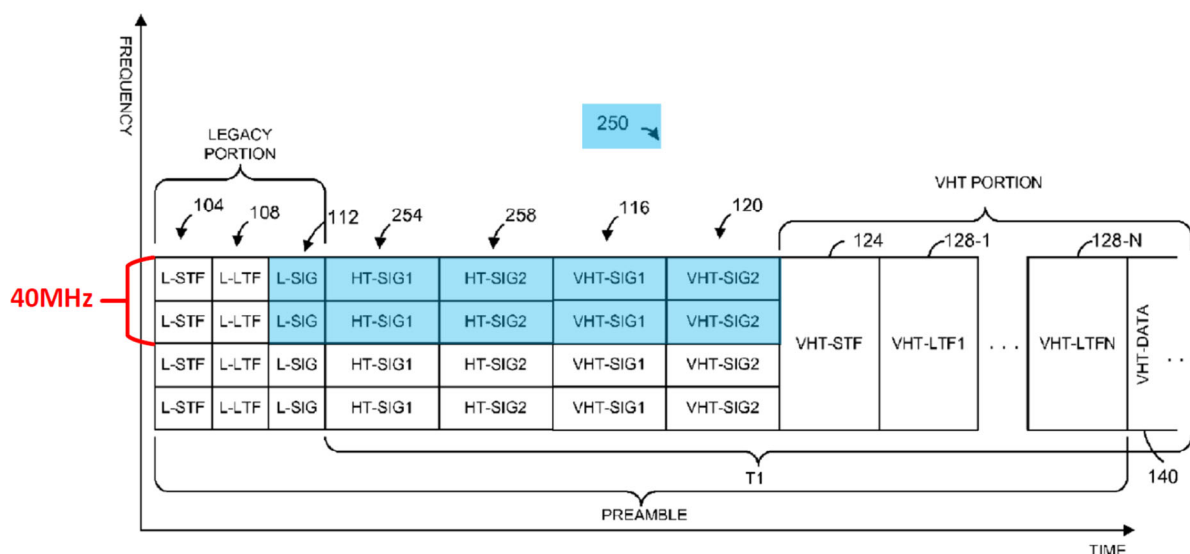
Furthermore, Maltsev discloses a “flexible channel-width capability” with overlapping 20MHz and 40MHz channels in a wireless OFDM system. (INTEL-1018, 1:9–19, 3:47–54 (“wider-band channels may comprise one or more of the narrower-band channels.”).) Devices in Maltsev’s WLAN are configured with a flexible channel-width capability to communicate with wideband devices in a wider frequency bandwidth (*e.g.*, 40MHz) and with narrowband devices in a narrower frequency bandwidth (*e.g.*, 20MHz) that overlaps with the 40MHz band. (INTEL-1018, 3:29–54.) Therefore, the combination of Zhang and Maltsev discloses a “*first*

narrower” (e.g., 40MHz) and “*second wider*” (e.g., 80MHz) frequency bands “*have one or more overlapping frequency regions*” (e.g., 80MHz comprises two 40MHz frequency bands). (INTEL-1003, ¶179.)

D. Claims 2, 12, 29, and 32

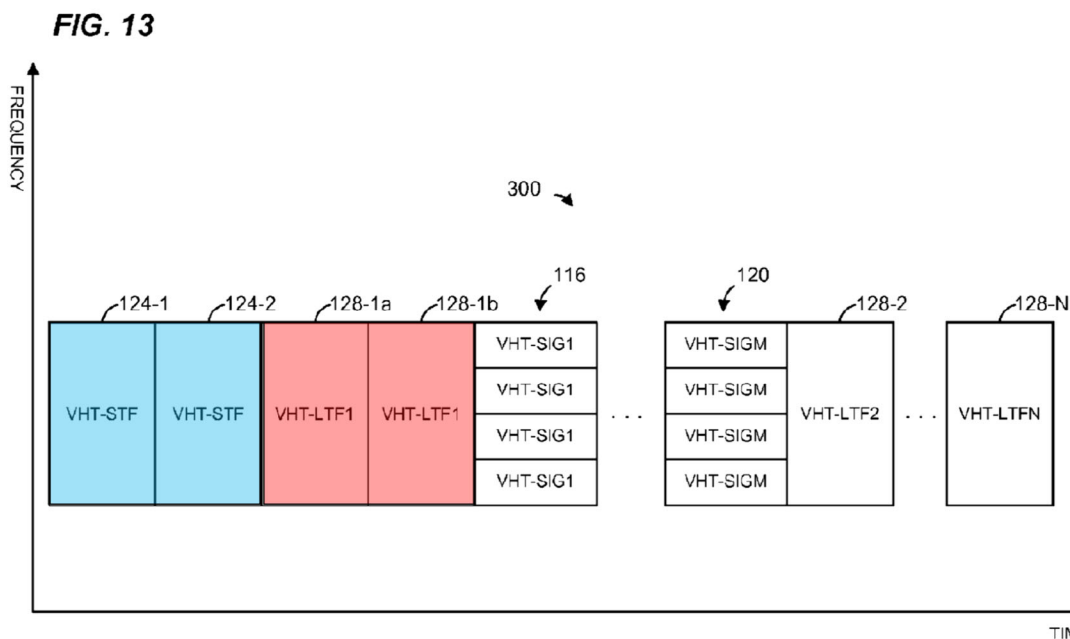
The “wherein” clauses of claims 2, 12, 29, and 32 should not be afforded any patentable weight because each merely recites the intended result of the recited function. *See, e.g., Hoffer v. Microsoft Corp.*, 405 F.3d 1326, 1329 (Fed. Cir. 2005). For this reason, claims 2, 12, 29, and 32 are obvious for the same reasons as independent claims 1, 11, 21, and 31. Additionally, Zhang’s 802.11-compliant transceivers include a transmitter to transmit OFDM symbols of a mixed-mode packet (e.g., data unit 250) in a 40MHz frequency band (“*first narrower frequency band*”), wherein header fields are repeated in two 20MHz subcarriers of the 40MHz band which is a plurality. (INTEL-1017, ¶102, Fig. 10; INTEL-1019, Fig. 5; §§VI.C.2.c–d and VI.C.3.a–b, *supra*.)

FIG. 10



A POSITA would have understood that repetition of transmitted information in different frequencies bands—*e.g.*, repeating the L-SIG, HT-SIG, and VHT-SIG in two 20MHz frequency bands as described in Zhang—results in increased diversity for the transmitted signal, which improves reliability of the transmitted signal. (See INTEL-1001, 2:65–3:2 (“The decoding of each additional OFDM header symbol provides additional diversity thereby increasing the likelihood of decoding the header information correctly.”); *see also* INTEL-1003, ¶181 (citing INTEL-1016, 5–6 (“Diversity techniques increase reliability by sending the same information through multiple independently faded paths so that the probability of successful transmission is higher.”), 49 (“diversity techniques” improve performance “[b]y sending signals that carry the same information through different paths” so that “more reliable detection can be achieved.”).)

Zhang also teaches repeating header fields in the time domain, which a POSITA would understand is another diversity technique that increases reliability. (INTEL-1003 ¶182; INTEL-1017 ¶116, Fig. 13; INTEL-1019, 41.)



Therefore, a POSITA reading Zhang would have understood it to disclose that “the at least one repeated header bit” (L-SIG, HT-SIG1, HT-SIG2, VHT-SIG1 and VHT-SIG2 of data unit 250 repeated in two 20MHz subbands) “increases reliability of the first packet” (diversity improves reliability) “in the first narrower frequency band” (e.g., 40MHz). (INTEL-1003, ¶183.)

E. Claims 3, 13, 30, and 33

The “wherein” clauses of claims 3, 13, 30, and 33 should not be afforded any patentable weight because each merely recites the intended result of the recited function. *See, e.g., Hoffer*, 405 F.3d at 1329. Claims 3, 13, 30, and 33 are thus

obvious for the same reasons as independent claims 1, 11, 21, and 31. Additionally, as discussed in §VI.D., *supra*, L-SIG, HT-SIG and VHT-SIG of data unit 250 are repeated in two 20MHz subcarriers of the 40MHz frequency band, which provides additional diversity to increase the likelihood of correctly communicating the transmitted information to the receiver. (INTEL-1003, ¶184.) A POSITA reading Zhang would have understood it to disclose that “*the at least one repeated header bit*” (e.g., repeated L-SIG, HT-SIG, and VHT-SIG header fields in two 20MHz subbands) “*provides additional diversity to increase a likelihood of correctly communicating header information of the first packet*” (diversity increases the likelihood of correctly communicating the packet information) “*in the first narrower frequency band*” (e.g., 40MHz). (INTEL-1003, ¶184.)

F. Claims 4, 14, 26, and 34

As discussed in §VI.C.6., *supra*, Zhang discloses transmitting mixed-mode data unit 250 in a narrower 40MHz frequency band and greenfield data unit 200 in an 80MHz frequency band, which is two times wider. (*See supra* §§VI.C.3.a–b., VI.C.5.a.)

G. Claims 5, 15, 27, 35

Zhang discloses transmitting data units in different-sized frequency bands, including 20/40/80/120/160MHz, “or any suitable bandwidth.” (INTEL-1017, ¶¶100, 102; INTEL-1019, 5–6, 10–11, 15, 30.) Zhang further discloses the benefits

of operating in wider frequency bandwidths to transmit “a different suitable number” of header fields depending on the requirements of the channel and the devices operating in the WLAN—i.e., “**one of each**” for “an OFDM data unit occupying 20 MHz,” “**two of each** ... for a 40 MHz bandwidth OFDM data unit,” “**six of each** ... for a 120Mhz bandwidth OFDM data unit,” and “**eight of each** for a 160 MHz bandwidth OFDM data unit,” and so on. (INTEL-1017, ¶75; INTEL-1019, 5–6, 10–11, 15, 30.) In addition, Maltsev discloses that the “terms narrower-band and wider-band refer to a relative communication bandwidth that may be utilized” and that the wideband devices (CUs) “may communicate on wider-band channels (e.g., channels of up to 80 MHz **or greater**).” (INTEL-1018, 3:40–47.) Thus, the combination of Zhang and Maltsev discloses transmitting data units (packets) in a first narrower 40MHz band and a second wider 160MHz band, which is **four** times wider. (INTEL-1003, 186.)

H. Claims 6, 16, 28, 36

Zhang discloses transmitting data units in different-sized frequency bands, including 20/40/80/120/160MHz, “or any suitable bandwidth.” (INTEL-1017, ¶¶100, 102; INTEL-1019, 5–6, 10–11, 15, 30.) Zhang further discloses the benefits of operating in wider frequency bandwidths to transmit “a different suitable number” of header fields depending on the requirements of the channel and the devices operating in the WLAN—i.e., “**one of each**” for “an OFDM data unit occupying 20

MHz,” “**two of each** ... for a 40 MHz bandwidth OFDM data unit,” “**six of each** ... for a 120Mhz bandwidth OFDM data unit,” and “**eight of each** for a 160 MHz bandwidth OFDM data unit,” and so on. (INTEL-1017, ¶75; INTEL-1019, 5–6, 10–11, 15, 30.) In addition, Maltsev discloses that the “terms narrower-band and wider-band refer to a relative communication bandwidth that may be utilized” and that the wideband devices (CUs) “may communicate on wider-band channels (e.g., channels of up to 80 MHz **or greater**).” (INTEL-1018, 3:40–47.) Thus, the combination of Zhang and Maltsev discloses transmitting data units (packets) in a first narrower 20MHz band and a second wider 160MHz band, which is **eight** times wider. (INTEL-1003, 187.)

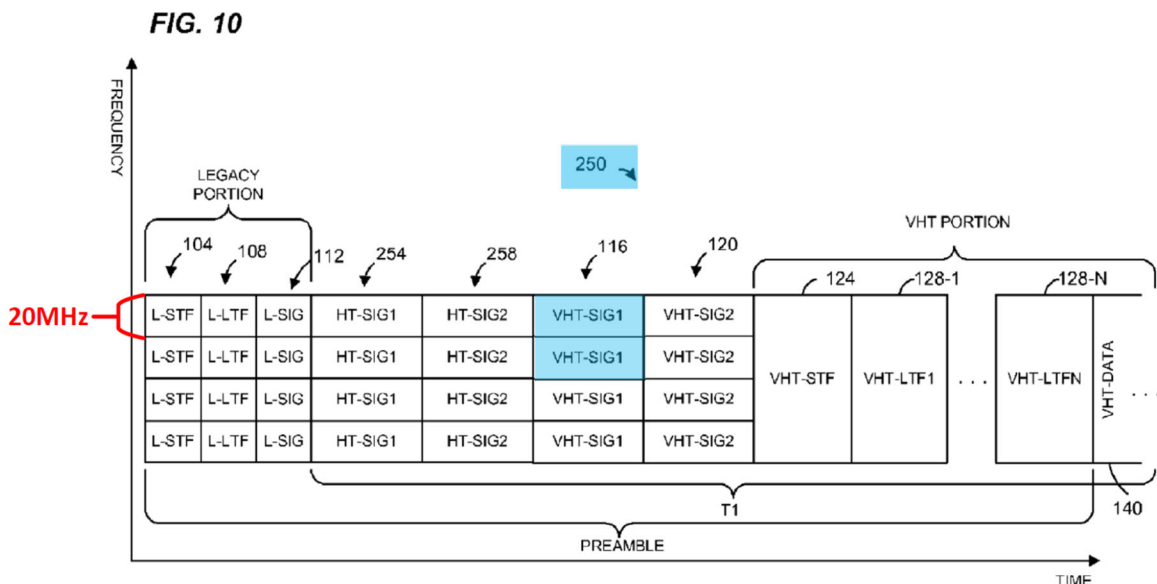
I. Claims 7, 17, 22, and 37

As discussed in §VI.C.4.d., *supra*, data unit 250 includes HT-SIG and VHT-SIG header fields that are carried over OFDM symbols and that contain different header bits. (See INTEL-1003, ¶188; INTEL-1017, Fig. 10, ¶107 (VHT-SIG fields “have different format” than HT-SIG fields); INTEL-1019, 11–12, 15, 25, 31.) Zhang therefore discloses “*a first OFDM symbol*” (e.g., HT-SIG) that “*contains different header bits than a second OFDM symbol*” (e.g., VHT-SIG).

J. Claims 8, 18, 23, and 38

As discussed in §VI.C.2.b.–d., *supra*, the OFDM header symbols of data unit 250 such as VHT-SIG1 are repeated in two 20MHz subbands of the 40MHz band.

(See INTEL-1003, ¶189; INTEL-1017, Fig. 10; INTEL-1019, 11, 25.)



As shown, data unit 250 includes first/second VHT-SIG1 symbols transmitted in upper and lower 20MHz subbands, respectively, that contain the same plurality of header bits. Zhang therefore discloses a “*first packet*” with a “*first OFDM symbol*” (e.g., VHT-SIG1 in the lower 20MHz subband) and a “*second OFDM symbol*” (e.g., VHT-SIG1 in the upper 20MHz subband) that both contain “*the first plurality of header bits.*”

K. Claims 10, 20, 25, 40

The WLAN devices disclosed in Zhang and Maltsev (e.g., APs) support multiple versions of IEEE 802.11 (INTEL-1017 ¶¶19, 76; INTEL-1019, 2, 10; INTEL-1018, 2:18–22), which are “*wireless standards.*”

VII. DISCRETIONARY DENIAL IS NOT APPROPRIATE

The Board should reach the merits in this proceeding because the Petition

presents a compelling unpatentability challenge. (See Interim Procedure for Discretionary Denials (“Interim Procedure”), 4-5 (“[W]here the PTAB determines that the information presented at the institution stage presents a compelling unpatentability challenge, that determination alone demonstrates that the PTAB should not discretionarily deny institution under *Fintiv*.”).) As set forth herein, the evidence presented in this Petition, “if unrebutted in trial, would plainly lead to a conclusion that one or more claims are unpatentable by a preponderance of the evidence.” (Interim Procedure, 4.)

The ’566 patent is “directed toward header repetition in a communications environment.” (INTEL-1001, 1:22–26.) The purported novelty of the challenged claims lies in “accommodate[ing] different repetition[] schemes ... in a single domain.” (INTEL-1001, 2:23–25.) However, PO acknowledged in its provisional application that the use of repeated headers and repeated extended headers was publicly proposed during development of the ITU-T G.hn standard, prior its earliest possible priority date. (See INTEL-1008, 30; INTEL-1024 (09CC-046); INTEL-1025 (09XC-100); INTEL-1026 (09XC-119).) Petitioner further established in §III.A. that these two concepts were also publicly proposed and discussed in the IEEE 802.11 TGn working group, years before the earliest priority date of the ’566 patent. The compelling merits of this IPR weigh heavily against discretionary denial.

The *Fintiv* factors also weigh against discretionary denial. No stay has been

requested or denied in the district court case, rendering Fintiv factor 1 neutral. Although the Court set a trial date in the co-pending district court litigations involving the listed real parties in interest (*See* §§VIII.A.–B.), these dates are tentative considering the pending motion to dismiss for improper venue in the Lenovo Group litigation and transfer motion in the Dell litigation. Given this uncertainty, Fintiv factors 2 and 3 weigh against discretionary denial.

VIII. MANDATORY NOTICES

A. Real Party In Interest Under 37 C.F.R. §42.8(b)(1)

The real parties in interest include Petitioner, as well as Dell Inc., Dell Technologies Inc., and Lenovo Group Ltd.

B. Related Matters Under 37 C.F.R. §42.8(b)(2)

To the best of Petitioner's knowledge, the '566 patent is involved in the following district court litigations:

- *AX Wireless LLC, v. Dell Inc., and Dell Technologies Inc.*, 2-22-cv-00277 (EDTX).
- *AX Wireless LLC, v. Lenovo Group Ltd.*, 2-22-cv-00280 (EDTX).
- *AX Wireless LLC, v. HP Inc.*, 2-22-cv-00279 (EDTX).
- *AX Wireless LLC, v. Acer Inc.* 2-23-cv-00041 (EDTX).

C. Notice Of Counsel And Service Information

Pursuant to 37 C.F.R. §§42.8(b)(3), 42.8(b)(4) and 42.10(a), Petitioner appoints **Lori A. Gordon** (Reg. No. 50,633) at the address of Perkins Coie LLP, 700

Thirteenth Street, N.W., Suite 800, Washington, DC 2005-3960, telephone number (202) 654-6200, as lead counsel; **Jon R. Carter** (Reg. No. 75,145) at the address of Perkins Coie LLP, 1155 Avenue of the Americas, 20th Floor, New York, NY 10036-2711, telephone number (212) 262-6900; and **Matthew W. Hindman** (Reg. No. 57,396) at the address of Perkins Coie LLP, 3150 Porter Drive, Palo Alto, CA 94304-1212, telephone number (650) 838-4300, as backup counsel.

Petitioner consents to electronic service by email at the email addresses: gordon-ptab@perkinscoie.com, carter-ptab@perkinscoie.com, and hindman-ptab@perkinscoie.com.

IX. CONCLUSION

Inter Partes Review of the challenged claims is respectfully requested.

Date: July 3, 2023

Respectfully submitted,

/Matthew W. Hindman/

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CERTIFICATE OF WORD COUNT UNDER 37 CFR §42.24(d)

Petitioner hereby certifies that this Petition complies with the type-volume requirements of 37 C.F.R. §42.24(a). The word processing program used to prepare this Petition indicates that it contains 13,996 words, excluding the table of contents, table of authorities, mandatory notices under §42.8, certificate of service, certificate of word count, appendix of exhibits, and any listing of the claims.

Date: July 3, 2023

Respectfully submitted,

/Matthew W. Hindman/

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that true copies of the Petition for *Inter Partes* Review of U.S. Patent No. 9,614,566 and supporting materials (Exhibits and Power of Attorney) were served via overnight delivery on the Patent Owner at the correspondence address of record as listed in USPTO records:

Jason H. Vick
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Denver, CO 80202

and via email to the attorneys of record for Plaintiff in the concurrent *AX Wireless LLC, v. Dell Inc., and Dell Technologies Inc.*, 2-22-cv-00277 (EDTX), *AX Wireless LLC, v. Lenovo Group Ltd.*, 2-22-cv-00280 (EDTX), *AX Wireless LLC, v. HP Inc.*, 2-22-cv-00279 (EDTX), and *AX Wireless LLC, v. Acer Inc.*, 2-23-cv-00041 (EDTX)litigations:

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Date: July 3, 2023