

**UNITED STATES PATENT AND TRADEMARK OFFICE**

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**BEFORE THE PATENT TRIAL AND APPEAL BOARD**

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DELL INC. and DELL TECHNOLOGIES INC.,  
Petitioners

v.

AX WIRELESS LLC,  
Patent Owner.

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IPR2024-00680

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

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**DECLARATION OF THOMAS F. LA PORTA, PH.D.  
IN SUPPORT OF INTER PARTES REVIEW OF U.S. 9,614,566**

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## **I. Introduction**

I, Thomas LaPorta, Ph.D., declare as follows:

1. I have been retained by Perkins Coie LLP on behalf of Dell Inc. and Dell Technologies Inc. (collectively “Petitioner” or “Dell”) to provide this Declaration concerning technical subject matter relevant to the petition for *Inter Partes* Review (“Petition”) of U.S. Patent No. 9,614,566 to Kim, et al (“the ’566 patent”). It is my understanding that the ’566 patent is currently assigned to AX Wireless LLC (“Patent Owner”).

2. I am over 18 years of age. I have personal knowledge of the facts stated in this Declaration and could testify competently to them if asked to do so. I have reviewed and am familiar with the specification and the claims of the ’566 patent. In general, I will cite to the specification of a United States Patent using the following formats: (Patent No., Col:Line Number(s)) or (Patent No., Paragraph Number(s)). For example, the citation (’566 patent, 1:1-10) points to the ’566 patent specification at column 1, lines 1-10. Also, for convenience, I use italics to denote limitations from the challenged claims.

3. All of the opinions contained in this Declaration are based on the documents I have reviewed and my knowledge and professional judgment. In forming the opinions expressed in this Declaration, I reviewed the documents listed in the attached Appendix. I have also reviewed and am familiar with any

other document referred to in this Declaration.

4. I have been asked to provide my technical opinions regarding how a person of ordinary skill in the art (“POSITA”) would have understood the claims of the ’566 patent at the time of the alleged invention. For purposes of whether the teachings of the prior art render the claims of the ’566 patent obvious, I have been asked to assume the date of August 21, 2009, for the analysis in this document.

5. I have also been asked to provide my technical opinions on how concepts in the ’566 patent specification relate to claim limitations of the ’566 patent. In reaching the opinions provided herein, I have considered the ’566 patent, its prosecution history, and the references cited in Attachment A, and have drawn as appropriate on my own education, training, research, knowledge, and personal and professional experience.

#### **A. Qualifications**

6. In formulating my opinions, I have relied on my knowledge, training, and experience in the relevant field, which I will summarize briefly. A more detailed summary of my background, education, experience, and publications is set forth in my curriculum vitae (“CV”), which is provided as DELL-1004.

7. I have personal knowledge of the facts and opinions set forth in this declaration and believe them to be true. If called upon to do so, I would testify competently thereto. I have been warned that willful false statements and the like

are punishable by fine or imprisonment, or both.

8. I am being compensated for my time at my standard consulting rate. I am also being reimbursed for expenses that I incur during the course of this work. My compensation is not contingent upon the results of my study and analysis, the substance of my opinions, or the outcome of any proceeding involving the Challenged Claims. I have no financial interest in the outcome of this matter or in any litigation involving the '566 patent.

9. I am the Director of the School of Electrical Engineering and Computer Science at Penn State University. I am also an Evan Pugh Professor in the Department of Computer Science and Engineering and the Department of Electrical Engineering at Penn State University. I was the founding Director of the Institute of Networking and Security Research at Penn State. I have worked on telecommunications networks since 1986.

10. I received my B.E. and M.E. in Electrical Engineering from The Cooper Union for the Advancement of Science and Art in 1986 and 1987, respectively, and my Ph.D. in Electrical Engineering from Columbia University in 1992.

11. I joined AT&T Bell Labs (which later became Bell Labs, Lucent Technologies) in 1986 after receiving my B.E. degree, and pursued my M.E. degree part-time. In my first job at Bell Labs, I tested the performance and

interoperability of many data communication devices within the AT&T network. I transferred into Bell Labs Research in 1990 to pursue research full-time.

12. Starting in 1994, I performed research directed towards mobile and wireless networks. During this period, I worked extensively on signaling protocols and call processing for mobile telephony networks and mobile data applications. A large portion of my work was directed at architectures, protocols, and software for enabling different types of services on wireless networks. As part of this work I worked on efficient wireless link layer protocols.

13. In 1997, I became the Director of the Mobile Networking Research Department within Bell Labs Research. This group, which included approximately 30 researchers and support developers, carried out basic research on mobile networks including cellular telephony, mobile Internet, integrated networks and mobile data services. In 2000, I was named the Director of the Advanced Mobile Networking Department within the Wireless Business Unit of Lucent Technologies. My role in this job was to work with development organizations to turn technology into products.

14. During both my development and research careers, I interacted extensively with computer scientists and engineers responsible for the design, development, and testing of mobile telephony and data networking products with a focus on wireless networks. As a research manager, I oversaw a department that

executed many large-scale joint projects with development organizations to release products for Lucent Technologies. Examples of such joint projects include, the control software for Lucent Technologies' 3G network access controllers used for interconnecting CDMA base stations, processor overload controls in Lucent Technologies' cellular soft switches, the industry's first multi-protocol Home Location Register, servers and protocols for enabling services and interactive text messaging via cellular networks, the first systems to interwork 2G and 3G networks of different types with all-IP networks, and mobile Internet services. These interactions exposed me to a wide range of computer scientists and engineers working on wireless network technologies and applications.

15. As the Director of both the Networking Research Department in Bell Labs and the Advanced Mobile Networking Department within the Wireless Business Unit of Lucent Technologies, I met extensively with product managers and marketing organizations for the Wireless Business Unit of Lucent Technologies and representatives of many cellular service providers. In these meetings, I would often present new concepts and product directions that the company was advancing in the wireless market.

16. I also taught as an adjunct member of the faculty at Columbia University in 1993 and from 1996-2001. I taught graduate classes in networking protocol design (1993) and mobile computing and networking (1996-2001). As

such, I am familiar with the curricula taught to Electrical Engineers and Computer Scientists from the early 1990s until today.

17. I am a co-inventor on at least 39 United States Patents and 18 foreign patents, of which the large majority pertain to mobile telecommunications. Two of my patents, one of which helped enable the mobile Internet, were awarded the Thomas Alva Edison Patent Award by the Research and Development Council of New Jersey. For my early work I was recognized with an Eta Kappa Nu Outstanding Young Electrical Engineer Award and the Bell Labs Distinguished Staff Award.

18. While at Bell Labs, I led my research department into creating new network, service and software architectures for building some of the first wireless mobile data services. One example was designing a link layer protocol for more efficient wireless transmissions. This led to two patents and two published papers. I performed several other research efforts to improve the efficiency of the use of wireless networks in different types of data systems.

19. After joining Penn State I continued my work on wireless networks and services including several that were related wireless communications. This included work on allocating resources to efficiently use wireless bandwidth in OFDM systems and resulted in several published papers.

20. Because of my expertise on security in wireless networks, I was

appointed to The President's National Security Telecommunications Advisory Committee. My role on this Committee was to identify security risks for current and evolving cellular networks.

21. Based on this experience, and my continuing work at Penn State University, I have intimate knowledge of wireless and mobile networks and services. I have been highly recognized as an expert in such systems. I was recognized with the Bell Labs Distinguished Member of Technical Staff award in 1996. My award letter stated in part, "[y]our contributions to wireless call processing have profoundly impacted Lucent. You are very well-known as demonstrated by your three best paper awards...". I was named a Bell Labs Fellow in 2000, "[f]or outstanding contributions in mobile wireless networks in the area of call processing, signaling, mobility management, and applications." I was named an IEEE Fellow in 2002 "for contributions to systems for advanced broadband, mobile data and mobile telecommunication networks."

22. I previously served as the Editor-in-Chief of IEEE Personal Communications Magazine and was the founding Editor-in-Chief of IEEE Transactions on Mobile Computing. I have published about 300 technical papers in this field.

23. My research is supported primarily by the Department of Defense and the National Science Foundation. I was the Director of a center funded by the U.S.

Army Research Lab studying network science as it relates to communication networks. I also led a recently concluded project funded by the Defense Threat Reduction Agency to improve network reliability against attack by weapons of mass destruction. I am currently the Penn State Principle Investigator on an NSF/DoD funded project on 5G networks.

## **II. Understanding of Relevant Legal Principles**

24. I am not a lawyer and will not provide any legal opinions. Although I am not a lawyer, I have been advised certain legal standards are to be applied by technical experts in forming opinions regarding the meaning and validity of patent claims.

25. I understand that a patent claim is invalid if it is anticipated or obvious in view of the prior art, and that a claim can be unpatentable even if all of the requirements of the claim cannot be found in a single prior-art reference. I further understand that invalidity of a claim requires that the claim be anticipated or obvious from the perspective of a person of ordinary skill in the art at the time the invention was made.

26. I have been informed that a patent claim is invalid if it would have been obvious to a person of ordinary skill in the art. In analyzing the obviousness of a claim, I understand the following factors may be taken into account: (1) the scope and content of the prior art; (2) the differences between the prior art and the

claims; (3) the level of ordinary skill in the art; and (4) any so called “secondary considerations” of non-obviousness, if they are present. I am not aware of any evidence of secondary considerations of non-obviousness relevant to the ’950 patent. I reserve the right to supplement this Declaration if Patent Owner (“PO”) introduces evidence of secondary considerations of non-obviousness.

27. I understand that to prove that prior art or a combination of prior art renders a patent obvious, it is necessary to:

- identify the particular references that, singly or in combination, make the patent obvious;
- specifically identify which elements of the patent claim appear in each of the asserted references; and
- explain why a person of ordinary skill in the art would have combined the references, and how they would have done so, to create the invention(s) claimed in the patent.

28. I further understand that exemplary rationales that may support a conclusion of obviousness include:

- combining prior art elements according to known methods to yield predictable results;
- simple substitution of one known element for another to obtain predictable results;

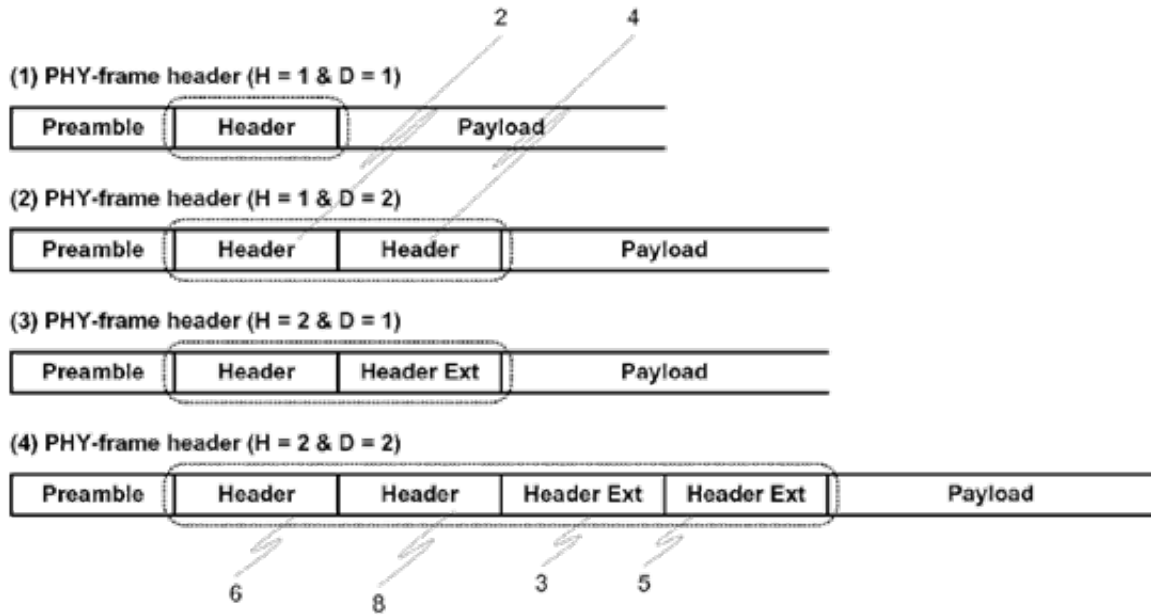
- use of known technique(s) to improve similar devices (methods or products) in the same way;
- applying a known technique to a known device (method or product) ready for improvement to yield predictable results;
- “obvious to try” - choosing from a finite number of identified, predictable solutions with a reasonable expectation of success;
- known work in one field of endeavor may prompt variations of the work for use in either the same field or a different field based on design incentives or other market forces if the variations are predictable to a person of ordinary skill in the art; and
- some teaching, suggestion, or motivating in the prior art that would have led a person of ordinary skill in the art to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

29. I have also been informed that, in considering obviousness, hindsight reasoning derived from the patent at issue itself may not be used.

### **III. The '566 Patent**

30. The '566 patent relates to “exemplary methods [and] systems . . . directed toward header repetition in a communications environment.” (DELL-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.” (DELL-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<sub>H</sub> 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.” (DELL-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<sub>H</sub> bits in the header (H=1 or 2).” (DELL-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. (DELL-1001, 5:46–59, Fig. 1.)



31. 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.” (DELL-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.” (DELL-1001, 2:16–21, 2:67–3:2.)

32. 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.” (DELL-1001, 2:23–26.) A “transceiver” is

illustrated in Figure 2, including a “modulation module” (in red) and “transmitter” (in pink).

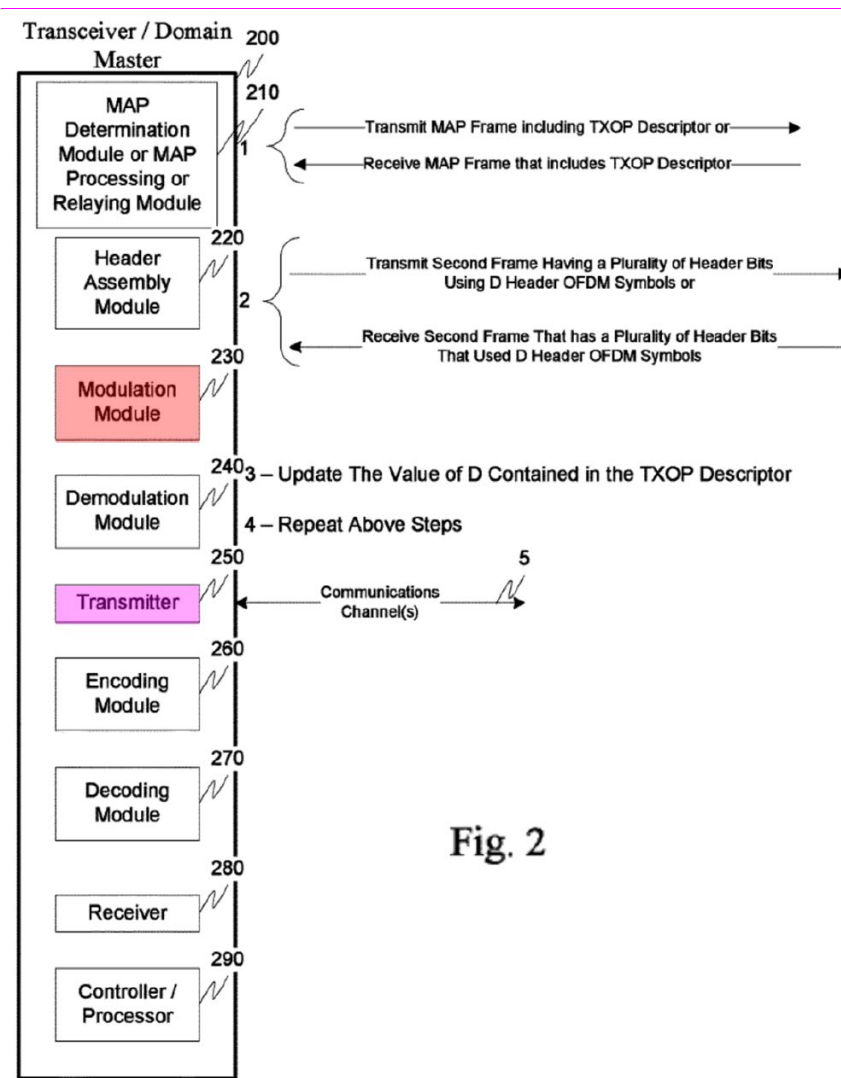


Fig. 2

## A. Technical Background

33. In this section, I first provide a brief technical background of OFDM wireless communications and physical layer (PHY) packet headers in 802.11 standard-compliant wireless local area networks (WLANs), a high-level overview of the '566 patent and its prosecution history, and a discussion regarding claim

construction.

34. The concepts of repeating and extending a header field in a wireless packet, and repeating an extended header field, were not novel prior to the earliest priority date of the '566 patent. In fact, the Applicant, Applied Transform, admitted these concepts were proposed in submissions by other companies during development of the "G.hn" standards mentioned in the '566 patent that were promulgated by the International Telecommunication Union – Telecommunication Standardization Sector (ITU-T). (*See* '566 provisional, 21-22; 09CC-046; 09XC-100; 09XC-119.) I discuss the G.9960 standard and these contributions in §III.A.2. below.

35. The ITU-T G.hn standards group was not the only standards group openly discussing the concepts of repeating and extending a physical layer header prior to the earliest possible priority date of August 2009. Four years before ITU-T G.hn considered these concepts, the IEEE 802.11 TGn working group discussed similar proposals from the TGn Sync and WWiSE industry groups during development of the IEEE 802.11n standard. I discuss these further in my analysis of Ground 1.

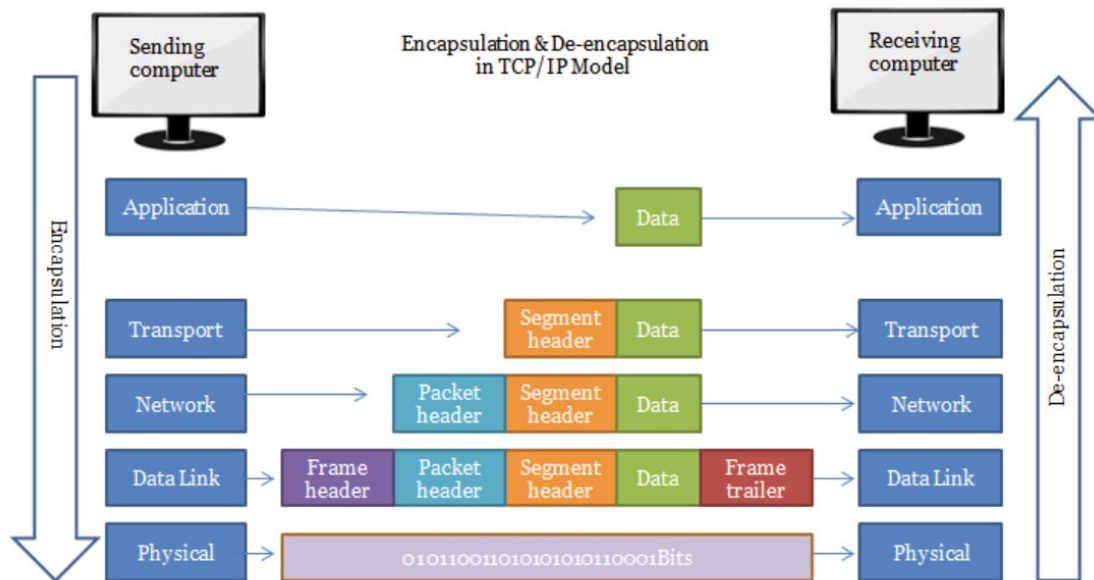
## **1. Communications Systems Overview**

36. Computing devices communicate with one another over a network via network communication protocols. These communications generally involve

transmitting information in the form of electrical signals (generally frequency waves) that propagate over a physical transmission medium that are subsequently received and processed in order to recover the information at the other end of the channel or link. These networks include wired and wireless networks and examples of transmission mediums include signal lines, coaxial cables and wireless air interfaces.

37. The network communication protocols that are used to communicate over the transmission medium are generally defined in layers, with each layer being responsible for one aspect of the communications. The following figure illustrates this concept with reference to the common Open Systems Interconnection (OSI) model and the Transmission Control Protocol/Internet Protocol (TCP/IP) protocol suite. The application layer, at the top of the stack, handles interactions at the application level. The transport layer provides the flow of data between two computers for the application layer above it. TCP and UDP are two common transport layer protocols. The network layer handles the movement of packets around the network. IP is a common network layer protocol. The data link layer handles the details of physically interfacing with the physical media (*e.g.*, coax, power line, air, etc.). And the physical layer performs the formatting operation that transforms the information received from the upper layers into a frame (or packet) that can be communicated as signals over the

physical medium.



38. When an application sends data to an application running on a different computer, the data is sent down the protocol stack. Each layer adds information to the data by prepending headers (and sometimes trailer information) to the data that it receives, as shown in the figure above. Both the ITU G.hn and IEEE Std. 802.11, referenced by the '566 patent, are focused on the two lowest layers of the protocol stack—the data link layer and the physical layer.

#### a. Physical Medium

39. The difference between “wired” (e.g., coax) and wireless LANs is the physical communication medium. Unlike wired media, wireless media “are very difficult to control because the dynamics of the propagated signals over the media are constantly changing.” (O’Hara, 161.) One key consideration in the design of a

wireless LAN (WLAN) system is therefore path loss. As transmitting devices transmit signals to receiving devices in an area, “the signal attenuates as a square of the distance (D).” (O’Hara, 166.) And “[a]s the receiver moves away from the transmitter, the receiver’s signal power decays until it reaches the receiver’s noise floor, at which time the bit error rate becomes unacceptable.” (O’Hara, 166.) Additional path losses may occur because of the fading characteristics of the operating environment.

40. Fading is a major problem in WLAN system design. Most 802.11 equipment uses omnidirectional antennas, radiating RF energy in every direction. The waves are reflected, for example, by the ground or buildings and scattered by objects such as trees, people, towers, or other moving and stationary objects present in the area. (See, e.g., Sklar, 771-772.) Reflections of a signal cause a delayed copy of the same transmission to be received on a different path. These environmental conditions contribute to fading. Large-scale fading is due to path loss of signal as a function of an object coming between the transmitter and receiver. (See Sklar, 947; D. Tse, et al., *Fundamentals of Wireless Communication*, 2 (2005) (“Tse”)) Small-scale fading is due to the constructive and destructive interference of the multiple signal paths between the transmitter and receiver. (Sklar, 947, 953-954; Tse, 2.)

41. One solution to improve performance in a fading channel is to ensure

that the information passes through multiple signal paths, each of which fades independently, making sure that reliable communication is possible provided one of the paths is strong. (Tse, §3.1.4.) This technique creates what is called “diversity” for the transmission, and it can dramatically improve the performance of the system over fading channels. (Tse, §3.1.4.) Three main forms of diversity are traditionally exploited in communication systems for fading channels: temporal (repeating transmission in information in different time intervals), spectral (repeating transmission in information in different frequencies), and spatial diversity (repeating transmission in information over different transmit antennas).

42. A simple mechanism for achieving time diversity uses repetition coding. If a transmitted symbol is not repeated, a deep fade can wipe out a transmitted signal. And if the information lost due to the deep fade is part of the packet header, the entire packet cannot be decoded by the receiver. However, if the information is repeated, a deep fade wipes out only one copy of the repeated information, allowing the data to be potentially recovered in the other copy.

**b. Idealized system model for orthogonal frequency division multiplexing (OFDM)**

43. This section describes an idealized Orthogonal Frequency Division Multiplexing (OFDM) system model. OFDM is a digital multi-carrier modulation scheme that extends the concept of single subcarrier modulation by using multiple subcarriers within the same single channel. Rather than transmit a high-rate stream

of data with a single subcarrier, OFDM makes use of a large number of closely spaced orthogonal subcarriers that are transmitted in parallel. Each subcarrier is modulated with a conventional digital modulation scheme (such as QPSK, 16QAM, etc.) at low symbol rate. This is also referred to as constellation mapping. However, the combination of many subcarriers enables data rates similar to conventional single-carrier modulation schemes within equivalent bandwidths.

44. OFDM is based on the well-known technique of Frequency Division Multiplexing (FDM). In FDM different streams of information are mapped onto separate parallel frequency channels. Each FDM channel is separated from the others by a frequency guard band to reduce interference between adjacent channels. The OFDM scheme differs from traditional FDM in the following interrelated ways: (i) multiple carriers (called subcarriers) carry the information stream; (ii) the subcarriers are orthogonal to each other, and (iii) a guard interval is added to each symbol to minimize the channel delay spread and intersymbol interference.

45. In the frequency domain, multiple adjacent subcarriers (or tones) are each independently modulated with complex data. An Inverse Fast Fourier Transform (IFFT) function is performed on the frequency-domain subcarriers to produce the OFDM symbol in the time-domain. Then in the time domain, guard intervals are inserted between each of the symbols to prevent inter-symbol

interference at the receiver caused by multi-path delay spread in the radio channel. Multiple symbols can be concatenated to create the final OFDM signal. At the receiver, a Fast Fourier Transform (FFT) is performed on the OFDM symbols in the received packet to recover the original data bits.

46. An OFDM carrier signal is the sum of a number of orthogonal subcarriers, with baseband data on each subcarrier being independently modulated using some type of quadrature amplitude modulation (QAM) or phase-shift keying (PSK) technique. This composite baseband signal is typically used to modulate a main radio frequency (RF) carrier for transmission over the channel, which is a band of frequencies or a “frequency band”.

### **Transmitter IFFT Modulation**

47. An IFFT function is computed on each set of symbols (time samples) to produce a set of complex time domain symbols (i.e., to “modulate” the symbols) which are the time-domain OFDM symbols. In OFDM, “modulation” takes place at the IFFT mapping the streams of data symbols onto OFDM symbols for transmission over the channel. The IFFT is therefore a “modulator” in an OFDM system. The OFDM symbols are transmitted over the channel to the receiver.

### **Receiver FFT Demodulation**

48. At the receiver, a forward FFT function is used to convert the time-domain OFDM symbols back to the frequency domain (i.e., to “demodulate” the

symbols). In OFDM, “demodulation” occurs at the FFT converting the received OFDM symbols to data symbols. The FFT is therefore a “demodulator” in an OFDM system. The output of the FFT is mapped onto binary values that are then decoded to produce the binary output data, which is an estimate of the originally transmitted data stream.

**c. Simple digital OFDM system implementation using Fast Fourier Transform (FFT)**

49. These IFFT/FFT transform functions are well known in the art and are important from the OFDM perspective because the IFFT maps digitally modulated input data (data symbols) onto orthogonal subcarriers (OFDM symbols) for transmission, and vice versa for reception at the FFT. The IFFT is the “modulator” in an OFDM system because it takes frequency-domain input data (complex numbers representing the modulated subcarriers) and converts it into the time-domain output data (analog OFDM symbol waveform).

50. The IFFT takes in  $N$  source data symbols at a time. Each of these  $N$  input symbols has a symbol period of  $T$  seconds. The output of the IFFT is  $N$  orthogonal sinusoid waveforms. Thus, the IFFT block provides a simple way to “modulate” data onto  $N$  orthogonal subcarriers. The block of  $N$  output samples from the IFFT make up an OFDM symbol.

51. At the receiver, an FFT block is used to process the received signals and convert them (*i.e.*, demodulate them) into the frequency domain which is used

to ultimately recover the originally transmitted data bits. Figure 2.14 of R. van Nee, et. al., *OFDM for Wireless Multimedia Communications*, 47-48 (2000) (“Van Nee”) below depicts a block diagram of a typical OFDM transceiver (or modem) where the upper path corresponds to the transmitter path and the lower path corresponds to the receiver path. As discussed above, the IFFT “modulates” the input values (*e.g.*, QAM, PSK, etc.) “onto a number of subcarriers” and “[i]n the receiver, the subcarriers are demodulated by an FFT, which performs the reverse operation of an IFFT.” (Van Nee, 47-48.) “An FFT is used to demodulate all subcarriers” and the output of the FFT is “mapped onto binary values and decoded to produce binary output data.” (Van Nee, 48.) In this particular implementation, the same IFFT/FFT hardware is used for both transmitter and receiver.

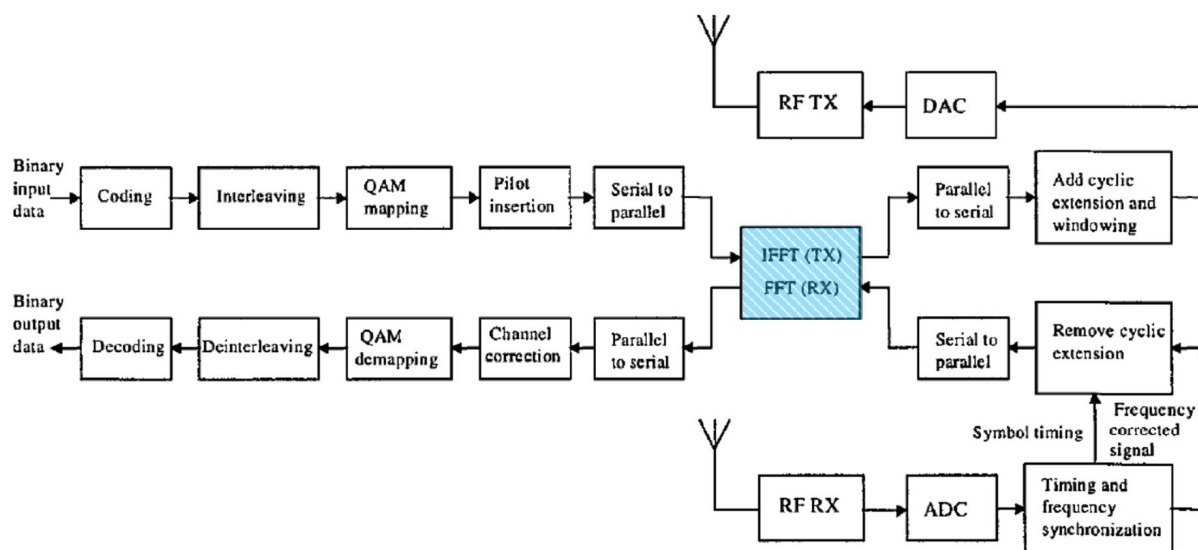


**Figure 2.14** Block diagram of an OFDM transceiver.

## 2. ITU G.hn

52. ITU-T G.hn was tasked with developing standards for a next generation home networking technology that enabled transmission of video, audio and data over existing coax, phone line and power line wires in the home. The '566 patent is drafted using the same terminology as is found in the G.9960 standard specification.

### a. G.9960

53. The goal of G.hn is to optimize a single transceiver for multiple types of media. The G.9960 specification defines the physical layers of G.hn. The '566 patent acknowledges the January 2009 version of G.9960 as prior art in its background section. (*See*, DELL-1001, 1:46-55 (“In G.9960, which is incorporated herein by reference in its entirety, and **should be familiar to those skilled in the art**<sup>1</sup>”).)

54. The protocol reference model of a transceiver is illustrated in Figure 5-11 below. At the physical layer, the reference model includes (1) the physical coding sub-layer (PCS) which “encapsulates transmit packets into the PHY frame and adds PHY-related control and management overhead”, (2) the physical medium attachment (PMA) sub-layer, and (3) the physical medium dependent (PMD) sub-layer which “modulates and demodulates PHY frames for transmission

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<sup>1</sup> Unless otherwise noted, all emphasis by bold is added.

over the medium using” OFDM. (G.9960 1/09, 24:711-715.)

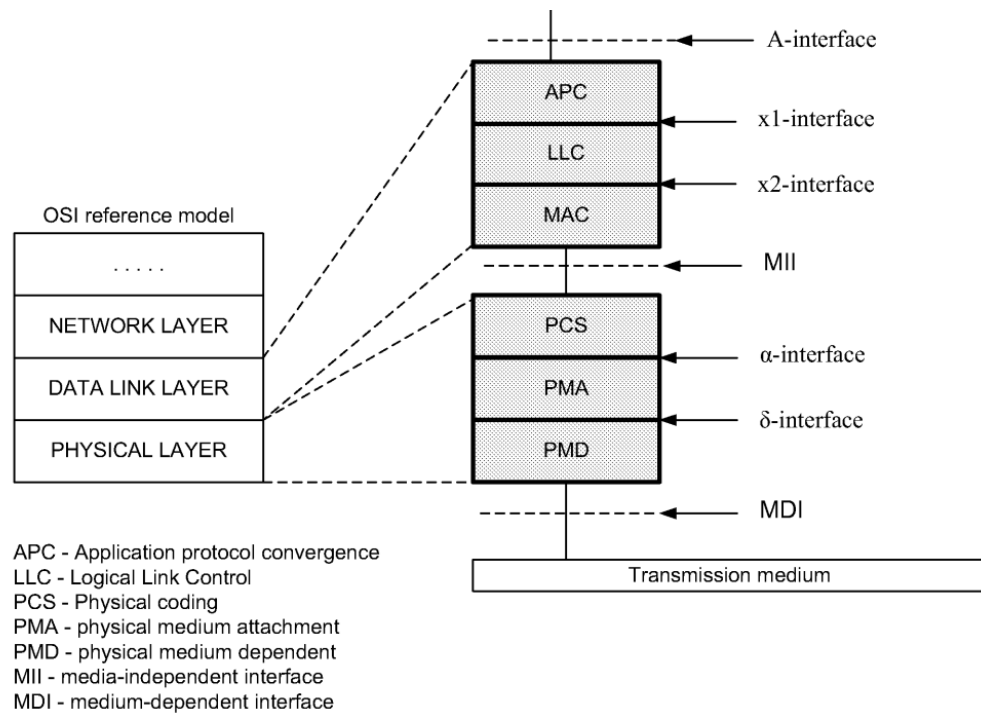


Figure 5-11/G.9960 – Protocol reference model of HN transceiver

55. In the transmit direction, data enters the PHY from the MAC as a block of data called a MAC protocol data unit (MPDU). (G.9960 1/09, 30:854-855.) The incoming MPDU “is mapped into the PHY frame originated in the PCS, scrambled and encoded in the PMA, modulated in the PMD, and transmitted over the medium using OFDM modulation with relevant parameters.” (G.9960 1/09, 30:855-858.) In the PMD, the “preamble is added to assist synchronization and channel estimation in the receiver.” (G.9960 1/09, 30:858-859.)

### (i) Physical Coding Sub-Layer (PCS)

56. The functional model of the PCS is shown in Figure 7-2 of G.9960,

reproduced below. In the transmit direction, “the incoming MPDU is mapped into a payload field of a PHY frame” and the PHY-frame header “is added to form a TX PHY frame.” (G.9960 1/09, 31:869-871.) The TX PHY frame is passed over the  $\alpha$ -interface to the PMD sublayer. (G.9960 1/09, 31:879.) In the receive direction, the decoded PHY-frame payload and header are processed and the MPDU provided to the MAC layer. (G.9960 1/09, 31:872-874.)

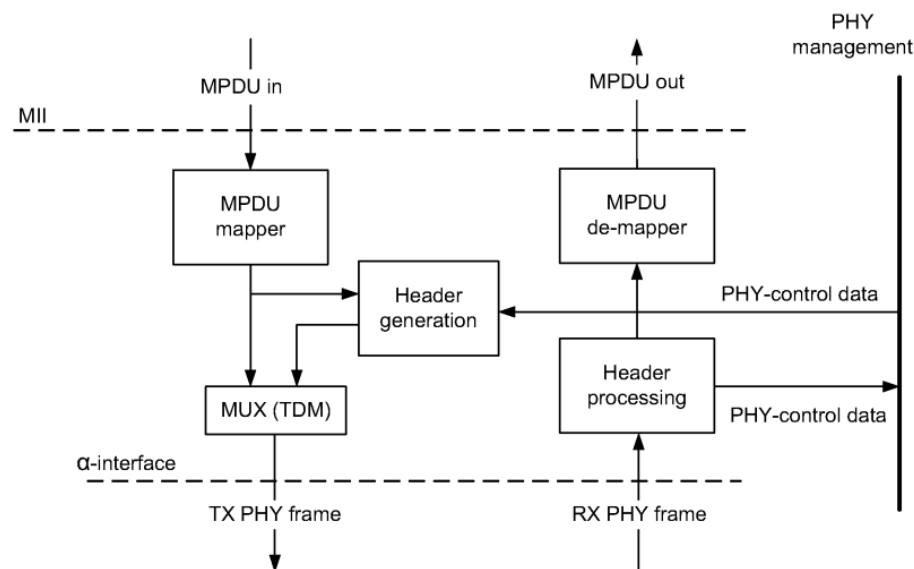


Figure 7-2/G.9960 – Functional model of PCS

57. The PHY frame (illustrated below) includes a preamble, header and payload. At the interface, the PHY frame includes only header and payload because the preamble is added in the PMD. (G.9960 1/09, 31:877-32:882.) The PHY-frame header is a two-part header. It is  $\text{PHY}_H$  bits long and is composed of (1) a common part (containing fields that are common for all PHY-frame types) and (2) a variable part that contains fields according to the PHY-frame type.

(G.9960 1/09, 32:895-897)

| Preamble         | Header               | Channel estimation | Payload                                                                                                                     |
|------------------|----------------------|--------------------|-----------------------------------------------------------------------------------------------------------------------------|
| Added in the PMD | 1 or 2 symbol frames | Added in the PMD   | Integer number of symbol frames;<br>Variable length<br>Variable inter-frame coding rate<br>Variable inter-frame bit loading |

**Figure 7-3/G.9960 – Format of the PHY frame**

**(ii) Physical Medium Attachment (PMA) Sub-Layer**

58. The functional model of the PMA is illustrated in Figure 7-4 of G.9960, reproduced below. As shown, in the transmit direction, the header bits and payload bits for the incoming PHY frame (except for preamble and channel estimation symbols) are scrambled and then encoded. After encoding, the header and payload are each segmented into an integer number of symbol frames and submitted to the PMD for modulation and transmission over the medium. (G.9960, 42:1101-1103.) In the receive direction, the inverse operations of decoding and descrambling are performed on received symbol frames.

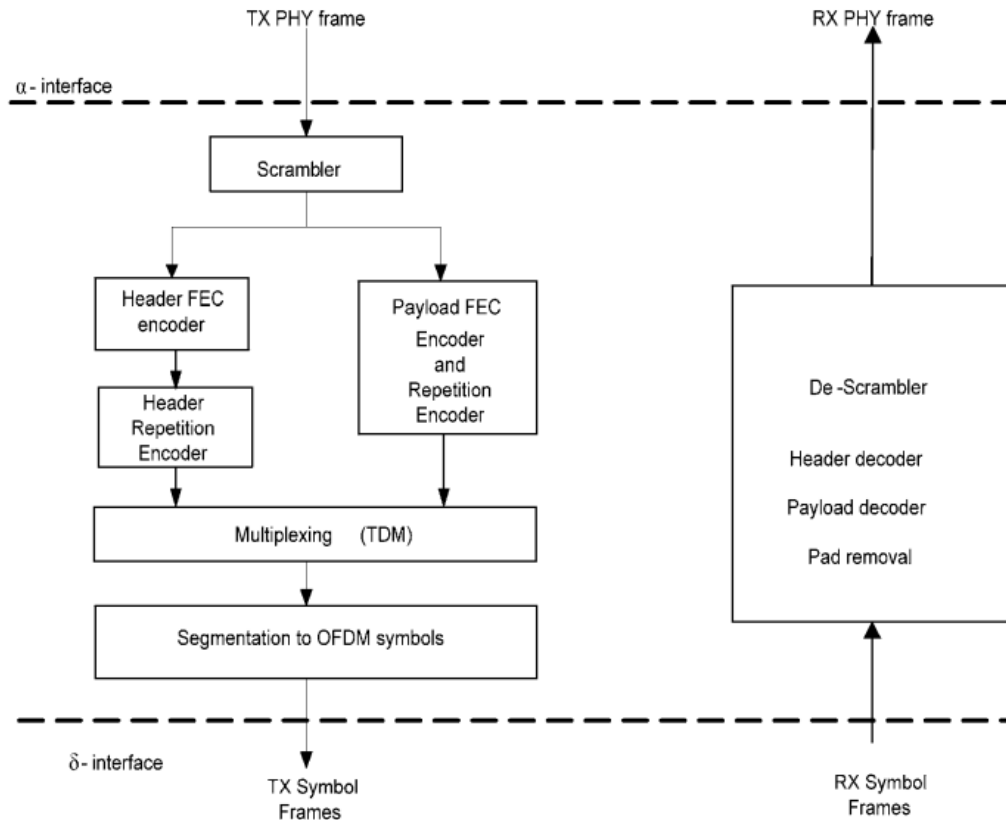


**Figure 7-4/G.9960 – Functional model of PMA**

### **(iii) Physical Medium Dependent (PMD) sub-layer**

59. The functional model of the PMD is illustrated in Figure 7-11 from G.9960, reproduced below. In the transmit direction, the tone mapper divides the incoming symbol frames into groups of bits and associates each group of bits with a specific sub-carrier onto which this group shall be loaded. (G.9960, 52:1397-1399.) The constellation encoder converts every group of incoming bits “into complex numbers which are, respectively, the real and imaginary part of the constellation point on which the particular group of bits is loaded for this subcarrier.” (G.9960, 52:1400-1402.) The OFDM modulator “converts the stream

of the  $N$  complex numbers at its input into a stream of  $N$  time domain samples.”  
 (G.9960, 53:1407-1408.) After adding the preamble, the transmit signal is up-  
 shifted to fit the required spectrum of the transmit signal. (G.9960, 53:1408-1410.)

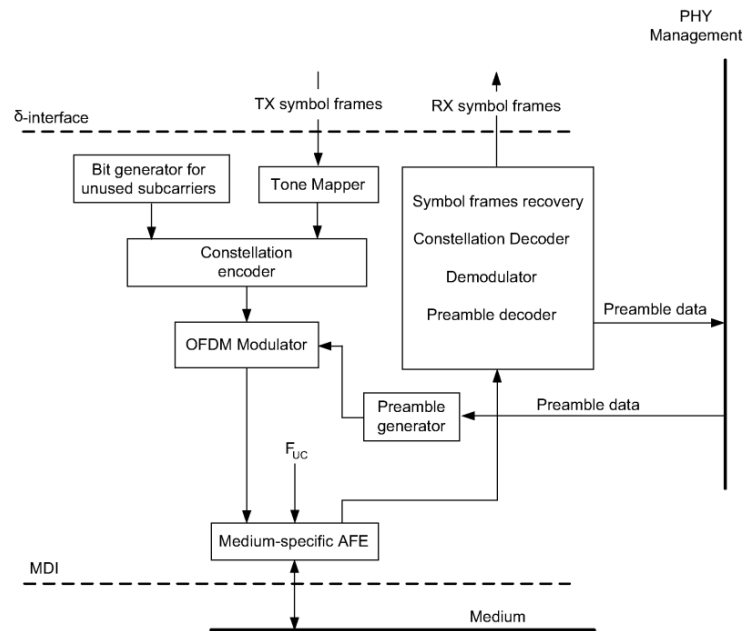


Figure 7-11/G.9960 – Functional model of the PMD

## b. “G.hn: Extended PHY Frame Header” Contribution (July 2009)

60. The ’566 provisional admits that the G.hn group agreed in April 2009 that “G.hn shall specify means to extend the PHY-frame header.” (Prov., 2.) The contribution, “G.hn: Extended PHY frame header”, from Intellon Corporation published in July 2009 proposed a technique for the header extension “add[ing] an option for supporting extended PHY frame headers that contain  $2 \times \text{PHY}_H$  information bits.” (G.hn 09XC-119, 1.) The ’566 patent further admits that this contribution is prior art in its background section. (DELL-1001, 2:5-10.)

61. Intellon's contribution also notes that the current draft of G.9960 alludes to PHY frame headers that contain more than one symbol (although the reference does not specify whether these additional symbols are for PHY frame header symbol repetition or to support additional frame header information bits). (G.hn 09XC-119, 1.) The contribution proposes to define two one-bit fields in the PHY header: (1) an extended header indication (EHI) which indicates whether the header contains an extended number of bits and (2) an immediate response frame extended header indication (IREHI) which tells receivers if they should respond with a header containing  $\text{PHY}_H$  or  $2 \times \text{PHY}_H$  bits. (G.hn 09XC-119, 2.)

**c. "G.hn: Using Two Symbols for the Header of a PHY frame on Coax" Contribution**

62. The contribution, "G.hn: Using Two Symbols for the Header of a PHY frame on Coax," by CopperGate Communications in July 2009 "proposes that the number of symbols used for the header of the PHY frame on coax" be fixed to exactly two because a single symbol does not provide adequate reliability. (G.hn 09XC-100, 1.) The '566 patent also admits that the CopperGate contribution was prior art. (DELL-1001, 1:46-62.) And the '566 provisional admits that this contribution was provisionally agreed to at the July 30, 2009 meeting. (Prov., 2.)

63. The CopperGate contribution notes that the PHY-header "contain[s] important information necessary in order to process the payload." (09XC-100, 1.) The effective number of repetitions of the header "depends on the number of active

subcarriers and on the number of header symbols.” (09XC-100, 1.) CopperGate proposes to always use two header symbols on the coax medium. The contribution also describes a Header Encoder which includes a Header FEC encoder followed by a Header repetition encoder, which copies the FEC codeword. (09XC-100, 2.)

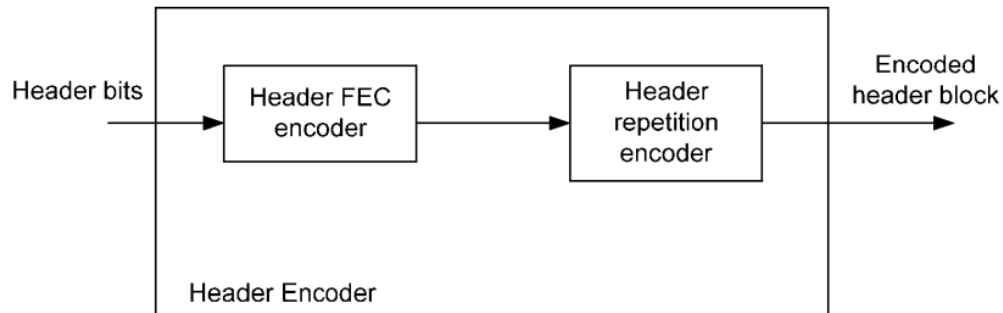
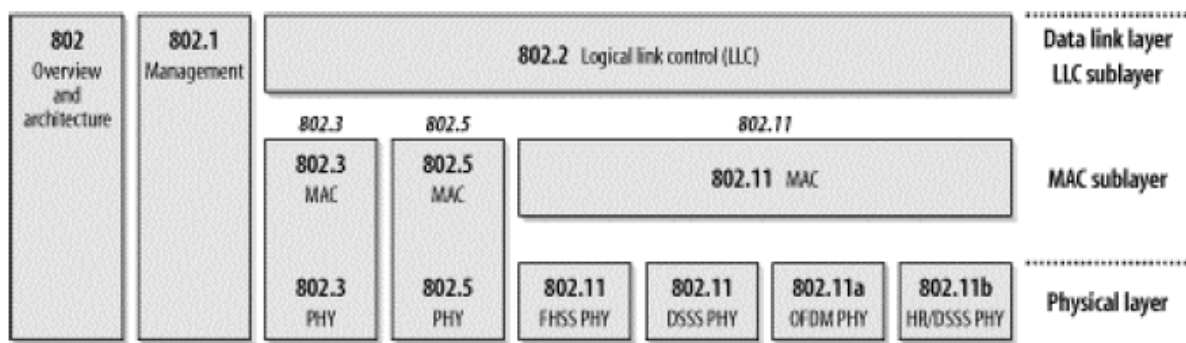


**Figure 7-10/G.9960 – Functional diagram of the Header Encoder**

### **3. IEEE 802**

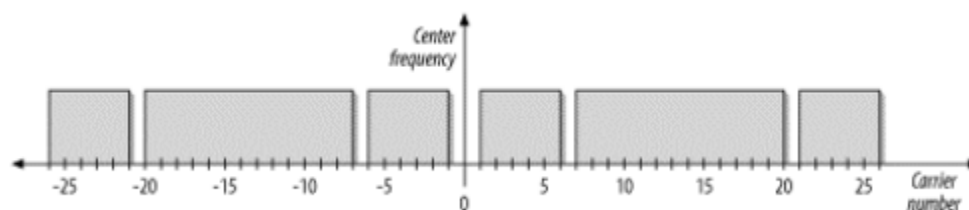
64. IEEE 802.11 is a member of the IEEE 802 family, illustrated below, which is a series of specifications for local area network (LAN) technologies. The base 802.11 specification includes two physical layer specifications: a frequency-hopping spread spectrum (FHSS) physical layer and a direct-sequence spread-spectrum (DSSS) layer. (Gast, 8.) A later revision, 802.11a, added a physical layer based on orthogonal frequency division multiplexing (OFDM). (Gast, 8.) Because the '566 patent relates to an OFDM physical layer, Petitioner describes 802.11a further below.



## a. OFDM PHY (802.11a)

### (1) Operating Channels

65. The OFDM PHY organizes the available spectrum “into operating channels.” (Gast, 206.) For example, the operating channels in 802.11a “are specified as 20 MHz wide.” (Gast, 206.) In the United States, channels in the 5-GHz band are numbered starting every 5 MHz and therefore each 20 MHz 802.11a channel “occupies four channels” shown in the following Table. (Gast, 207). Each 20-MHz 802.11a channel is composed of 52 subcarriers. Four of the subcarriers are used as pilot carriers and 48 subcarriers are used to transmit data. The subcarriers are numbered from -26 to 26, as shown below. Subcarrier 0 is not used. Pilot carriers are assigned to subcarriers -21, -7, 7, and 21.



**Gast, Figure 11-8**

## (i) Physical Layer

66. The physical layer in 802.11 is divided into two sublayers: the Physical Layer Convergence Procedure (PLCP) sublayer and the Physical Medium Dependent (PMD) sublayer. (Gast, 151.) The PLCP is “the glue between frames of the MAC and radio transmissions in the air.” (Gast, 151.) The PMD is responsible for transmitting any bits it receives from the PLCP over the air using the antenna. (Gast, 151.)

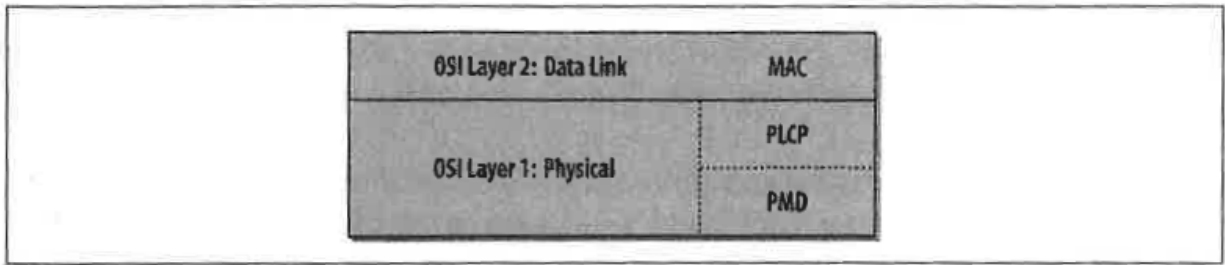


Figure 9-1. Physical layer logical architecture

67. The OFDM PHY layer creates a frame, referred to as the physical protocol data unit (PPDU), by adding a preamble and header to the data received for transmission from the MAC layer, as illustrated in Figure 122 from 802.11a standard. (Gast, 208.) The 802.11a PPDU, illustrated below, includes a preamble that “synchronizes various timers between the transmitter and the receiver.” (Gast, 209.) The PLCP header is transmitted in the Signal field. (Gast, 209.) The header includes information regarding the data rate and number of bytes of the embedded MAC frame (length). (Gast, 210.)

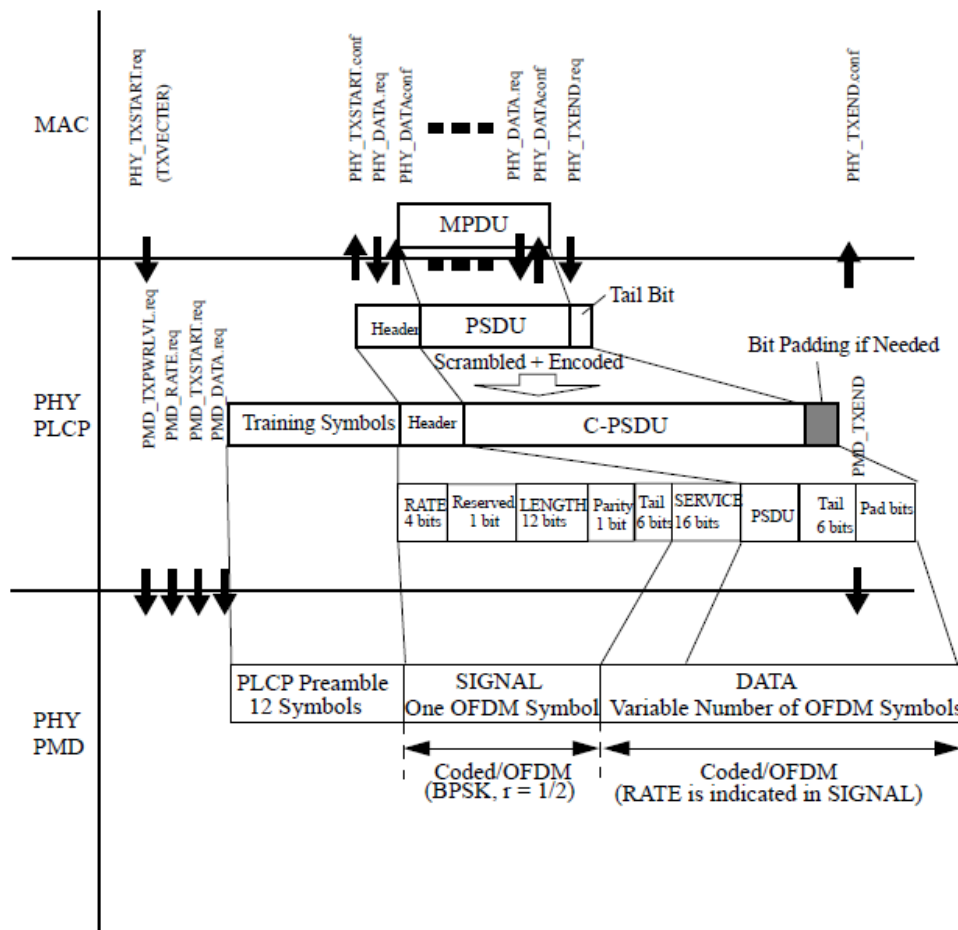


Figure 122—PLCP transmit procedure

## b. IEEE 802.11n

68. In 2004, IEEE created the IEEE 802.11n task group (TGn) and charged the group with crafting a standard for WLANs that can sustain up to 100 Mbits/second throughput. This new standard, 802.11n, builds upon previous 802.11 standards, especially 802.11a. Two competing proposals emerged during the deliberations of TGn—a proposal from the World-Wide Spectrum Efficiency (WWiSE) group and a proposal from the TGn Sync group. As discussed in further detail in §IV.A.1., the TGn Sync proposal included support for an extended

physical layer header. The WWiSE proposal included support for an extended range mode which duplicates (repeats) the physical layer header. (*See*, §IV.A.1.)

## **B. Level Of Ordinary Skill In The Art**

69. I understand that certain issues relating to the validity of the '566 patent must be judged from the perspective of a person of ordinary skill in the relevant art, as I discuss below. I have been asked to define the level of a “person of ordinary skill in the art” or “POSITA” at the time the alleged invention was made. In deciding the level of ordinary skill, I have considered the following factors, which I have been informed are relevant to the determination of ordinary skill in the art:

- the level of education and experience of persons working in the field;
- the types of problems encountered in the art;
- the prior art solutions to these problems;
- the rapidity with which innovations are made; and
- the sophistication of the technology.

70. In my opinion, a person of ordinary skill in the art (“POSITA”) at the time of the purported invention described in the '566 patent 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 the field of wireless communication protocols, or an equivalent combination of education and experience. My opinion below explains how a POSITA would have understood the

technology described in the references identified in this declaration as of the priority date of the '566 patent.

### **C. Claim Construction**

71. I understand that “claim construction” is the process of determining a patent claim’s meaning. I understand that the Patent Office applies the same claim construction standard used in district courts which seeks to give claim terms their plain and ordinary meaning to a POSITA at the time of the claimed invention in view of the claims, specification, and prosecution history. I also understand that if the patent applicant gave a term a special meaning in the specification or during prosecution, then the special meaning should be used.

72. I do not believe that any terms require explicit construction.

Therefore, I apply the plain and ordinary meaning to the recited claim terms.

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

73. 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**

74. Hansen is the publication of U.S. Patent Application 11/151,772, which matured into U.S. Patent 8,737,189 (DELL-1009; “Hansen Patent”). Hansen

relates “to a method and system for compromise greenfield preambles for 802.11n.” (DELL-1006, ¶7, 1:24–25.)

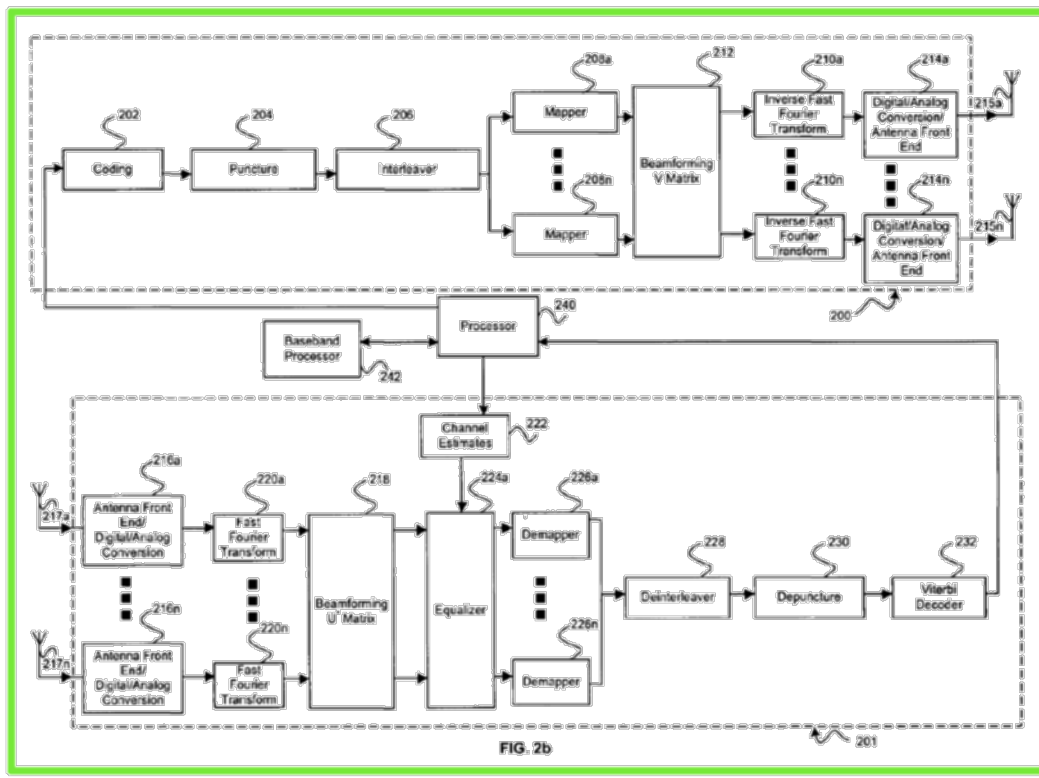
75. The IEEE 802.11 task group N (TGn) was “chartered to develop a standard to enable WLAN devices to achieve throughput rates beyond 100 Mbits/s” to “be documented in IEEE resolution 802.11n.” (DELL-1006, ¶9.) The task group was “to develop a standard that will enable WLAN devices compatible with IEEE 802.11n to also interoperate with IEEE 802.11 devices that are not compatible with IEEE 802.11n” (“legacy” devices). (*See* DELL-1009, 1:41–44; DELL-1010, 13; DELL-1006, ¶¶1, 6, 32 (incorporating the Hansen Provisional).) This “backward compatible” access is referred to as “mixed mode access.” (DELL-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. (DELL-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. (DELL-1006, ¶¶32, 59, 77, 87.)

76. Two proposals emerged as “candidates for incorporation in IEEE 802.11n.” (DELL-1006, ¶9.) The first, from TGn Sync industry group, supported mixed-mode access but did “not provide a mechanism to support greenfield

access.” (DELL-1009, 4:42-43; DELL-1006, ¶33.) The second, from WWiSE industry group, supported both greenfield and mixed-mode access. (DELL-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. (DELL-1006, ¶¶7, 11, 27, Fig. 4a, Fig. 5a, Fig. 6a; Hansen Provisional, 14; *see also* DELL-1006, ¶¶1, 6 (incorporating the Hansen Provisional by reference).) 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* DELL-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 (DELL-1005).

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

## Wireless OFDM Transceiver



### 1. WWiSE

78. 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 DELL-1005, 13-14, 48-49, 55, 84.)

79. 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 DELL-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.” (DELL-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. (DELL-1005, 69-70.)

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

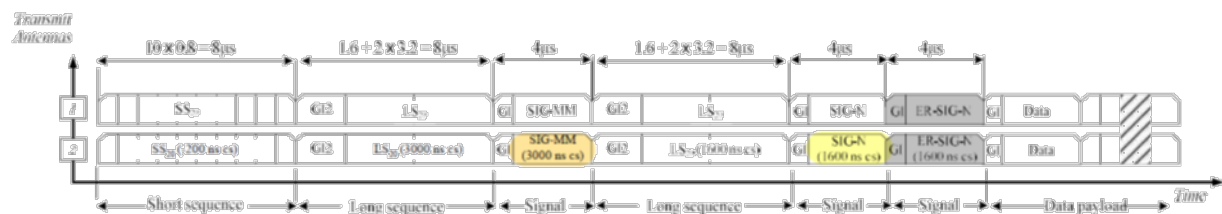
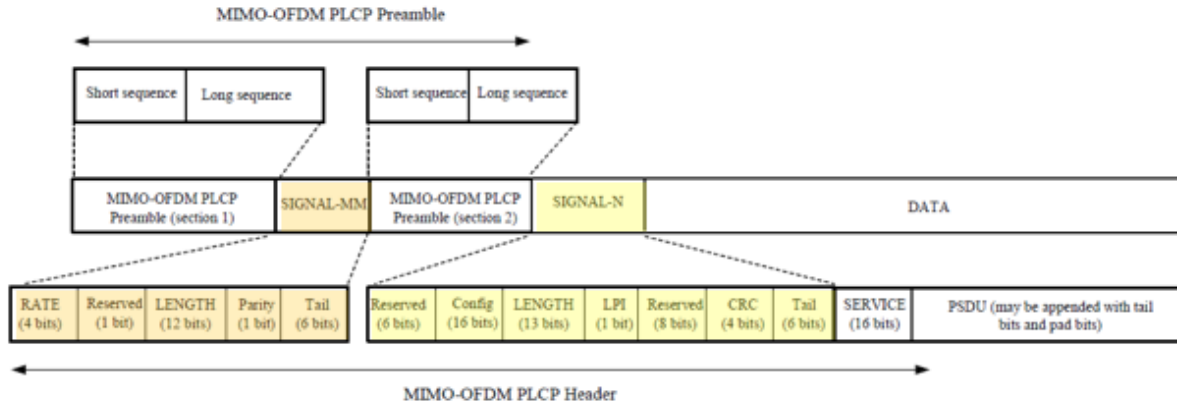


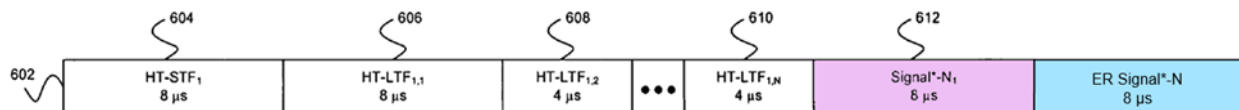
**Figure 008 – MIMO-OFDM Training structure for N<sub>Tx</sub> = 2, 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.**

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



## B. Motivation to Combine

81. A POSITA would have been motivated to combine Hansen and WWiSE. Specifically, a POSITA would have included support for WWiSE's ER communication in Hansen's transceiver. 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. 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

82. 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. For example, a POSITA would have been motivated to use 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. A POSITA would have understood that the added bit(s) could be used for the REXT field. (DELL-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. A POSITA would have had several reasons to make this proposed combination.

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

WWiSE and TGN Sync January 2005 proposals. (DELL-1006, Title (“Method and system for compromise green field preambles for 802.11n”), ¶7 (“certain embodiments of the invention relate to a method and system for compromise green field preambles for 802.11n”); DELL-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”); DELL-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.

84. ***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. Diversity is a known technique to improve system performance over fading channels. (DELL-1015, 130.) 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. (DELL-1022.) Large-scale fading occurs when an obstacle comes in-between the transmitter and receiver. (DELL-1022, 947.) Small-scale fading is concerned with rapid fluctuations of received signal strength over a very short distance and short time period. (DELL-1022, 947.)

85. The three main forms of diversity that are “traditionally exploited in communication systems for fading channels: temporal, spectral, and spatial diversity.” (DELL-1015, 130.) By repeating the header (Signal-N) in the time domain, WWiSE’s ER capability introduces temporal diversity. (See DELL-1005, ¶¶67–69.) Each repeated symbol provides additional diversity, which increases the likelihood of decoding the information correctly at the receiver. 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. A POSITA would have been motivated to include WWiSE’s ER capability to improve robustness of communication. A POSITA would have understood that WWiSE’s ER capability permits communication in noisy or otherwise degraded channel conditions.

86. **Third**, this combination is merely the application of 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. 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.

87. ***Fourth***, this combination is merely 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. 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. Indeed, reserved bits are provided for this specific purpose. (*See, e.g.*, DELL-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. The results of this combination

would have been predictable, and a POSITA would have had a reasonable expectation of success. Both Hansen and WWiSE describe PPDU's for use in the 802.11n standard being developed. Existing 802.11 standards, which both Hansen and WWiSE build upon, would have been well-known to a POSITA by the earliest priority date of the '566 patent. And as discussed above, the combination adds fields/sub-fields to an existing packet structure. 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.

**C. Independent Claims 1, 11, 21, and 31<sup>2</sup>**

**[1P]** A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:

**[1A]** 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;

**[1B]** a wireless OFDM communications transmitter, connected to and in communication with the modulator, operable to transmit in a first

---

<sup>2</sup> 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.

narrower frequency band, the first packet comprising the first number of OFDM symbols;

[1C] 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

[1D] 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,

[1E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.

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

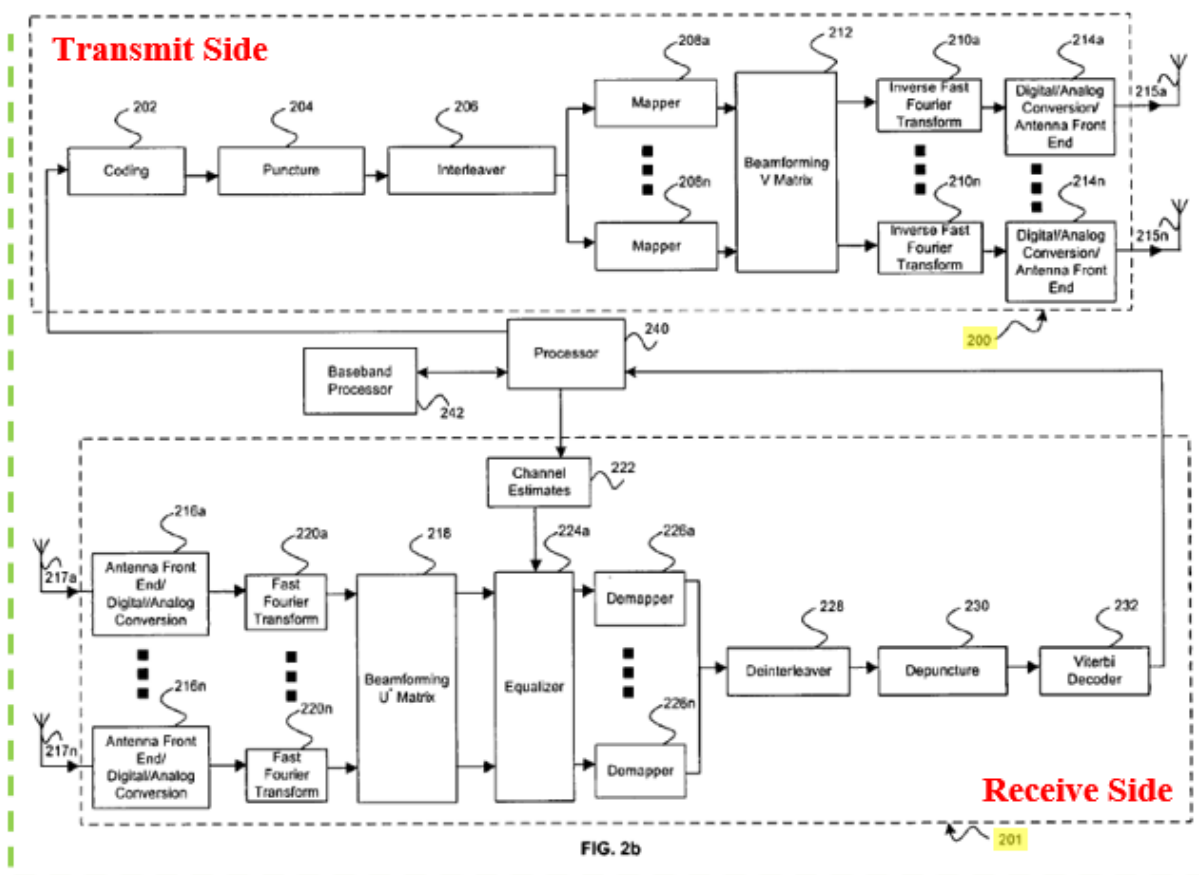
**1. Preamble [1Pre], [11Pre], [21Pre], and [31Pre]**

89. Petitioner does not acquiesce that the preamble is limiting.

Nevertheless, the combination of Hansen and WWiSE discloses the preamble.

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

## 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., DELL-1006, ¶¶48, 51.)

90. 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 DELL-1005, 13–14, 30 55.) WWiSE

further describes “mandatory” transmitting and receiving capabilities (e.g., DELL-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. A POSITA would therefore have had a reasonable expectation of success in implementing WWiSE’s PPDU s using Hansen’s transceiver.

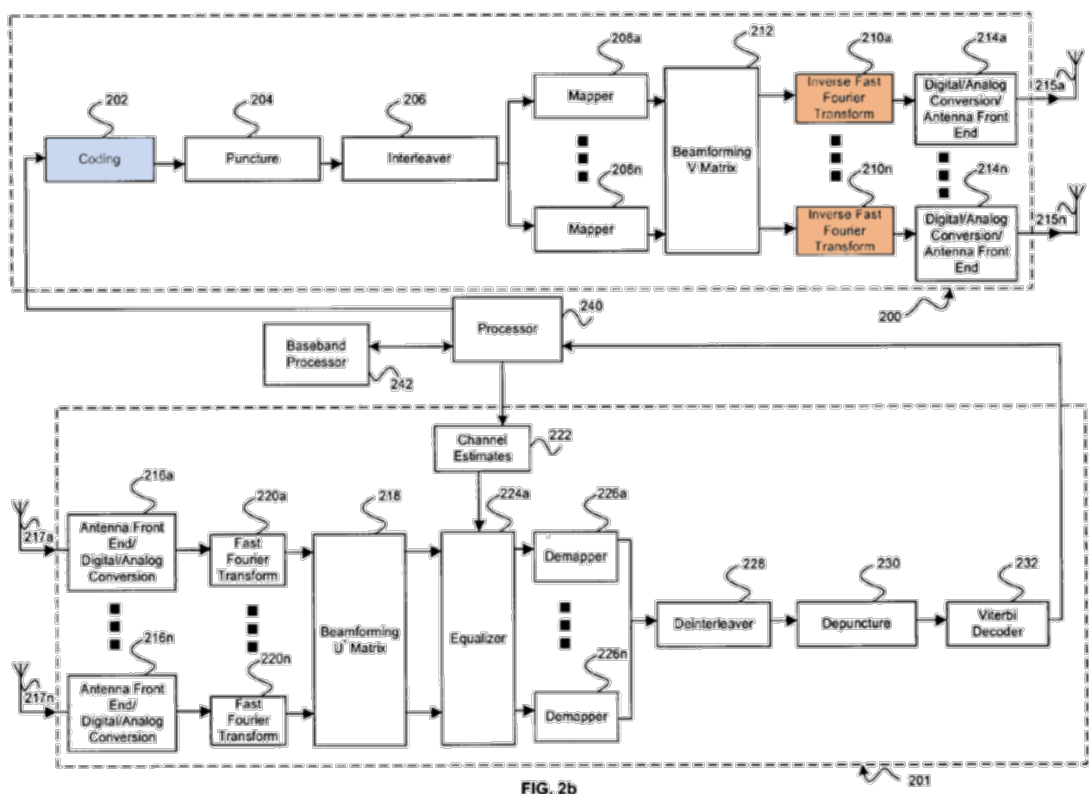
**1. Claim Limitations [1A], [11A], [21A], and [31A]**

91. The combination of Hansen and WWiSE discloses this limitation.

**a. Modulator operable to modulate ... OFDM symbols**

92. The combination of WWiSE and Hansen discloses 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. (DELL-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)<sup>3</sup> bits associated with the PPDU to be transmitted. (DELL-1006, ¶59; DELL-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”).)



**Hansen, Annotated Figure 2b**

<sup>3</sup> The preamble is not added until after modulation which completes the PPDU (“packet”). (See DELL-1005, 61:37–39.)

93. The output of mapper block 208 is provided to IFFT 210<sup>4</sup>, which “subdivide[s] the bandwidth of the RF channel into a plurality of  $n$  sub-band frequencies to implement orthogonal frequency division multiplexing (OFDM), buffering a plurality of received signals.” (DELL-1006, ¶48.) Each buffered signal is “modulated by a carrier signal whose frequency is based on [] one of the sub-bands.” (DELL-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.*) (DELL-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* DELL-1005, 70:18–21; DELL-1012, 121:1–122:2.) IFFT 210 (shaded orange above) is therefore a “modulator” that generates OFDM symbols.

94. 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

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<sup>4</sup> Although Hansen describes beamforming after the mapper, beamforming is not performed on the header because the header is repeated on each transmit antenna. Instead, the same data would be provided to each IFFT when the header is being processed. (*Id.*)

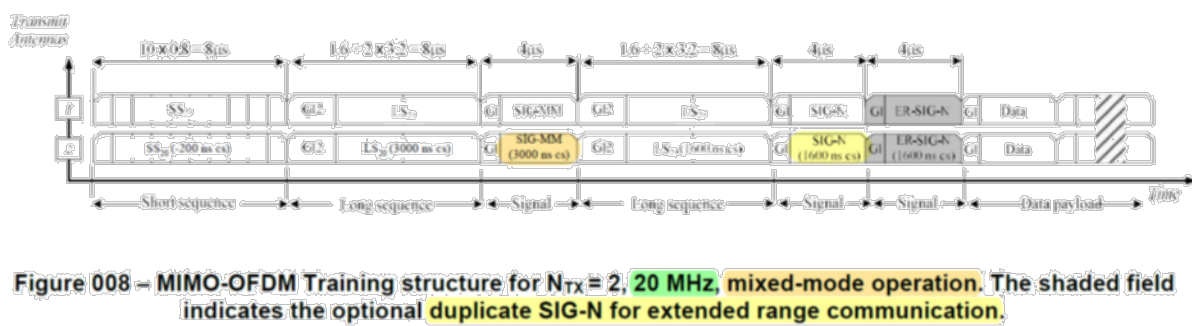
generate an OFDM symbol. (See DELL- 1005, 61:32–35, 83:21–25 (TX Block Diagram showing “add cyclic extension (guard)”); DELL-1038, 260–262.)

95. Accordingly, the combination of WWiSE and Hansen discloses a “*modulator*” that generates an OFDM symbol. Thus, the combination discloses “*a modulator operable to generate*” an OFDM symbol corresponding to a set of bits in the PPDU input stream.

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

96. 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.” (DELL-1005, 15, 50, 69.) “A characteristic of ER MCS is that they have a longer range than NR MCS” (DELL-1005, 50), meaning that ER MCS provides improved reliability when, for example, a STA operates farther away from an AP. 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. (DELL-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.” (DELL-1005, 58–59, 69–70, 83.) An example is shown in Figure 008 for a device in “mixed-mode operation.” (DELL-1005, 13–14, 58)



97. As also shown, mixed-mode includes “another [OFDM] symbol, denoted SIGNAL-MM (SIG-MM)” that provides additional information in mixed-mode communications. (DELL-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.”

### c. “Header” bits/portion

98. 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.” (DELL-1005, 58–59, 69–70, Fig. 003.) This likewise describes the ER-SIG-N field, which repeats the SIG-N field. (*Supra* §IV.C.2.b; DELL-1005, 50, 67, 69,

Fig. 008.) 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.” (DELL-1005, 69–71, Fig. 008.) 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. (DELL-1005, 58–59, 70, 92, 95; DELL-1006, ¶¶59, 79–81.)

**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**

99. 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.”

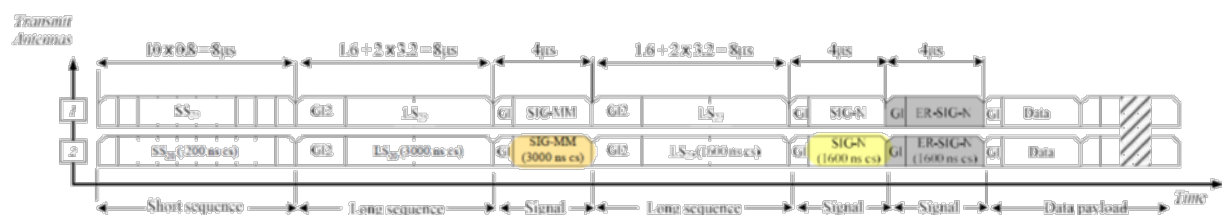


**Figure 008 – MIMO-OFDM Training structure for  $N_{TX} = 2$ , 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.**

As a result, 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).

(DELL-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.

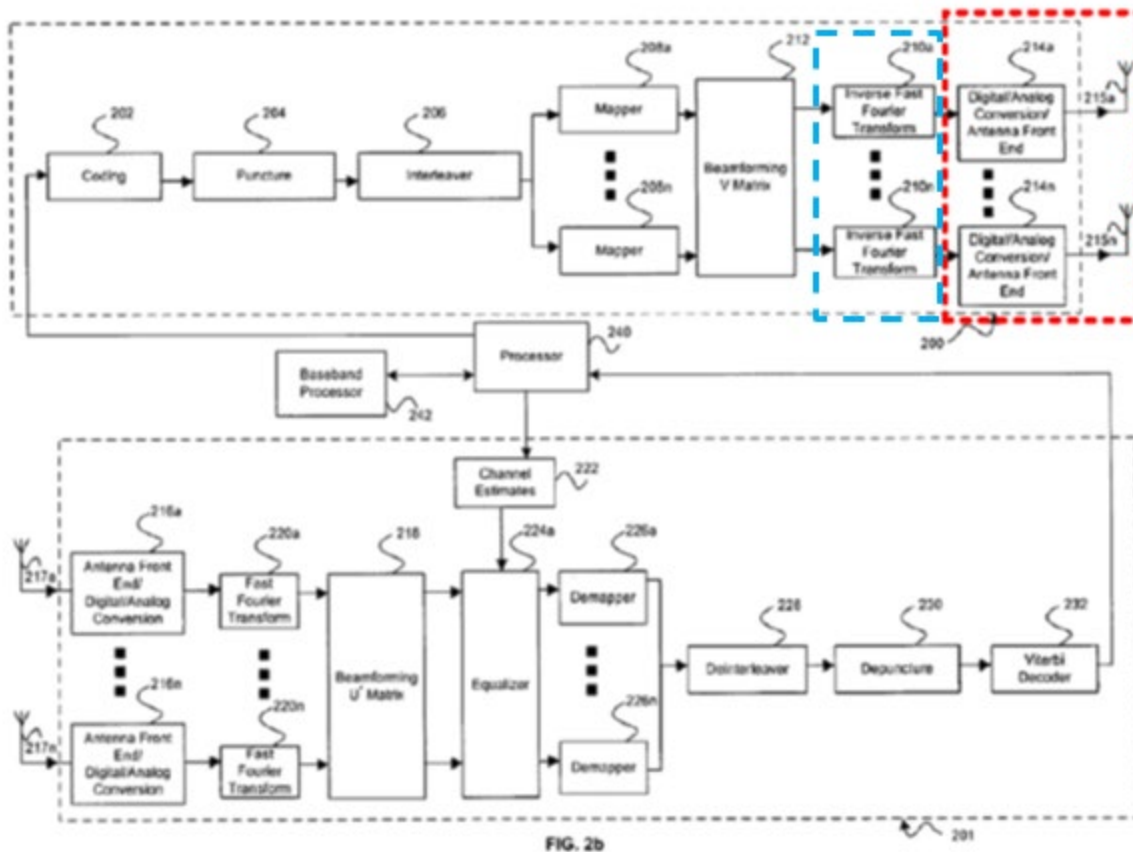
100. WWiSE and Hansen thus disclose a “*modulator operable to modulate a first number of OFDM symbol to transmit a first plurality of header bits*” (e.g., Hansen’s IFFT modulating OFDM symbols carrying header bits of SIG-N, ER SIG-N and SIG-MM) “*in a first packet*” (Figure 008’s mixed-mode ER packet) “*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).

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

101. The combination of Hansen and WWiSE discloses this limitation.

**a. A wireless OFDM communications transmitter, connected to and in communication with the modulator**

102. 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.” (DELL-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.” (DELL-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 to correspond to a transmitter for transmitting wireless packets.

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

103. As discussed above (*see supra* §IV.C.2.b.), 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 symbols of 4  $\mu$ s each in duration as shown below.

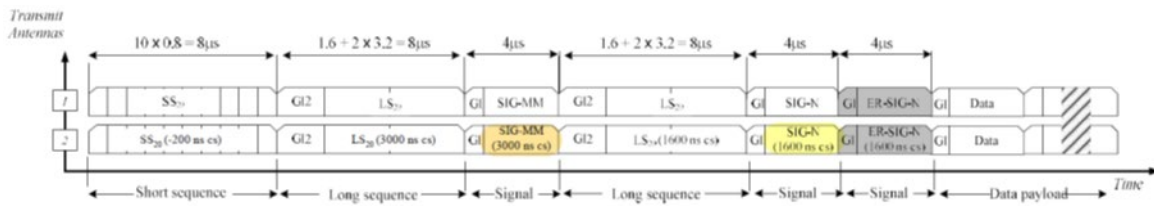


Figure 008 – MIMO-OFDM Training structure for  $N_{Tx} = 2$ , 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.

(WWiSE, 67.)

104. Hansen similarly describes a PPDU—a type of packet in 802.11—that is analogous to 802.11 PDUs in WWiSE (which WWiSE also calls “frames”) and is also transmitted in mixed-mode operation in the 20MHz frequency band. (DELL-1005, ¶¶59, 67.). (DELL-1006, ¶59; DELL-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. (DELL-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.*”

105. To the extent that 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, who would have been motivated to make the modification for the reasons discussed above (*see supra* §IV.B.).

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

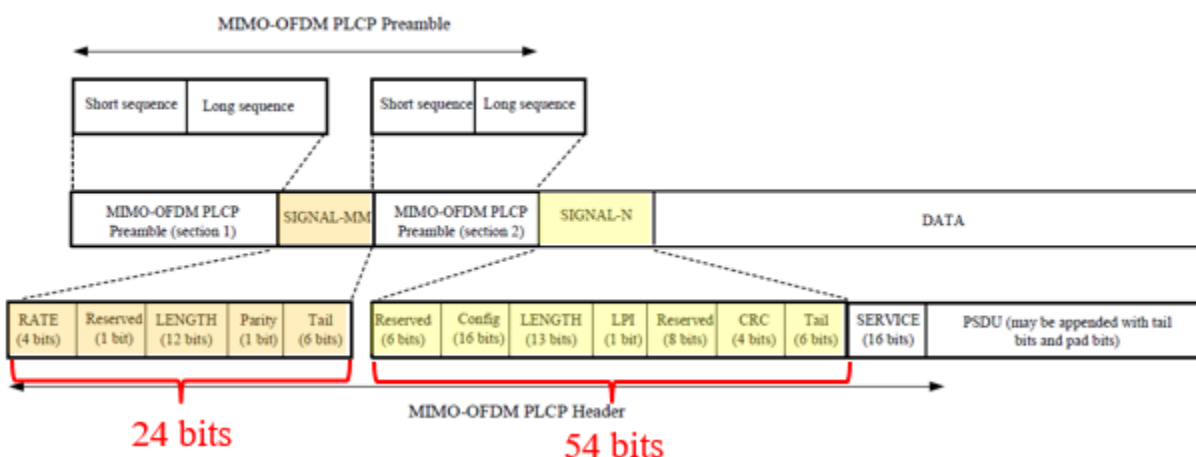
106. The combination of WWiSE and Hansen discloses this limitation.

#### a. Modulator operable to modulate ... OFDM symbols

107. As discussed in §IV.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

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



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* §IV.C.2b; DELL-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).

**c. “Header” bits/portion**

109. 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*.”<sup>5</sup> (See *supra* §IV.C.2.c.) 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.” (DELL-1005, 58–59, 70–71, Fig. 003.)

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<sup>5</sup> Claims 11 and 31 recite a “header portion” rather than “plurality of header bits” (as in claims 1 and 121). The analysis in this section applies equally to both claim terms.

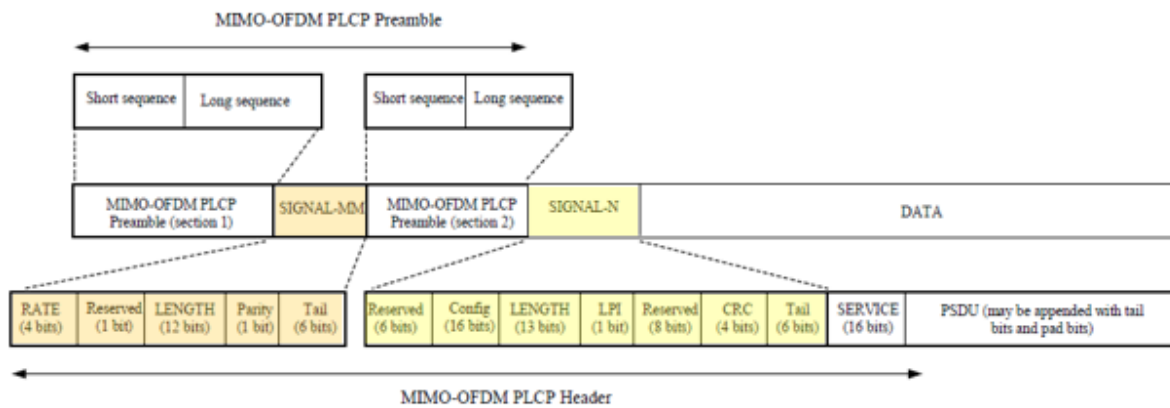


Figure 003 – PPDU frame format: Mixed-mode access in the 1TX (40 MHz) and 2TX (20 and 40 MHz) modes

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

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

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

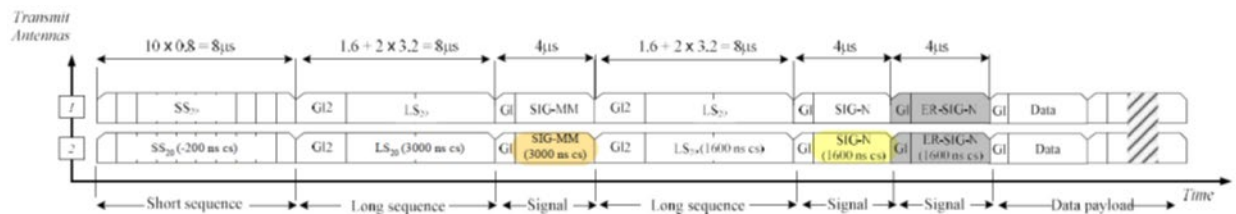
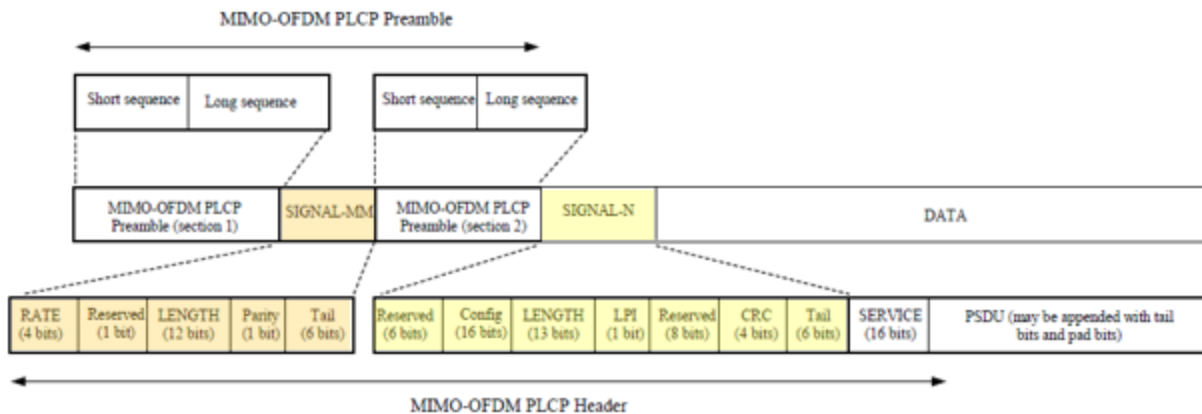


Figure 008 – MIMO-OFDM Training structure for  $N_{TX} = 2$ , 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.



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. (DELL-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. 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                                                                                                                                             |

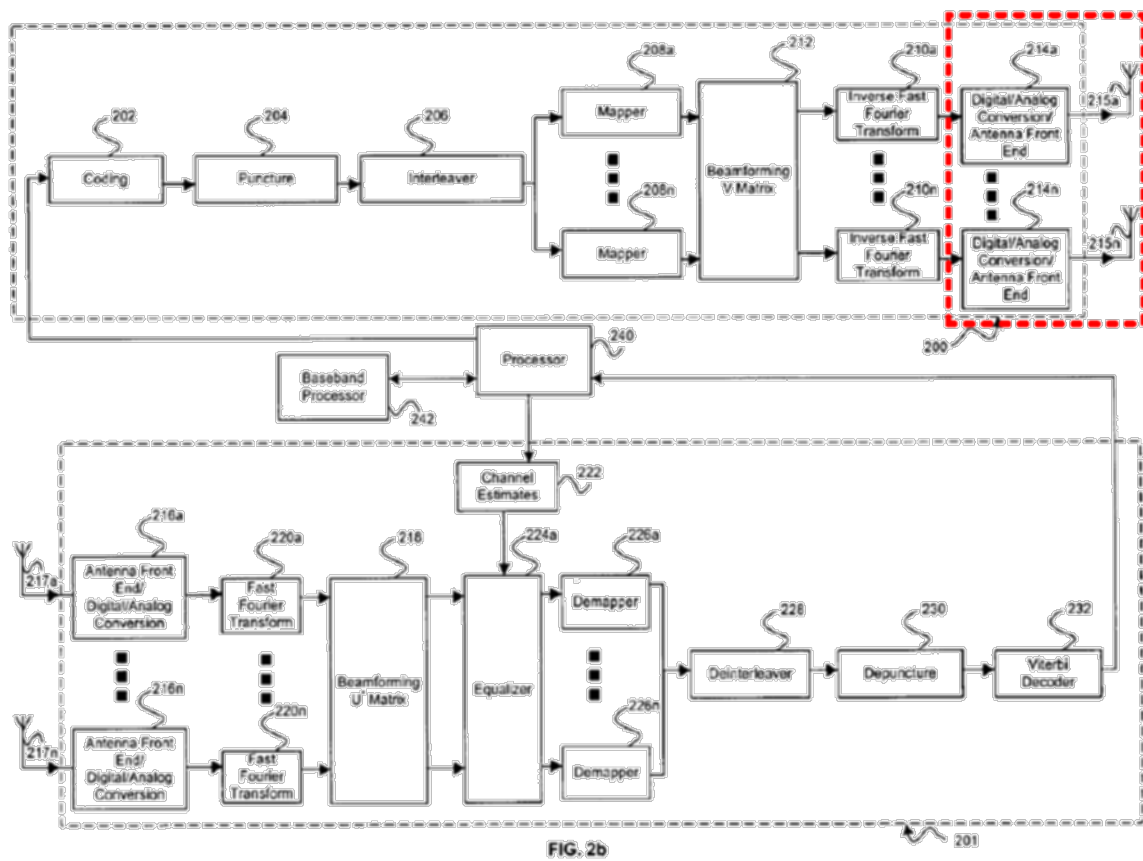
(DELL-1005, 70.)

111. 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.

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

112. As discussed in §IV.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*, §IV.C.3.b; DELL-

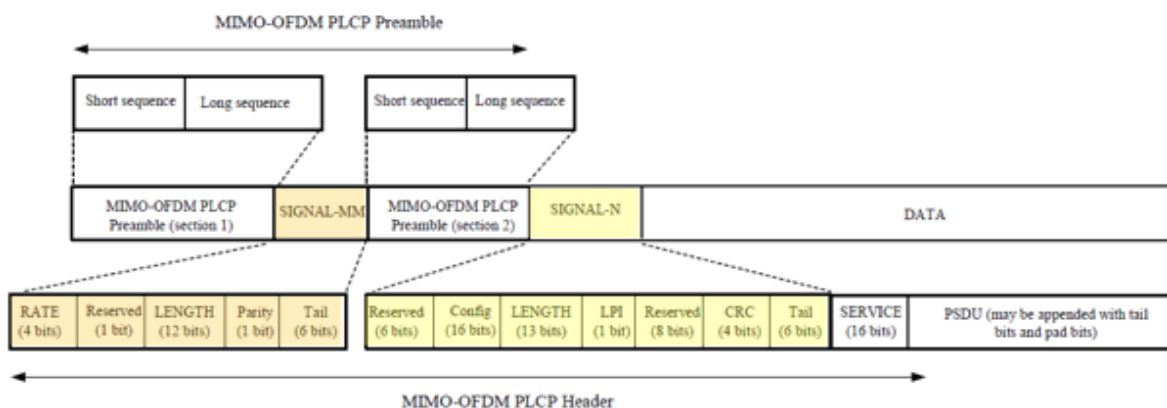
1006, ¶¶65, 67–68 (“20 MHz or 40 MHz bandwidth field 494 may indicate whether the PPDU was transmitted utilizing a 20 MHz RF channel, or a 40 MHz RF channel”), 79.) Hansen’s transmitter (outlined in red) is illustrated in Figure 2b below.



113. 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. (DELL-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 repeatedly describes transmission over the 40MHz frequency band. (DELL-1006, ¶¶65, 68, 79.)

114. Hansen’s transceiver thus transmits packets in the 40MHz “*wider frequency band*.” This includes, for example, WWiSE’s NR mixed-mode packets that can be transmitted in the 40MHz band, as illustrated in Figure 003 below.



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* §IV.C.2.b.)

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

115. As discussed above, Hansen and WWiSE each disclose the use of 20/40MHz frequency bands for transmission. (*See supra* §IV.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. (DELL-1005, 14.) 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.*” (DELL-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 . . .” (DELL-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.” (DELL-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).

#### D. Claims 2, 12, 29, and 32

116. 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* §IV.C.2.b.)

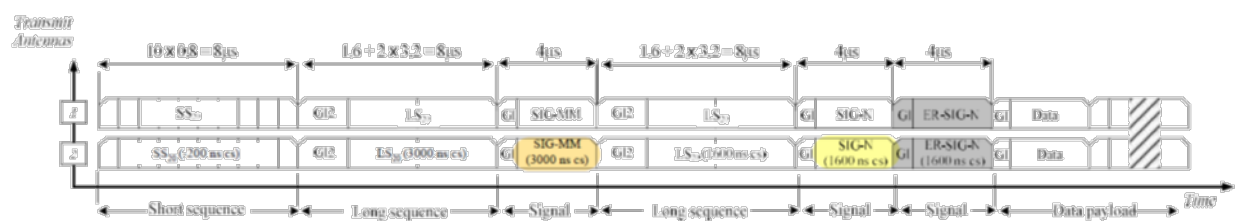


Figure 008 – MIMO-OFDM Training structure for N<sub>TX</sub> = 2, 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.

(DELL-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” in the time domain. (*See supra* §IV.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* §IV.C.2.d; DELL-1005, 69.) Thus, SIG-N’s header bits are repeated in time and frequency.

117. 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* Tse, et al., *Fundamentals of Wireless Communication* (Cambridge University (2005)) (DELL-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).

#### **E. Claims 3, 13, 30, and 33**

118. 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.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* DELL-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”).)

119. 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).

**F. Claims 4, 14, 26, and 34**

120. 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.5; DELL-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.” (DELL-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*”).

**G. Claims 5, 15, 27, 35**

121. As discussed above, Hansen and WWiSE disclose the use of a 40 MHz wider frequency band that is twice as wide as the 20 MHz frequency band. (*See supra* §IV.C.5.) 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. 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.

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

122. As discussed above, Hansen and WWiSE disclose the use of a 40 MHz wider frequency band that is twice as wide as the 20 MHz frequency band. (*See supra* §IV.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. 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. 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.*, 160MHz transmission.

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.)

## I. Claims 7, 17, 22 and 37

123. 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; DELL-1005, 67.)

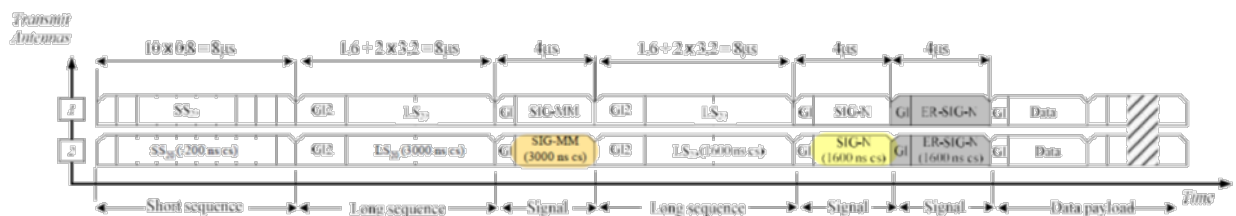


Figure 008 – MIMO-OFDM Training structure for  $N_{TX} = 2$ , 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.

124. 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” (DELL-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. (DELL-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:

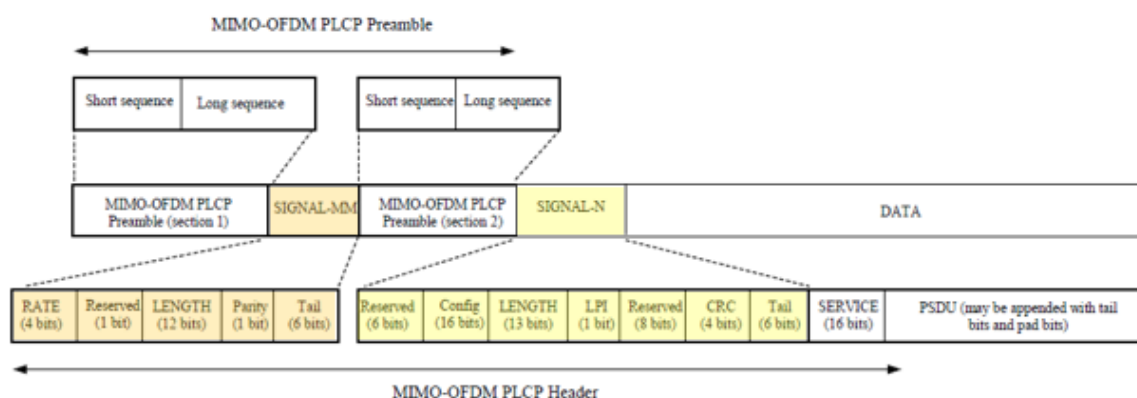


Figure 003 – PPDU frame format: Mixed-mode access in the 1TX (40 MHz) and 2TX (20 and 40 MHz) modes

125. 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

126. 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* §IV.C.2.b; DELL-1005, 67, 69.)

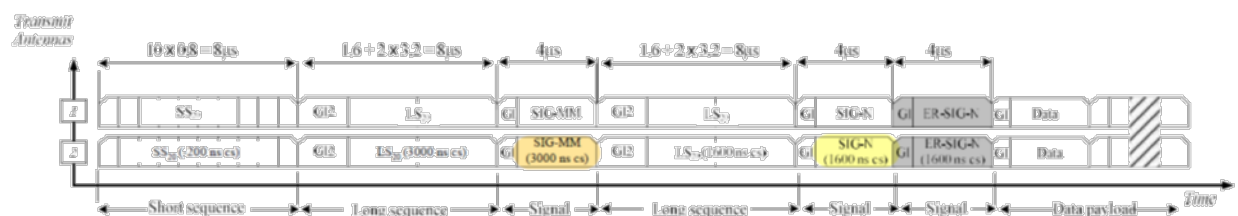


**Figure 008 – MIMO-OFDM Training structure for  $N_{TX} = 2$ , 20 MHz, mixed-mode operation. The shaded field indicates the optional duplicate SIG-N for extended range communication.**

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* §IV.C.2.b; DELL-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

127. 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 ....” (DELL-1005, 1 and 13.) Accordingly, WWiSE builds upon

existing 802.11 standards that must be supported by a transmitter or receiver such as in Hansen’s transceiver. (*See, e.g.*, DELL-1005, 56, 71–72.)

128. 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.*, DELL-1006, ¶¶9, 32, 41, 61-62, 66, 111-112; DELL-1006, ¶57 (transceiver supports “the invention”).) Hansen also expressly references WWiSE’s support for “legacy IEEE 802.11 WLAN devices.” (DELL-1006, ¶34.) Thus, the combined system of WWiSE and Hansen “*supports one or more wireless standards*” (*e.g.*, 802.11a/g).

## **V. GROUND 2: Claims 1–4, 8–12, 16–17, 21–28 and 32 are Obvious Based On the Combination of Zhang and Maltsev.**

### **A. Combination Overview**

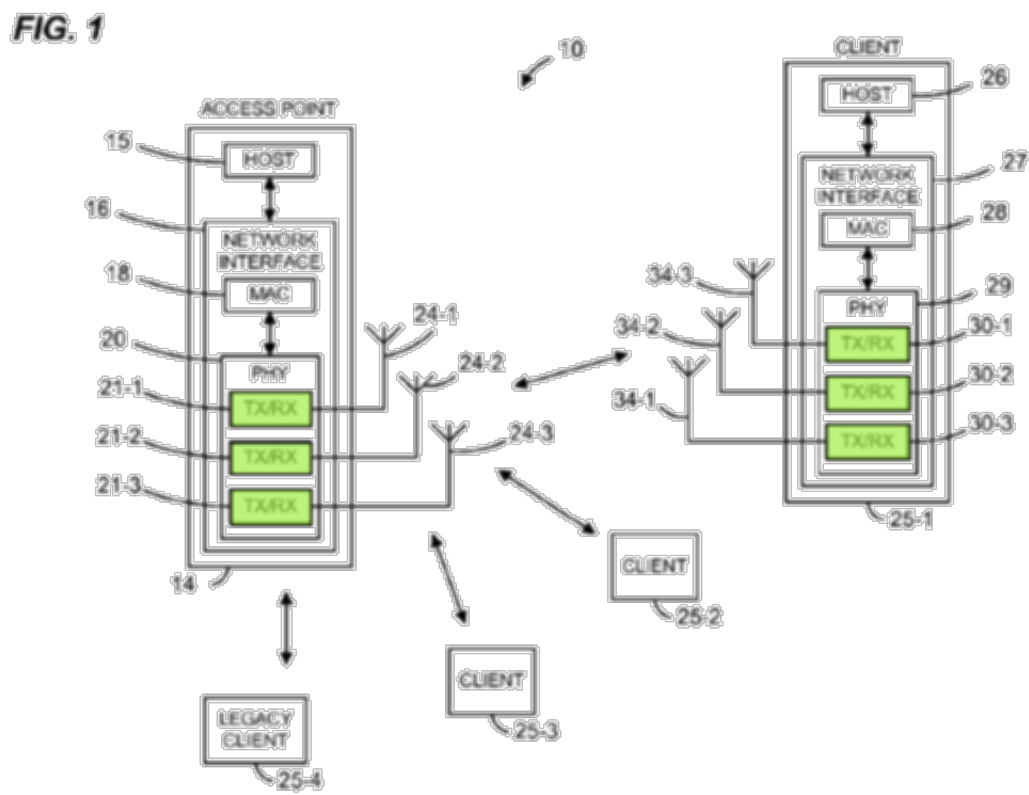
129. The proposed combination involves the use of Zhang’s packet formats and hardware for communicating with 802.11-compliant devices in different frequency bandwidths with Maltsev’s “flexible channel-width capability” for communicating with narrowband devices in a narrower frequency band and wideband devices in a wider frequency band within the same network. (Maltsev, 3:51–55.)

#### **1. Zhang**

##### **a) Overview**

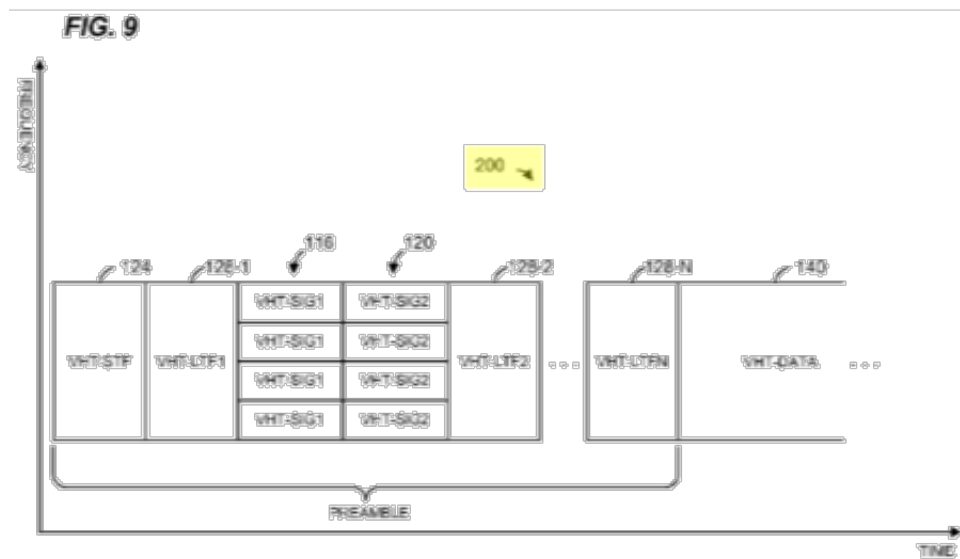
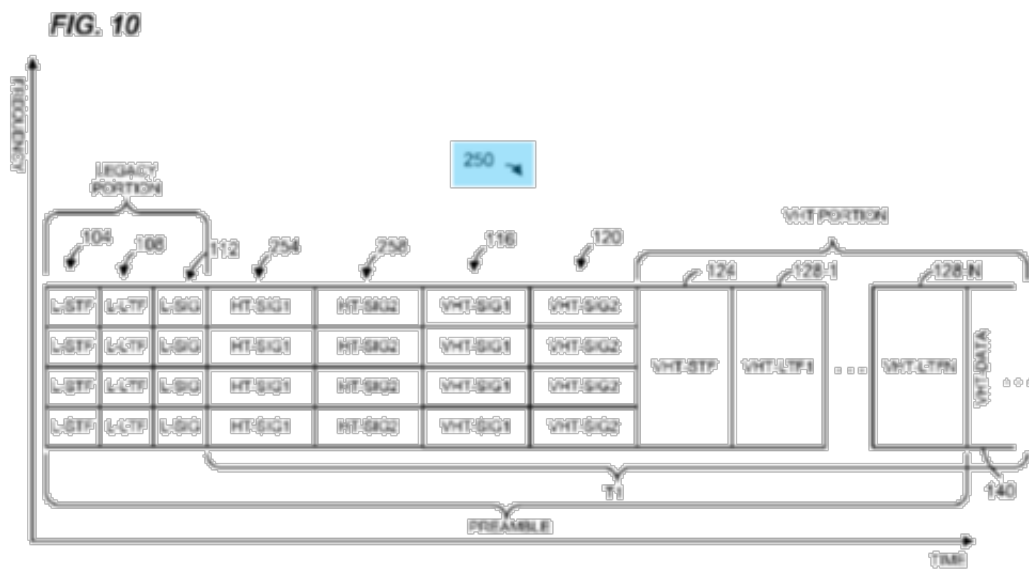
130. Zhang discloses “wireless local area networks that utilize orthogonal

frequency division multiplexing (OFDM)” (Zhang ¶17) and that include wireless network devices “such as an access point (AP) ... [that] transmits data streams to one or more client stations” (Zhang Fig. 1 (below), ¶62). Zhang’s devices (*e.g.*, APs and STAs) each include a wireless OFDM transceiver operable to transmit/receive packets in a wireless network. (See Zhang Fig. 1, ¶¶64, 66, 69–70.)



131. 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 (Zhang, Abstract, ¶62–63), including “legacy” devices such as those

that support 802.11a (Zhang ¶¶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 conforms to 802.11a (Zhang ¶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]” (Zhang ¶100, Fig. 9).



132. Zhang further discloses communicating 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 bandwidth 20/40/80MHz is being used for transmission. (See Zhang ¶¶83, 85, 95, 100, 102).

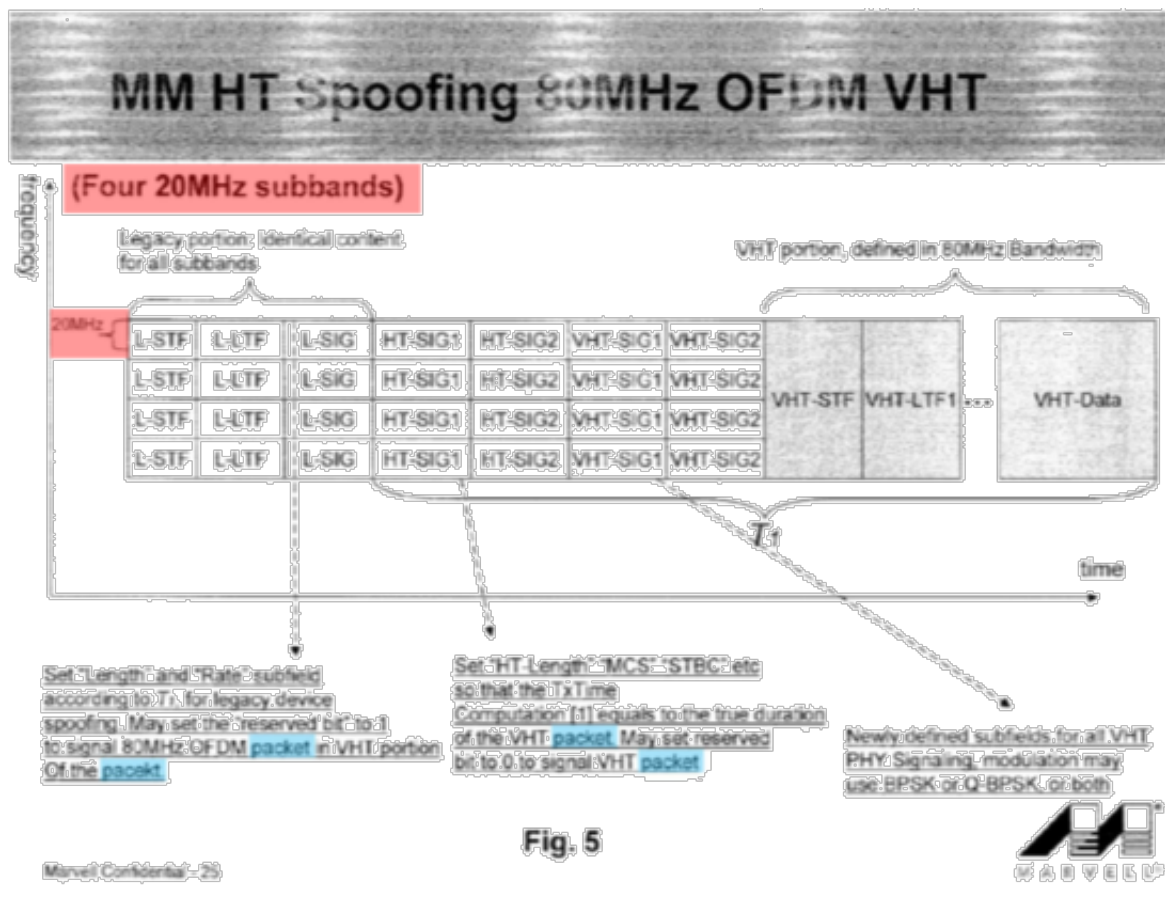
**b. Disclosure by the '900 Provisional**

133. I have been asked to demonstrate that claim 1 of Zhang is supported by the disclosure in the '900 provisional application. My analysis below shows that the '900 provisional supports at least claim 1 of Zhang, which recites as follows:

| <b>Zhang's Published Claim 1</b> |                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>[1PRE]</b>                    | 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:                                                                                                                                                                                                                                                          |
| <b>[1A]</b>                      | 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, |
| <b>[1B]</b>                      | 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                                                                                                                                                                                                                 |
| <b>[1C]</b>                      | 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                                                                                                                                                                                                                                    |
| <b>[1D]</b>                      | 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]

134. The '900 provisional discloses a “method for generating a data unit for transmission via a communication channel, the data unit conforming to a first communication protocol.” In particular, the '900 provisional discloses an 80MHz mixed-mode (MM), high-throughput (HT) spoofing, very high-throughput (VHT) wireless OFDM “packet,” conforming to the 802.11ac wireless standard, as shown in Figure 5 below.



(’900 provisional, 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. For example, the 802.11-1999 standard refers to network packets/frames as protocol *data units* (PDUs). (See IEEE Std. 802.11-1999, at 7.) Zhang also uses the terms “data unit” and “packet” interchangeably. (See Zhang ¶110 (“the current *packet* could be either an IEEE 802.11a *data unit* or a *data unit* that conforms to the first communication protocol.”); see also ’900 provisional, 4 (referring to legacy 11a/n frame formats as protocol data units (“PPDUs”)).)

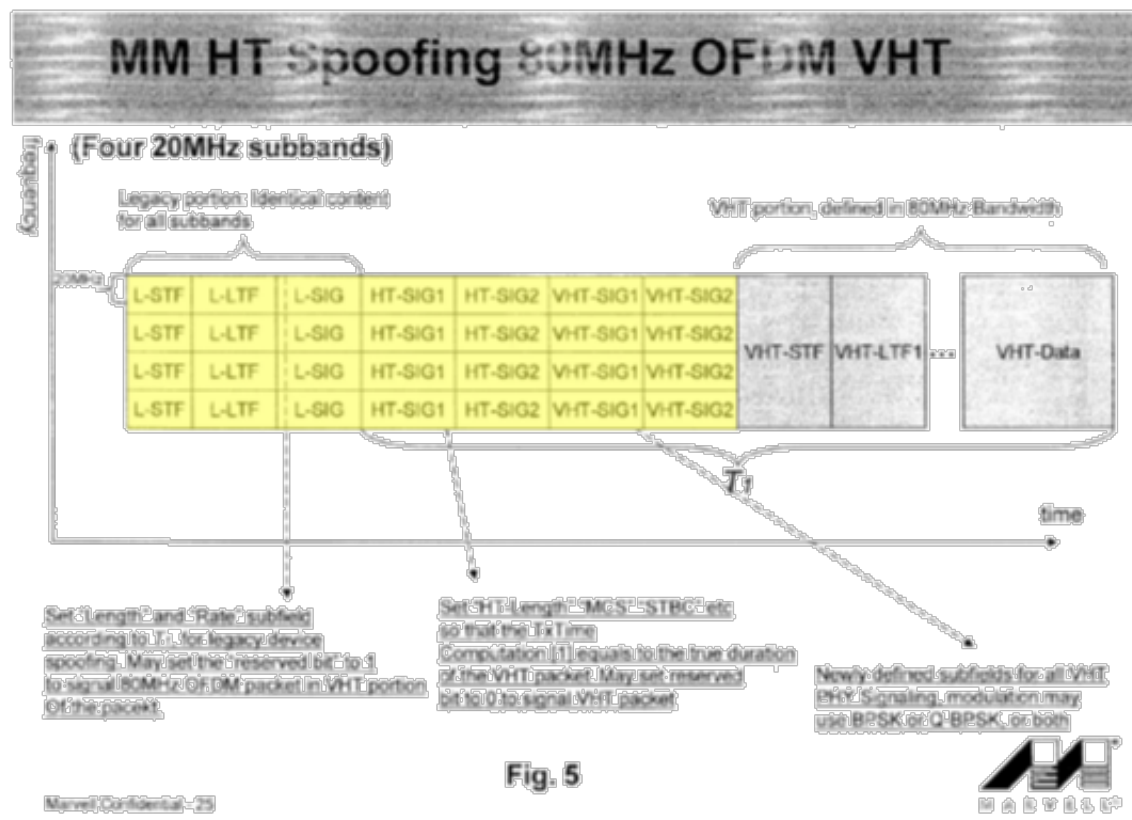
135. The packet in Figure 5 is thus a “data unit.” The data unit of Figure 5 contains very high-throughput fields “VHT-SIG1” and “VHT-SIG-2” which a POSITA would recognize as conforming to the then-forthcoming IEEE 802.11ac standard (“*first communication protocol*”). (’900 Provisional, Figure 5); see also ’900 provisional, slide 1 (“Thoughts on 802.11ac Preamble.”).)

136. Further, as shown in Figure 5, the VHT data unit is transmitted in an 80 MHz communications channel comprising four 20 MHz subbands. (’900 provisional, 2, 5, Fig. 5.) Thus, the ’900 provisional discloses “*generating a data unit*” (e.g., 80MHz mixed-mode spoofing OFDM VHT data unit) “*for transmission via a communications channel*” (e.g., 80MHz channel comprising four 20MHz subbands), “*the data unit confirming to a first communication protocol*” (e.g., IEEE Std. 802.11ac).

(ii) Claim Limitation [1A]

(a) *Generating a preamble of the data unit with a first field indicating the duration of the data unit*

137. Figure 5 of the '900 provisional discloses generating a VHT data unit with preamble fields (shaded yellow below). ('900 provisional, 25; *see also* '900 provisional, 43 (“Preamble Design” of a short mixed-mode packet.)



138. The preamble of the VHT data unit includes a legacy signal field “L-SIG” (“*first field*”) that is compatible with legacy devices (e.g., devices that support 802.11a). (See '900 provisional, 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.

- 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.

(’900 provisional, 10, 25.)

- (b) *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*

139. A POSITA would understand that a legacy receiver that conforms to 802.11a (“*second communication protocol*”) will not support subsequent versions of 802.11 that came later in time—including 802.11ac (“*first communication protocol*”)—without additional hardware and/or software development.

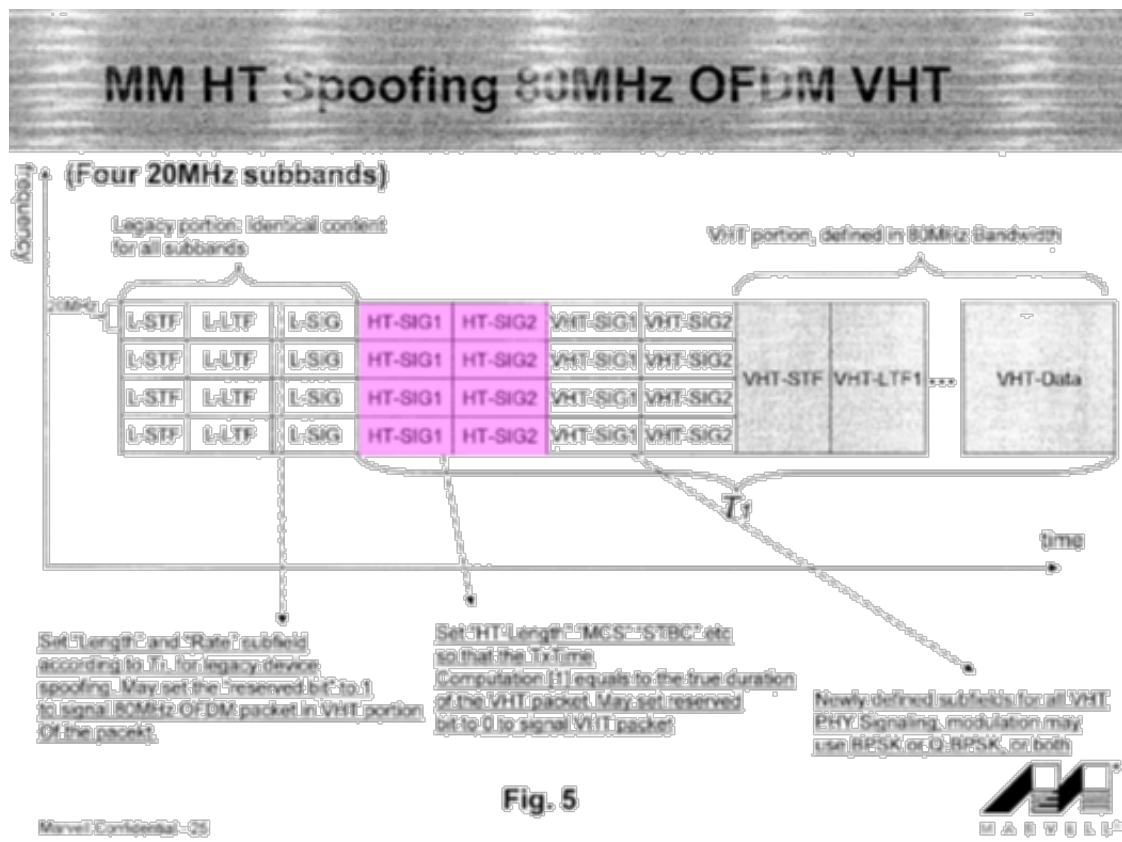
Accordingly, 802.11ac provides a VHT packet structure with VHT-SIG and VHT-DATA fields that are not decodable by 802.11a devices. In addition, VHT packets are transmitted in wider frequency bands beyond the 20 MHz in which a 802.11a receiver is configured to operate.

140. As discussed above, the L-SIG (“*first field*”) in a VHT packet 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  $T$ . The value of  $T$  is used to “spoof” legacy 802.11a devices on the WLAN by

telling them not to use the communication channel for the duration of the VHT data unit.

### (iii) Claim Limitation [1B]

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



(’900 Provisional, 25 (Fig. 5).) A POSITA would have known that HT-SIG fields conform to the 802.11n wireless standard (“*third communication protocol*”) and are decodable by 802.11n receivers. As the ’900 provisional explains, the fields are formatted and modulated “for a 11n receiver.” (’900 provisional, 11 (“The subfields format may be the same as HT-SIG of 11n.”), 28 (below).)

## 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.

('900 provisional at 28.)

142. But HT-SIG fields do not conform to 802.11ac ("first communication protocol"), and HT devices that conform to the 802.11n standard ("third communication protocol") are not capable of decoding the VHT-SIG fields of 802.11ac data units. ('900 provisional, 11-12.)

- 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-SIG2 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]**

143. The '900 provisional discloses VHT signal fields "VHT-SIG" decodable by forthcoming 802.11ac devices ("*first communication protocol*"). ('900 Provisional, slide 1 ("Thoughts on 802.11ac Preamble"), 2, 42.) The provisional teaches formatting the preamble by setting a "reserved bit in VHT-SIG2 to 0 ... to signal [to] VHT device[s] that the current packet is a VHT packet." ('900 provisional, 11.) This means that 802.11ac-compliant devices can determine that the data unit conforms to 802.11ac when the reserved bit in VHT-SIG2 is set to 0.

**(v) Claim Limitation [1D]**

144. As shown in Figure 5 below, the '900 provisional discloses generating the data portion (shaded red) of the VHT data units that conform to 802.11ac ("*first protocol*") but do not conform to 802.11a ("*second protocol*") or 802.11n ("*third protocol*").

# MM HT Spoofing 80MHz OFDM VHT

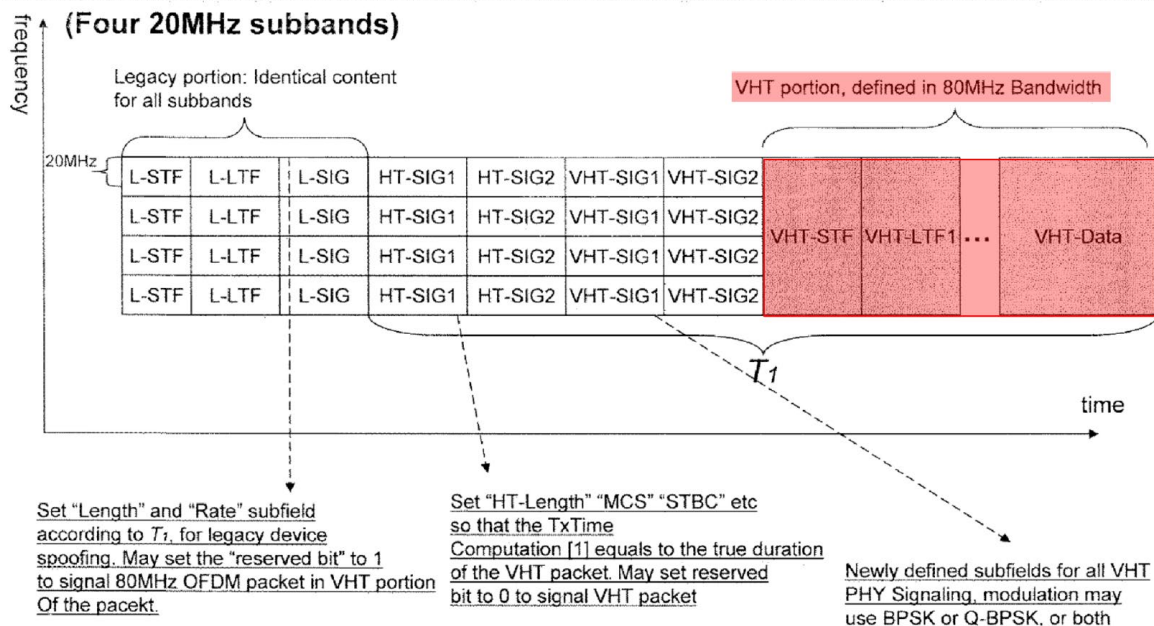


Fig. 5

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

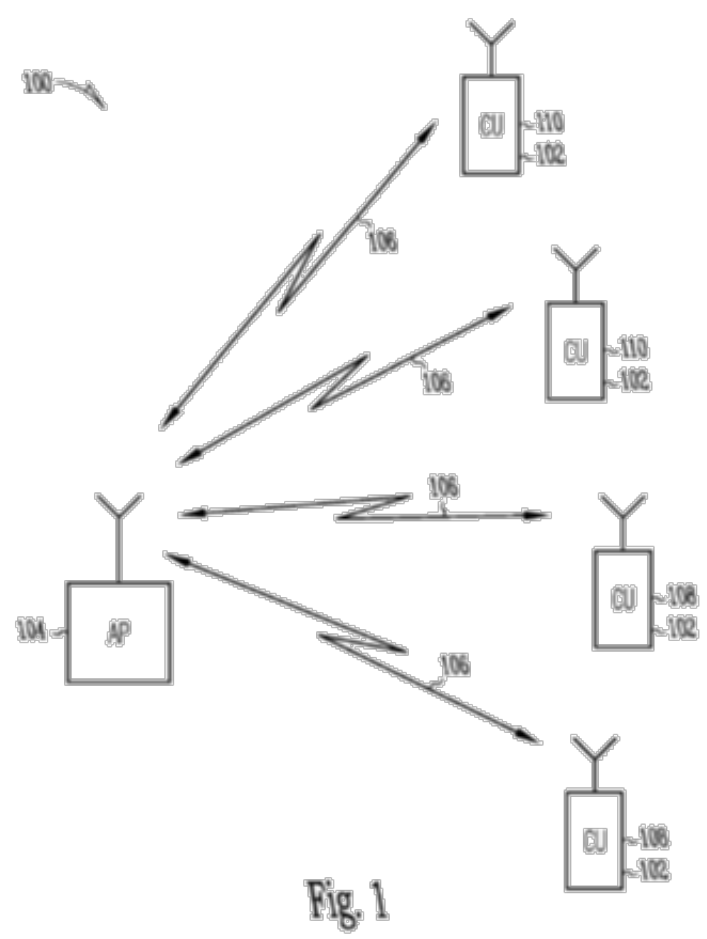
## Mixed Mode: VHT Portion

- 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.

145. As a result of the above, in my opinion the '900 provisional thus supports claim 1 of Zhang, confirming that Zhang is prior art to the challenged '566 patent.

## 2. Maltsev

146. 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. (Maltsev, Abstract, Fig. 1, 2:3–29.) Maltsev teaches a “flexible channel-width capability” for communicating with “wider-band” devices that are described as “high-throughput” 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. (Maltsev, 2:18–22, 3:29–55, 4:37–41, 5:58–63, 8:25–27.)



147. Maltsev also uses the terms “packets” and “data units” synonymously. (See Maltsev, 4:16–18 (“Physical layer 210 may generate a physical-layer *packet* format used to transport transmitted physical layer service *data units* ....”) Maltsev provides OFDM packets with a “predetermined frame structure” that facilitates “sharing of channels among narrow-band CUs [] and wider-band CUs ...” for a “flexible channel-width capability.” (Maltsev, 3:51–55; *see also* Maltsev, 4:27–31, 8:25–27.) Zhang’s channels—like the ones disclosed in Zhang—are “20 MHz channels” within an “80MHz portion of the spectrum ....” (Maltsev, 4:47–49.)

148. Maltsev further 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.” (Maltsev, 4:27–31.) These frame formats are the mechanism used in Maltsev “to adapt dynamically to channel conditions by measuring the state of a channel and providing feedback on channel state.” (Maltsev, 7:43–45.)

## **B. Motivation to Combine**

149. It would have been obvious to a POSITA for Zhang’s network packets to be communicated with 802.11ac devices in a wideband and with legacy devices in a narrowband in the same wireless network, as taught by Maltsev. For the reasons set forth below, in my opinion a POSITA would have been motivated to combine Zhang’s packet formats for communicating with 802.11 devices in

different frequency bandwidths in a WLAN with Maltsev's flexible channel-width capability for communicating with narrowband devices in a narrowband and wideband devices in a wideband.

150. **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 for a given packet communication over the WLAN. (Zhang ¶¶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.” (Maltsev, 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.

151. A POSITA would have recognized that combining the disclosures would give Zhang's devices greater flexibility and efficiency by allowing them to use 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 Maltsev, 3:1–15.)

Furthermore, allowing flexible channel-width transmission in different bandwidths would increase overall system capacity by allowing a given station to communicate with legacy and 802.11ac devices in parallel.

152. ***Second***, the combination involves a simple substitution of one known element (Maltsev's communication with both new and legacy 802.11 devices in different-sized frequency bands in the same WLAN) for another (Zhang's communication in different-sized frequency bands with both 802.11ac and legacy devices using 802.11 communication protocols compatible with these devices, respectively) 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." (Zhang ¶63.) And Zhang teaches using "mixed mode" packet formats for communicating with both devices compliant with 802.11ac and legacy devices compliant with older versions of 802.11, including 802.11a. (See Zhang ¶¶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, 80 MHz, 120 MHz or 160 MHz, and describes encoding one or more bits in a packet header to indicate the transmission bandwidth for network devices to use for communications over the WLAN. (See, e.g., Zhang ¶¶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 (Maltsev, 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.*, successive communications with 802.11ac and legacy devices. And indeed, as discussed above, this would have improved the efficiency and capacity of Zhang's system, especially when legacy 802.11 devices are present in the WLAN.

153. ***Third***, the combination of Zhang and Maltsev involves applying a known technique (Maltsev's communication with 802.11 devices in different-sized frequency bands) to a known device (Zhang's 802.11 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 more than one version of 802.11. (Zhang ¶¶31–32, 64; Maltsev 2:18–32, 3:29–40, 5:43–49, 6:8–18, etc.) 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 depending on whether the receiving devices are wideband or narrowband devices. (Maltsev, 3:29–55). Zhang already provided a mechanism to change the frequency bandwidth based on the 20/40/80MHz selection bit in the VHT-SIG field (Zhang,

¶¶83, 85), and nothing in Zhang suggests that the transceiver would have been incapable of using Maltsev's flexible channel-width capability for transmitting packets in different-sized frequency bandwidths based on the capabilities of the receiving device.

154. **Fourth**, Zhang and Maltsev teach that there are two ways to communicate with 802.11ac and legacy 802.11 devices over different bandwidths: communicate over one frequency band at a time or use a flexible channel-width capability such as Maltsev's to communicate over multiple different-sized frequency bands at a time. It would have been obvious to a POSITA reading Zhang to try Maltsev's flexible channel-width communication approach to improve WLAN efficiency and capacity as discussed above.

155. A POSITA would have had a reasonable expectation of success based on Maltsev's teaching of how to implement such a WLAN system. Both Zhang and Maltsev disclose transmitting header bits in different OFDM packet formats over different-sized frequency bandwidths. (Zhang Figs 2A, 3–6, 9–11, 13–15, 17–21, ¶¶74–75, 82, 83, 85, 95, 102; Maltsev Figs. 4–6, 3:29–55, 5:26–57.) Additionally, both Zhang and Maltsev disclose operating in a WLAN in a mixed-mode that supports one or more versions of 802.11. (Zhang ¶¶31–32, 64; Maltsev 2:18–32, 3:29–40, 5:43–49, 6:8–18, etc.) Thus, Maltsev's method of providing flexible channel-width capability communications with both narrowband

and wideband devices operating in different-sized frequency bands would be compatible with Zhang's network packets, which are designed to operate in 802.11 networks and already provide bits in the VHT-SIG header fields to indicate the transmission bandwidth to be used for communications over the WLAN. (Zhang ¶¶74–75, 83, 85.) And because Maltsev's methods can be deployed in the type of 802.11 WLAN environment described in Zhang, a POSITA would have expected Maltsev's teaching to provide the benefits and functionality to Zhang's networks that Maltsev describes. This includes the improved efficiency and capacity and reduced interference described above. (*See* Maltsev, 3:1–15.)

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

**[1P]** A wireless OFDM (Orthogonal Frequency Division Multiplexing) transceiver comprising:

**[1A]** 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;

**[1B]** 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;

**[1C]** 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

[1D] 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,

[1E] wherein the first narrower and second wider frequency bands have one or more overlapping frequency regions.

156. In my opinion, Zhang in combination with Maltsev renders these claims obvious, as I set forth below.

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

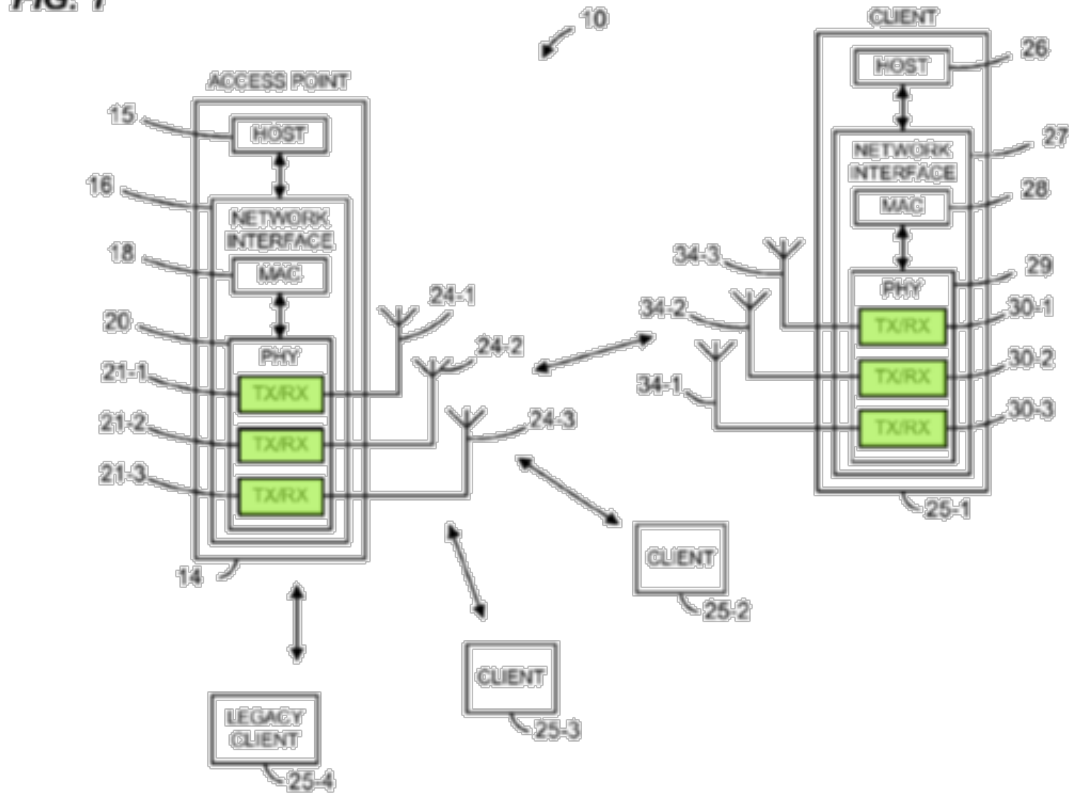
157. The combination of Zhang and Maltsev discloses the preamble. Zhang describes “wireless local area networks that utilize orthogonal frequency division multiplexing (OFDM)” (DELL-1017, ¶17) and “a wireless network device such as an access point (AP) ... [that] transmits data streams to one or more client stations” (DELL-1017, ¶¶62, 69 (DELL-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.<sup>6</sup> (DELL-1017, Fig. 1, ¶¶64, 66, 69–70 (DELL-1019, 3, 5–6, 49).)<sup>7</sup>

---

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

<sup>7</sup> Although the ’900PROV does not use the term “transceiver,” it repeatedly describes 802.11-compliant APs and STAs with both transmitting and receiving

**FIG. 1**



158. Furthermore, Maltsev discloses transceivers capable of“(HT)

capabilities (e.g., DELL-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 disposed in each device in Zhang’s WLAN. (See *IEEE 100: The Authoritative Dictionary of IEEE Standard Terms*, 1198 (IEEE 7th ed., 2000)); DELL-1001, 10:32–37 (“As used herein ... **the terms transmitter, transmitting node and transmitting transceiver have the same meaning and are used interchangeably.**”).)

wideband (WB) communications with wireless local area networks (WLANs).” (DELL-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. (DELL-1018, 2:5–14, Fig. 1; DELL-1017, ¶19 (DELL-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 capability to establish duplex communications therebetween” (DELL-1018, 2:18–25, 60–67), and (ii) communicate with each other “using a multi-carrier transmission technique, such as ... OFDM” (DELL-1018, 2:22–28).

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

159. In my opinion, the combination of Zhang and Maltsev discloses this limitation.

### **a. Modulator operable to modulate ... OFDM symbols**

160. Zhang discloses modulating the L-SIG, HT-SIG and VHT-SIG header fields. (DELL-1017, ¶¶86–89, Figs. 7A–7C.) Each of these fields is modulated by one OFDM symbol. (DELL-1017, ¶91 (DELL-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

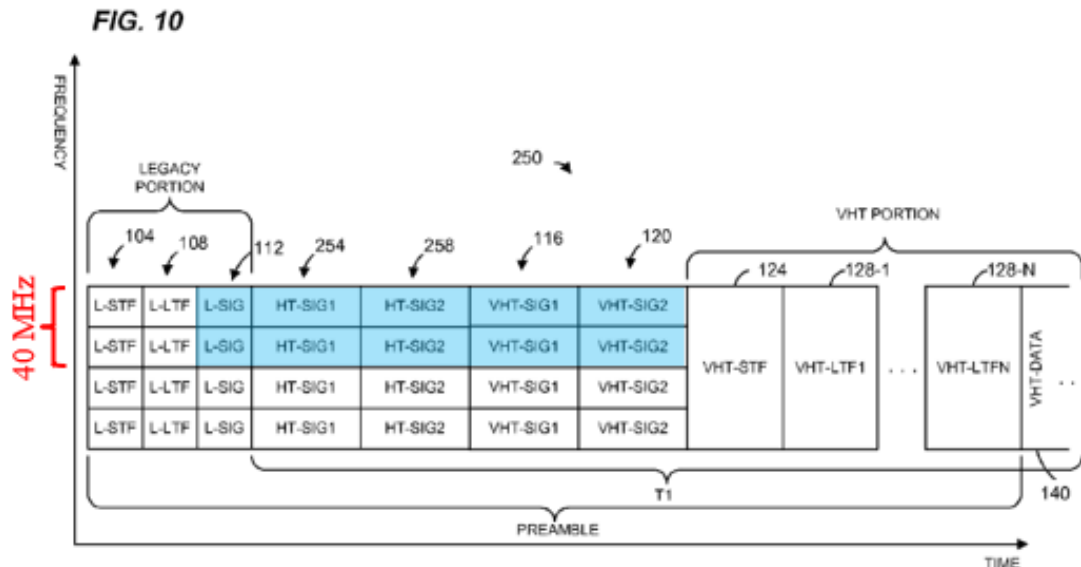
transmission over the channel. (DELL-1017, 95 (DELL-1019, 16), DELL-1021, 48–49.)

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

161. “The data unit 250 is similar to the data unit 100 of FIG. 5, but includes HT-SIG1s [] and HT-SIG2s ....” (DELL-1017, ¶103 (DELL-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’ (DELL-1017 ¶¶75, 91, 103 (DELL-1019, 11, 15, Fig. 1)) and is “repeated in four 20MHz subbands” of the 80MHz frequency band. (DELL-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.” (DELL-1017, ¶108 (DELL-1019, 30 (“Figs1~7 may be redrawn for 40MHz, or 20MHz BW VHT signals.”)).)

162. 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. (DELL-1017, ¶75 (DELL-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*

DELL-1017, ¶91 (DELL-1019, 11, 15 (“Each VHT-SIG is modulated by one OFDM symbol.”)).)



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

### c. “Header” bits/portion

163. 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.” (DELL-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. (DELL-1017, ¶¶79, 104, 135–136, 143 (DELL-1019, 11–15, 28).) 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.

(DELL-1017, ¶82 (DELL-1019, 11) 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.” (DELL-1017, ¶¶76, 103–104, 120 (DELL-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 ....” (DELL-1017, ¶120 (DELL-1019, *id.*).)

**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**

164. 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 §V.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.

Figure 1: A diagram illustrating a frame structure in a frequency-time plane. The vertical axis is labeled "FREQUENCY" and the horizontal axis is labeled "TIME". A red bracket on the left indicates a 40 MHz bandwidth. The frame is divided into a "LEGACY PORTION" and a "VHT PORTION". The Legacy Portion includes L-STF, L-LTF, L-SIG, HT-SIG1, HT-SIG2, VHT-SIG1, and VHT-SIG2. The VHT Portion includes VHT-STF, VHT-LTF1, ..., VHT-LTFN, and VHT-DATA. Various fields are labeled with numbers: 104, 108, 112, 254, 258, 116, 120, 124, 128-1, 128-N, and 140. A "PREAMBLE" label is at the bottom, and a "T1" label is near the end of the frame.

The diagram illustrates the structure of an 80MHz OFDM packet within the VHT portion. The vertical axis represents frequency, and the horizontal axis represents time. A 20MHz subband is highlighted at the top. The packet is divided into a Legacy portion (identical for all subbands) and a VHT portion (defined in 80MHz Bandwidth).

The Legacy portion consists of the following subfields:

|       |       |       |         |         |          |          |
|-------|-------|-------|---------|---------|----------|----------|
| L-STF | L-LTF | L-SIG | HT-SIG1 | HT-SIG2 | VHT-SIG1 | VHT-SIG2 |
| L-STF | L-LTF | L-SIG | HT-SIG1 | HT-SIG2 | VHT-SIG1 | VHT-SIG2 |
| L-STF | L-LTF | L-SIG | HT-SIG1 | HT-SIG2 | VHT-SIG1 | VHT-SIG2 |
| L-STF | L-LTF | L-SIG | HT-SIG1 | HT-SIG2 | VHT-SIG1 | VHT-SIG2 |

The VHT portion consists of the following subfields:

|         |          |     |          |
|---------|----------|-----|----------|
| VHT-STF | VHT-LTF1 | ... | VHT-Data |
|---------|----------|-----|----------|

The duration of the packet is indicated by  $T_1$ . The diagram shows that the Legacy portion and the VHT portion are transmitted simultaneously in the 80MHz bandwidth.

Annotations below the diagram:

- Set "Length" and "Rate" subfield according to  $T_1$  for legacy device spoofing. May set the "reserved bit" to 1 to signal 80MHz OFDM packet in VHT portion Of the packet.
- Set "HT-Length" "MCS" "STBC" etc so that the TxTime Computation [1] equals to the true duration of the VHT packet. May set reserved bit to 0 to signal VHT packet
- Newly defined subfields for all VHT PHY Signaling, modulation may use BPSK or Q-BPSK, or both



165. 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

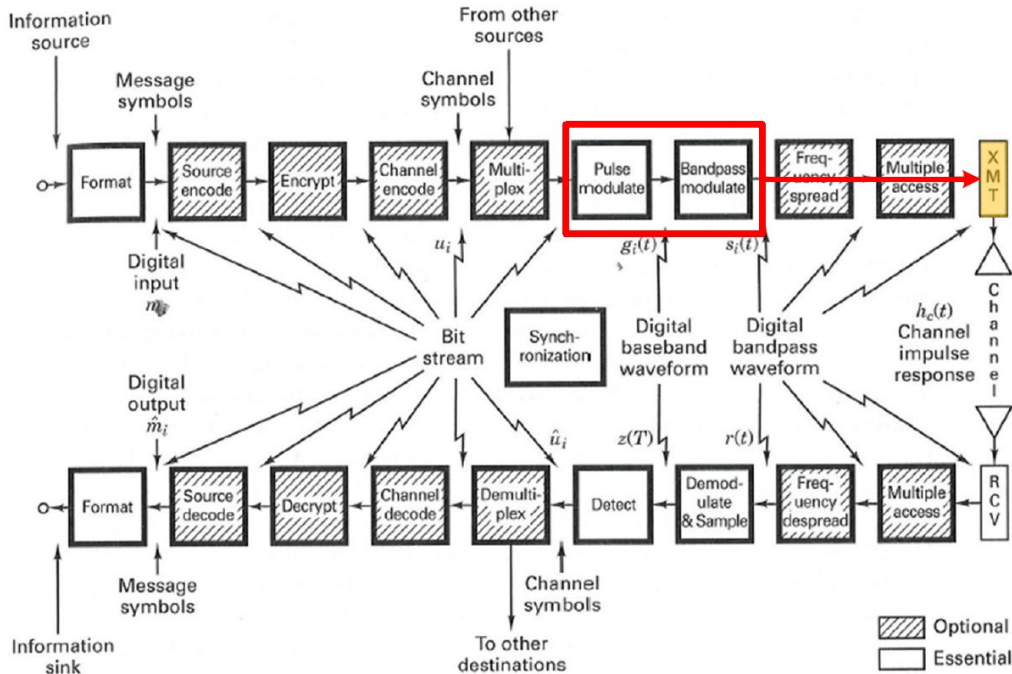
*symbols to transmit a first plurality of header bits” (e.g., ten symbols for transmitting L-SIGs, HT-SIGs, and VHT-SIGs) “in a first packet” (e.g., data unit 250) “wherein at least one header bit of the first plurality of header bits in the first packet is repeated on a plurality of OFDM subcarriers”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

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

166. In my opinion, the combination of Zhang and Maltsev discloses this limitation.

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

167. Zhang’s devices each include wireless transceivers for communicating packets over a WLAN using OFDM. (§V.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) ....” (DELL-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. (DELL-1017, ¶95 (DELL-1019, 16); DELL-1022, at 4–5, Fig. 1.2 (depicting a “typical digital communication system” that includes a modulator connected to and 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**

168. As discussed in §V.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.” (DELL-1017, ¶102, Fig. 10 (DELL-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). Zhang also provides bits in VHT-SIG to indicate/select the 20/40/80MHz frequency bandwidth for communications over the WLAN. (DELL-1017, ¶¶83, 85 (DELL-1019, 13–15).)

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

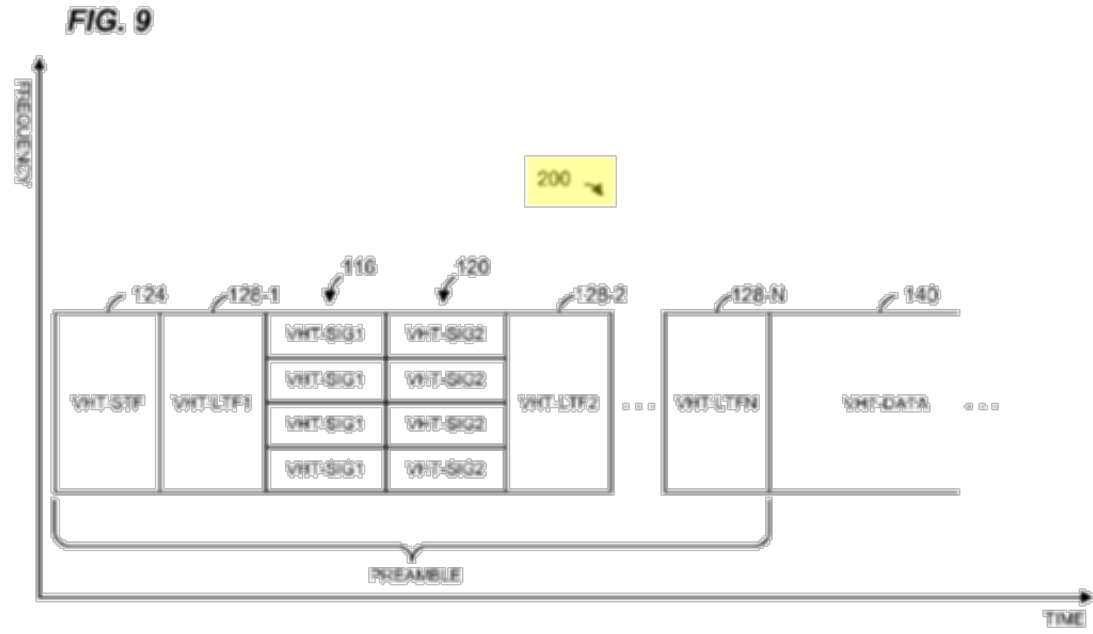
169. In my opinion, the combination of Zhang and Maltsev discloses this limitation.

##### **a. Modulator operable to modulate ... OFDM Symbols**

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

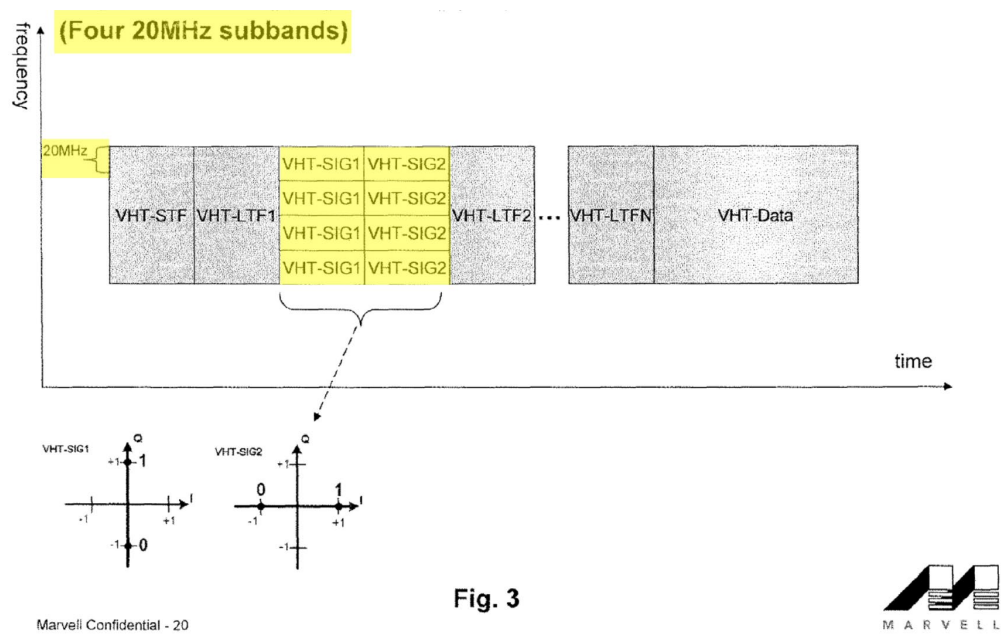
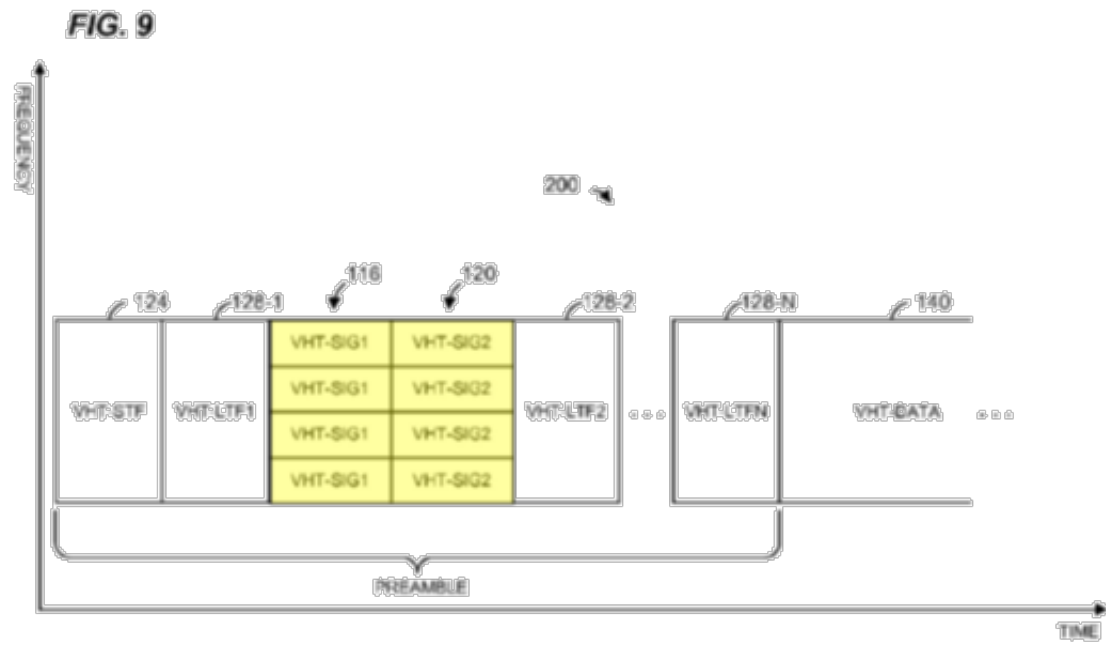
##### **b. A second number of OFDM symbols to transmit a second plurality of header bits in a second packet, less than the first number of OFDM symbols**

171. OFDM data unit 200 shown in Zhang’s Figure 9 below is a second packet with a second number of OFDM symbols. (DELL-1017, ¶100, Fig. 9 (DELL-1019, 20 (Fig. 3)).) Data unit 200 “conforms to the first communication protocol” and “occupies an 80 MHz band.” (DELL-1017, ¶100 (DELL-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] ....” (DELL-1017, ¶100, Fig. 9 (DELL-1019, 5, 20).) “The data unit 200 is similar to the data unit 100 of FIG. 5, but omits the legacy portion.” (DELL-1017, ¶101, DELL-1019, 8, 20.)

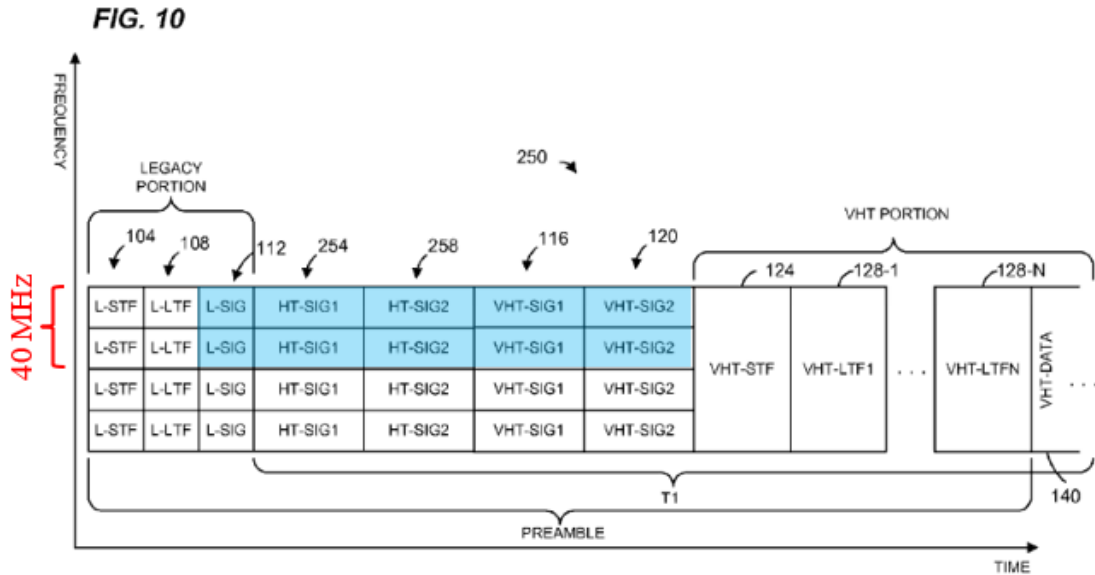


As discussed in §V.C.2.b., *supra*, each of the VHT-SIG fields “occup[ies] a 20 MHz band” and is “repeated in four 20MHz subbands” of the 80MHz frequency band. (DELL-1017, ¶75 (DELL-1019, Fig. 1, 6, 8.)

172. 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. (DELL-1017, ¶¶77, 100, Fig. 9 (DELL-1019, 6, 8, 10, 20 (Fig. 3)).) As a result, the number of OFDM symbols in data unit 200 is equal to eight (counting one symbol per field). (DELL-1017, Fig. 9, ¶¶91, 113 (DELL-1019, 11, 15 (“Each VHT-SIG is modulated by one OFDM symbol.”), 20 (Fig. 3 below)).)



173. 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” bits/portion**

174. As discussed above in §V.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; DELL-1001, 1:45–48; DELL-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) (DELL-1019, 10–15, 22, 24–25, 28, 42)).)

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

175. The header fields of Zhang’s first (Figure 10) and second (Figure 9) packets appear below. Notably, 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). (DELL-1017, Figs. 9–10, ¶¶100, 102.)

**FIG. 9**

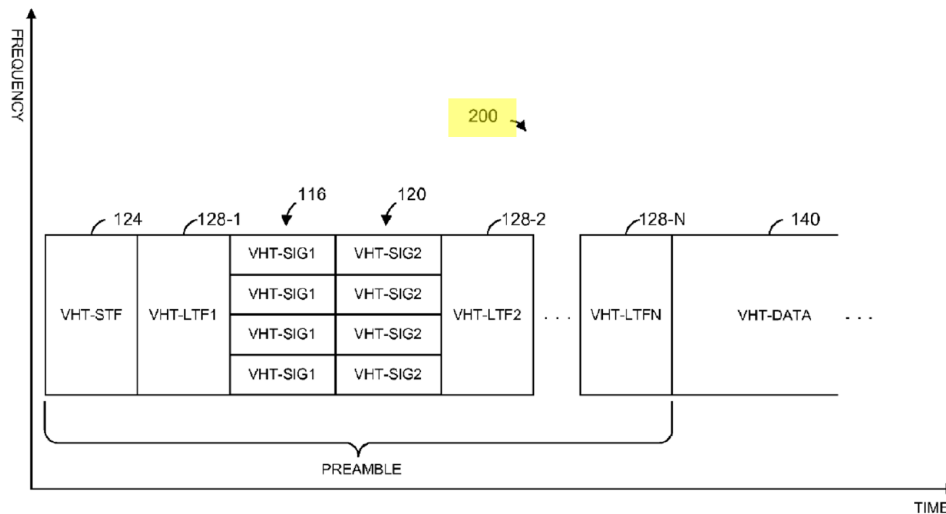
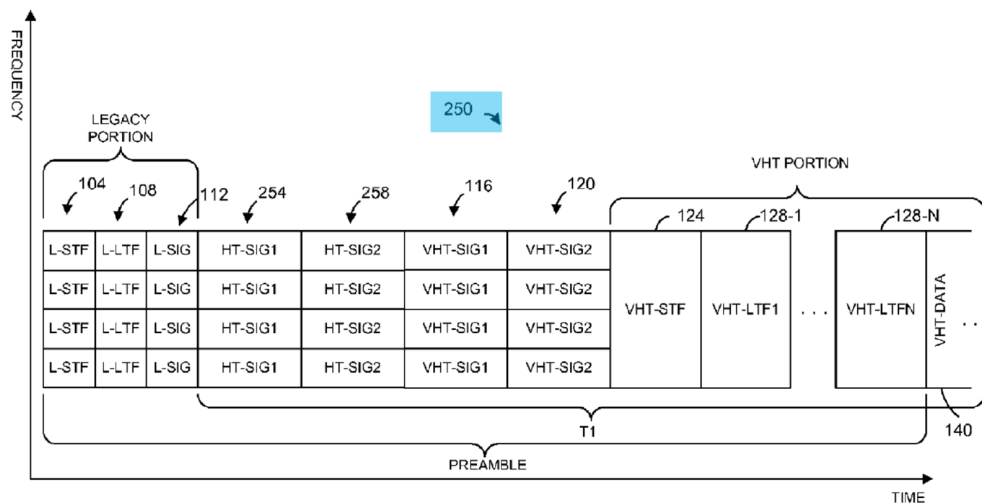


**FIG. 10**



(DELL-1017, Figs. 9–10; DELL-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 DELL-

1017, ¶107 (VHT-SIG fields “have different format” than HT-SIG fields) (DELL-1019, 11–12).)

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

176. In my opinion 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**

177. As discussed in §§V.C.4.a–b and V.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.” (DELL-1017, ¶100, Fig. 9 (DELL-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). Further, Zhang provides bandwidth selection bits in VHT-SIG to indicate/select the 20/40/80MHz frequency band for communications over the WLAN. (DELL-1017, ¶¶83, 85 (DELL-1019, 13–15).)

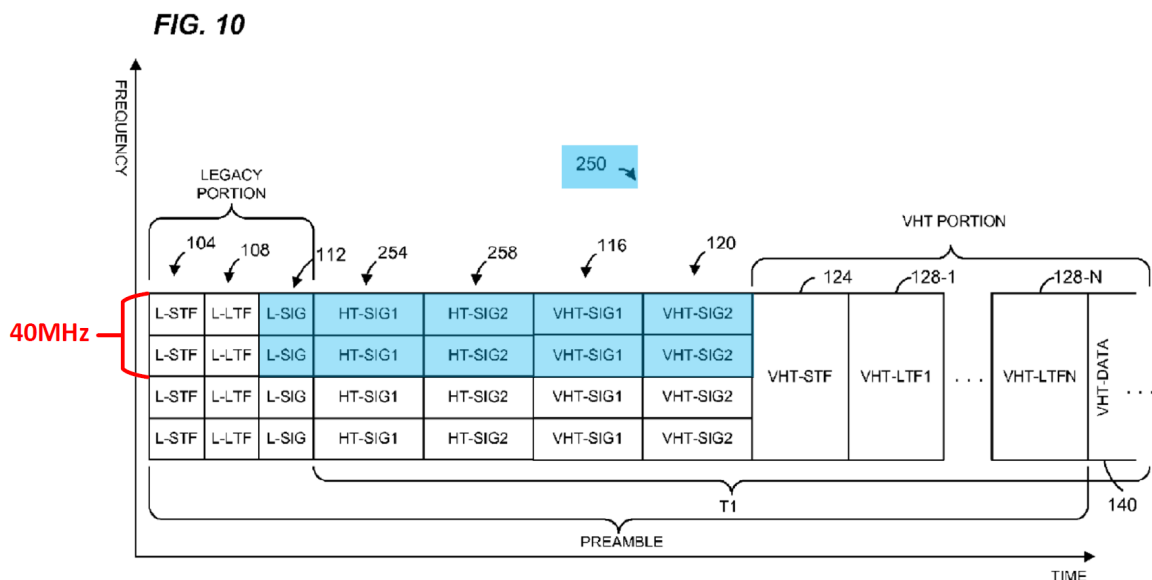
## 6. Claim Limitations [1E], [9E], [17E], and [25E]

178. Zhang discloses transmitting packets in a 40MHz narrowband and an 80MHz wideband. (*See supra* §§V.C.3.a–b., V.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. (DELL-1017, ¶83, 85 (DELL-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.

179. Furthermore, Maltsev discloses a “flexible channel-width capability” with overlapping 20MHz and 40MHz channels in a wireless OFDM system. (DELL-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. (DELL-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).

## D. Claims 2, 12, 29, and 32

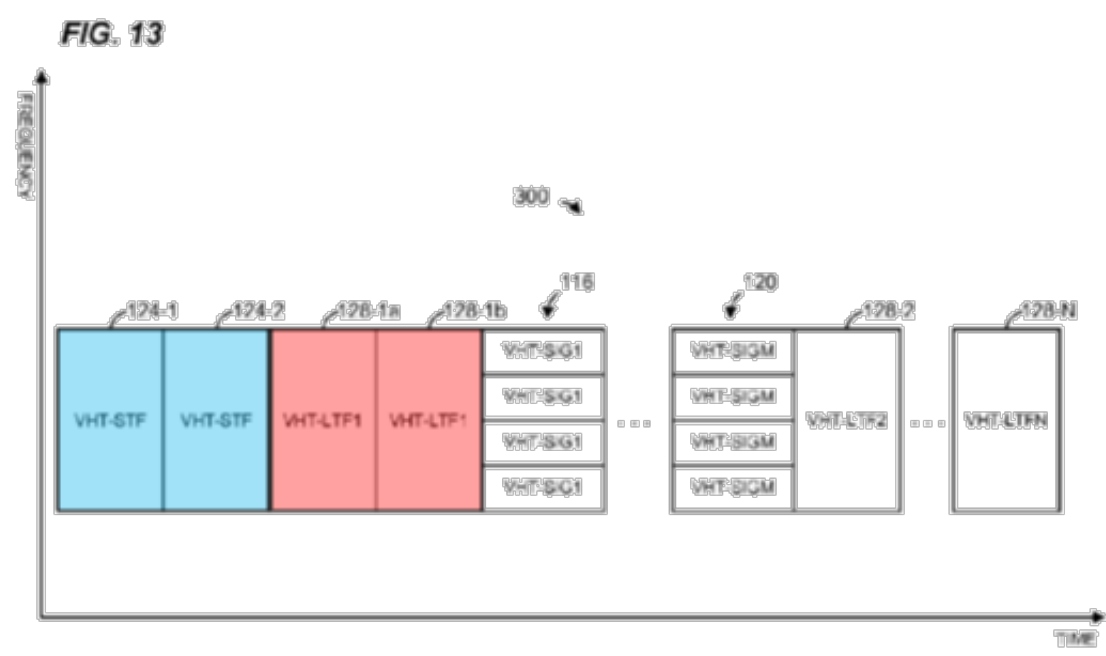
180. Zhang’s 802.11-compliant transceivers include a transmitter to transmit OFDM symbols of a mixed-mode packet (*e.g.*, data unit 250) in a 40MHz frequency band (“*first narrower frequency band*”), wherein header fields are repeated in two 20MHz subcarriers of the 40MHz band which is a plurality. (DELL-1017, ¶102, Fig. 10; DELL-1019, Fig. 5; §§VI.C.2.c–d and VI.C.3.a–b, *supra.*)



181. 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 DELL-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* DELL-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.”).)

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



183. 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).

**E. Claims 3, 13, 30, and 33**

184. 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. 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).

**F. Claims 4, 14, 26, and 34**

185. As discussed in §VI.C.6., *supra*, Zhang discloses transmitting mixed-mode data unit 250 in a narrower 40MHz frequency band and green field 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**

186. Zhang discloses transmitting data units in different-sized frequency

bands, including 20/40/80/120/160MHz, “or any suitable bandwidth.” (DELL-1017, ¶¶100, 102; DELL-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. (DELL-1017, ¶75; DELL-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**).” (DELL-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.

#### H. Claims 6, 16, 28, 36

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

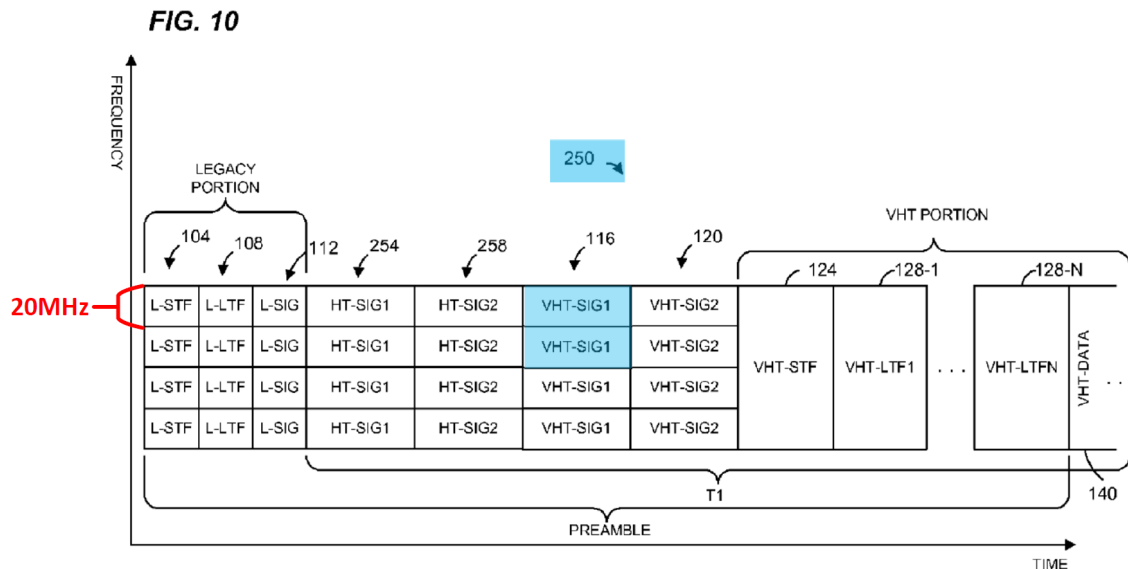
suitable number” of header fields depending on the requirements of the channel and the devices operating in the WLAN—i.e., “**one of each**” for “an OFDM data unit occupying 20 MHz,” “**two of each** ... for a 40 MHz bandwidth OFDM data unit,” “**six of each** ... for a 120Mhz bandwidth OFDM data unit,” and “**eight of each** .... for a 160 MHz bandwidth OFDM data unit,” and so on. (DELL-1017, ¶75; DELL-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**).” (DELL-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.

#### **I. Claims 7, 17, 22, and 37**

188. 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 DELL-1017, Fig. 10, ¶107 (VHT-SIG fields “have different format” than HT-SIG fields); DELL-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**

189. 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 frequency band. (See DELL-1017, Fig. 10; DELL-1019, 11, 25.)



190. As shown, data unit 250 includes first and 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

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

## **VI. CONCLUSION**

192. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

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

Executed this 14th day of March in Boadsburg PA.

Respectfully submitted,



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Tom La Porta, Ph.D.

## EXHIBIT LIST

| Exhibit | Reference                                                                                                                                                                                                       |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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”)                                                                                                                  |
| 1017    | U.S. Publication No. 2010/0260159 to Zhang et al. (“Zhang”)                                                                                                                                                     |

| <b>Exhibit</b> | <b>Reference</b>                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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 <a href="https://mentor.ieee.org/802.11/dcn/04/11-04-0422-04-0000-new-participantorientation.ppt">https://mentor.ieee.org/802.11/dcn/04/11-04-0422-04-0000-new-participantorientation.ppt</a> (Appendix A to DELL-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 Lansford Declaration, DELL-1007) IEEE 802wirelessworld                                                                                                                                                                                                                                                              |

| Exhibit | Reference                                                                                                                                                                                                                                                                                                                                                               |
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|         | website, July 2004 Meeting Minutes, available at <a href="http://grouper.ieee.org/groups/802/11/Minutes/Cons_Minutes_July-2004.pdf">http://grouper.ieee.org/groups/802/11/Minutes/Cons_Minutes_July-2004.pdf</a> (Appendix B to DELL-1007 ).                                                                                                                            |
| 1031    | U.S. Patent 7,415,074 (Appendix C to DELL-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, DELL-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, “WWiSE” Consortium and Motorola Team to Offer Enhanced Proposal for IEEE 802.11n (February 24, 2005); archived on April 6, 2005 at <a href="https://web.archive.org/web/20050406073808/http://www.wwise.org/presreleasefeb23.htm">https://web.archive.org/web/20050406073808/http://www.wwise.org/presreleasefeb23.htm</a> . |
| 1038    | Bahai, et al., <i>Multi-Carrier Digital Communications theory and Applications of OFDM</i> , (Springer 2004)                                                                                                                                                                                                                                                            |
| 1039    | Jan. 11, 2024 Letter from Sarah Piepmeier to Kevin Wheeler regarding Dell Stipulation                                                                                                                                                                                                                                                                                   |
| 1040    | Sixth Amended Docket Control Order, <i>AX Wireless LLC v. Dell Inc. et al.</i> , No. 2:22-cv-00277-RWS-RSP (E.D. Tex. Feb. 26, 2024), ECF No. 171                                                                                                                                                                                                                       |
| 1041    | Third Amended Docket Control Order, <i>AX Wireless LLC v. Lenovo Grp. Ltd.</i> , No. 2:22-cv-00280-RWS-RSP (E.D. Tex. Oct. 31, 2023), ECF No. 130                                                                                                                                                                                                                       |
| 1042    | Docket Control Order, <i>LightGuide, Inc. v. Amazon.com, Inc., et</i>                                                                                                                                                                                                                                                                                                   |

| Exhibit | Reference                                                                                                                                                 |
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|         | <i>al.</i> , No. 2:22-cv-00433-RWS-RSP (E.D. Tex. May 15, 2023)                                                                                           |
| 1043    | Docket Control Order, <i>Textron Innovations Inc., v. SZ DJI Tech. Co., Ltd, et al.</i> , No. 2:22-cv-0351-RWS-RSP (E.D. Tex. May 11, 2023)               |
| 1044    | “Time to Milestones – Judges: Robert W. Schroeder, III Case Filing Date: On or After Jan. 1st, 2008,” Docket Navigator                                    |
| 1045    | Dell’s Opposed Motion for Stay Pending IPR, <i>AX Wireless LLC v. Dell Inc. et al.</i> , No. 2:22-cv-00277-RWS-RSP (E.D. Tex. Mar. 13, 2024), ECF No. 179 |
| 1046    | Comparison between the current Petition and petition in IPR2023-01144                                                                                     |