

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Title: TRANSMIT ANNOUNCEMENT INDICATION

DECLARATION OF Christopher J. Hansen, Ph.D.

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

Date: August 14, 2024

By: 

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I. QUALIFICATIONS AND BACKGROUND INFORMATION

1. I have been retained as an expert witness by Ubiquiti Inc. to provide my opinion regarding the patentability of U.S. Patent No. 8,594,122 (hereinafter referred to as the “122 patent”). My qualifications for conducting my analysis and forming my conclusions are summarized below. My education and experience are described more fully in the attached curriculum vitae (APPENDIX A).
2. I received a B.S. in electrical engineering from Rensselaer Polytechnic Institute in 1987. I received an M.S. in electrical engineering from University of Massachusetts, Amherst in 1989. I received a Ph.D. in electrical engineering from University of California, Los Angeles in 1997.
3. I have over 25 years of experience working with wireless communications and IEEE standards and over 15 years of experience working in 802.11 WLAN chipsets and cellular base-station systems development.
4. A copy of my curriculum vitae listing my full employment history is included as Appendix A. I will briefly summarize aspects of my experience below.
5. From 1989 through 1992, my work focused on radio frequency (RF) and microwave systems and circuit development for radar systems and cellular (mobile) radio. This work included development of feed-forward amplifiers used in commercial base station equipment.

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

7. From 2000 through 2012, I was employed at Broadcom Corporation, where I served as system engineer for the IEEE 802.11a/b/g wireless local area network chipsets including analysis of radio and baseband DSP architectures for the physical layer design, and then project manager and lead system engineer for the IEEE 802.11n proposal to the IEEE at Broadcom. My responsibilities focused on technology developments and contributions to a number of the IEEE 802.11 standards, and in particular the IEEE 802.11n standard which incorporated a MIMO-OFDM physical layer and enhanced MAC layer for higher throughput wireless networks. My work covered many topics including preamble design, advanced channel coding, channel estimation, and multiple antenna beamforming.

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

9. From August 2013 to present, I have worked as a self-employed consultant while serving out my leadership role at the IEEE.

10. I am currently President of Covariant Corporation, which is a consulting firm that provides expertise on the IEEE 802.11 standards and product development.
11. I am named inventor on more than 125 issued patents, including many standard essential patents for the IEEE 802.11 standards. A listing of my patents is included in my curriculum vitae, which I have included as an appendix to this declaration. I am also an author on 7 peer-reviewed technical papers, including recent research work on methods for more reliable Wi-Fi networks.
12. I have been a member of the Institute of Electrical and Electronics Engineers (“IEEE”) since 1989. I became a senior member of the IEEE in 2011. I began participating in the IEEE’s standards-setting process in January 2000.
13. During my 12 years working for Broadcom, I was one of Broadcom’s lead representatives in the IEEE 802.11 standards-setting process. Specifically, I took on a number of significant roles during the development of the IEEE 802.11h, IEEE 802.11n, and the IEEE 802.11ad amendment. For IEEE 802.11n, these roles included making multiple technical contributions and attending all meetings of the study group responsible for defining the scope of the standard and all meetings of the task group responsible for writing the standard.
14. I was significantly involved in the development of IEEE 802.11n as part of my duties at Broadcom. I attended all meetings of the High Throughput Study

Group, which was responsible for defining the scope of IEEE 802.11n, and all meetings of the Task Group for 802.11n (TGn), which was responsible for writing the IEEE 802.11n specifications.

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

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

17. I have significant experience as an expert in litigation matters. This includes reviewing source code, writing declarations, and testifying in both depositions and trials. To date, I have been retained as a technical expert in more than 25 cases.

18. In writing this Declaration, I have considered the following: my own knowledge and experience, including my work experience in the fields of IEEE 802.11 wireless networks; my experience in teaching those subjects; and my experience in working with others involved in those fields. In addition, I have analyzed the following publications and materials, in addition to other materials I cite in my declaration:

19. I have reviewed the '122 patent (UBIQUITI-1001), the '122 patent's priority provisional application (UBIQUITI-1005), and relevant excerpts of the prosecution history (UBIQUITI -1002) of the '122 patent. I have also reviewed numerous textbooks, standards documents, and publications, including the following prior art references:

Prior Art Reference
U.S. Patent No. 8,374,096 to Gu et al., filed on November 21, 2005 (hereinafter referred to as “Gu” or UBIQUITI-1007)
U.S. Pat. Pub. 2005/0232208 to Hansen, filed on October 26, 2004 (hereinafter referred to as “Hansen” or UBIQUITI-1008)
U.S. Patent No. 8,200,164 to Trainin et al., filed on December 1, 2005 (hereinafter referred to as “Trainin” to UBIQUITI-1011)
GAST, 802.11 WIRELESS NETWORKS: THE DEFINITIVE GUIDE, (O'Reilly 2005) (hereinafter referred to as “Gast” or UBIQUITI-1009)
IEEE 802.11-1999 Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications (R2003) (2003 Reaffirmation) (hereinafter referred to as “802.11-1999” or UBIQUITI-1010)
IEEE 802.11-04/0889r7, “TGn Sync Proposal Technical Specification” (hereinafter referred to as “TGn Sync Proposal” or UBIQUITI-1019)
IEEE 802.11e-2005 Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 8: Medium Access Control (MAC) Quality of Service Enhancements (hereinafter referred to as “802.11e-2005,” “802.11e,” or UBIQUITI-1020)

U.S. Pat. Pub. 2008/0298306 to Larsson, filed on November 7, 2005
(hereinafter referred to as “Larsson” or UBIQUITI-1006)

802.11e/D6.0 Draft Amendment to STANDARD [for] Information
Technology – Telecommunications and Information Exchange Between
Systems – LAN/MAN Specific Requirements – PART 11: Wireless
Medium Access Control (MAC) and Physical Layer (PHY) specifications:
Medium Access Control (MAC) Quality of Service (QoS) Enhancements,
November 2003 (hereinafter referred to as “(“802.11e-D6.0” or
UBIQUITI-1017)

20. Counsel (Fish & Richardson) has informed me that I should consider these materials through the lens of one of ordinary skill in the art related to the ’122 patent at the time of the earliest possible priority date of the ’122 patent, and I have done so in my review of these materials. I have been informed by Counsel to use December 21, 2005 as the so-called “Critical Date” for prior art purposes, with the understanding that the ’122 patent claims a priority date of January 25, 2006.

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

22. My opinions, as explained below, are based on my education, experience, and expertise in the fields relating to the ’122 Patent. Unless otherwise stated, my

testimony below refers to the knowledge of one of ordinary skill in the art as of the earliest possible priority date. Any figures that appear within this document have been prepared with the assistance of Counsel and reflect my understanding of the '122 patent and the prior art discussed below.

II. OVERVIEW OF CONCLUSIONS FORMED

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

- Claims 1-5, 16-20, 22-30, and 38-41 are unpatentable as obvious in view of Gu and Trainin. This analysis is Ground 1A.
- Claims 6-8 and 31-33 are obvious in view of the Gu-Trainin combination, in further view of the 802.11e-2005 standard. This analysis is Ground 1B.
- Claims 11-15, 21, 34-37, and 42 are unpatentable as obvious in view of the Gu-Trainin combination, in further view of Hansen. This analysis is Ground 1C.

24. In support of these conclusions, I provide a discussion of the relevant technology in Section IV, an overview of the Petitioner's claim constructions and reasoning in Section VI, an overview of the references in Section VI and more detailed comments regarding the obviousness of claims 1-8 and 11-42 (**"the Challenged Claims"**) of the '122 patent in Section VII.

III. LEVEL OF ORDINARY SKILL IN THE ART

25. In my opinion, one of ordinary skill in the art relating to, and at the time of, the Priority Date would have been someone with (1) at least a bachelor's degree in computer science, computer engineering, electrical engineering, or a related field, and (2) at least two years of industry experience in wireless communications standards and/or product development. Additional advanced education could compensate for a deficiency in work experience, and *vice-versa*.

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

IV. TECHNOLOGY RELATED TO THE '122 PATENT

27. Before delving into the analysis of the prior art and the '122 patent challenged claims, I provide a brief discussion of the state of the 802.11 technology prior to the Critical Date. As will become evident from that discussion, the allegedly novel features of the '122 patent were known features at that time.

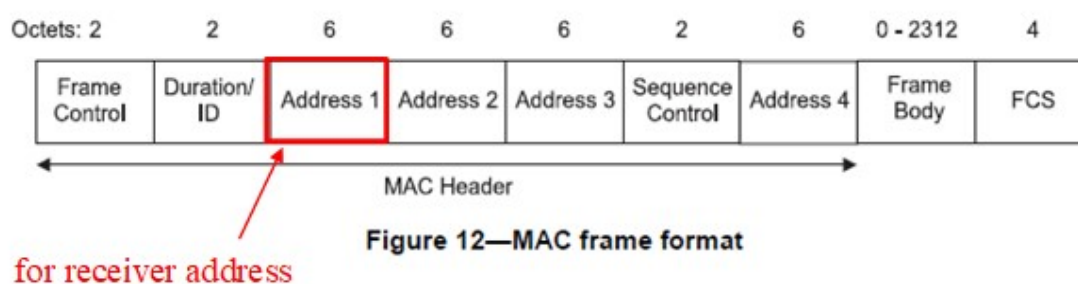
The '122 patent claims merely combine known and standardized information elements to achieve predictable results.

A. MAC and PHY

28. Wi-Fi technology employs protocols from the IEEE 802.11 family of standards. These protocols make use of a layered communications framework based on the Open Systems Interconnection (OSI) model. 802.11-1999, 3. The OSI model separates communications protocol structures into different conceptual layers, including the data link layer (which includes the medium access control (MAC) layer) and the physical layer (also referred to as the PHY layer, or simply, PHY). *See, e.g., id.*, 43.

29. The 802.11 standard defines the medium access (MAC) layer and a physical (PHY) layer for wireless local area networks. *See, e.g.,* Gast, 12-49; 802.11-1999, §§6-7, 15; '122 patent, 1:42-46; Trainin, 2:30-44, 4:20-67; Hansen, [0005]-[0011], [0036]. An early specification defining the MAC and PHY layer is 802.11-1999 titled, "Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications." 802.11-1999 was a well-known and widely used document that was made available to voting members for free and to the general public for sale, at least on the IEEE website, shortly after its reaffirmation on June 2003.

802.11-1999, 1.¹ A MAC frame is a MAC Protocol Data Unit (MPDU) that is passed down to the PHY layer. *See, e.g.,* 802.11-1999, §7.1.1 Conventions (“The MAC protocol data units (MPDUs) or frames in the MAC sublayer are described as a sequence of fields in specific order. Each figure in Clause 7 depicts the fields/subfields as they appear in the MAC frame and in the order in which they are passed to the physical layer convergence protocol (PLCP), from left to right.”), §14.3.2, §15.1.2; Gast, 47-50. A representation of a general MAC frame is reproduced below:



802.11-1999, Figure 12, 802.11-1999 MAC Frame (annotated)

¹ 802.11-1999 was originally approved and published in 1999. IEEE had a practice to revise or reaffirm its standards after several years to ensure that they would reflect the state of the art. 802.11-1999, 2. The original 1999 specification was voted for reaffirmation on June 12, 2003. UBIQUITI-1010 is the 2003 reaffirmation. I personally received a copy of this document when it was distributed in 2003.

The MAC frame includes a MAC header that carries up to four address fields, one of which can be the receiver address (RA). *See, e.g.*, 802.11-1999, §7.1.3, §7.3.3.6, FIGS. 12, 86. Receiver address matching is always performed on the contents of the Address 1 field in received frames. *Id.*, §7.1.3.3. The purpose of the RA is to indicate the intended immediate recipient for the information contained in the frame body field. *Id.*, §7.1.3.3.6. The frame body includes the data for transmission specific to the MAC subtype. *See, e.g.*, Gast, 53, FIG. 12-17 (showing PSDU (MAC frame) after PHY preamble and PHY header); *see also* 802.11-1999, §§7.1, 5.2. The receiver address of CTS and ACK frames is always obtained from the Address 2 field in the corresponding RTS frame.” 802.11-1999, §7.1.3.3. The duration field is used to update the NAV timer, which is used in RTS/CTS dialogs. Gast, 14, 22, 37; 802.11-1999, §7.1.3.2.

30. After its initial release in 1997, the 802.11 standard evolved over time through both maintenance updates and amendments. *See, generally*, 802-11e; 802.11e-D6.0. The 802.11e-2005 amendment, for example, provided MAC layer quality of service (QoS) enhancements. In the 802.11e-2005 specification, the generic MAC frame format had been updated to optionally include additional fields. *See, e.g.*, 802.11e-2005, §7.1.2; 802.11e-D6.0, §7.1.2, FIG. 12 (indicating that QoS enhancements were known as early as November 2003). The 802.11e generic MAC frame is shown below:

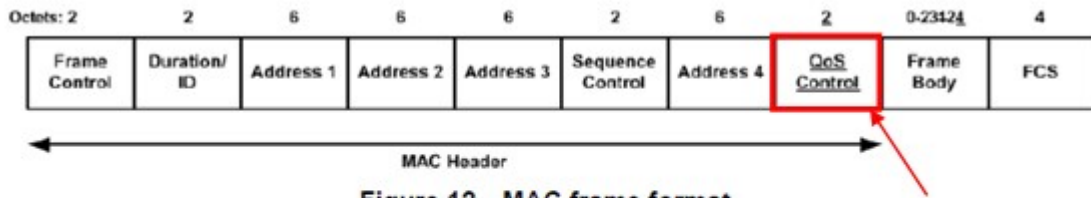


Figure 12—MAC frame format

802.11e-2005, FIG. 12 (annotated)

The quality of service (QoS) Control field is used in all QoS data frames, including QoS-null frames. *Id.*, 24. Among other things, the QoS Control field defines the ACK policy for a QoS data frame. *Id.*, Tables 3a, 3c. For QoS-null (no data) frames, the “only permissible” ACK policy is “Normal Ack.” *Id.*, Table 3c. Also, the 802.11e MAC frame includes a bitmapping in the Frame Control type and subtype fields for defining the frame as a QoS-null frame. *Id.*, §7.1.3.1.2, Table 1 (subtype 1100 QoS Null (no data)).

31. The 802.11-1999 specification and its amendments define different types of MAC layer frames, including data frames, control frames, and management frames. 802.11-1999, §7.1.3.1.2; 802.11e-2005, §7.1.3.1.2. In addition, for each type of frame, a subtype can be defined to indicate different “classes” of frames. 802.11-1999, §7.1.3.1.2; 802.11e-2005, §7.1.3.1.2; Gast, 19-20. Type and subtype fields are carried by the frame control field of a MAC header, as shown below:

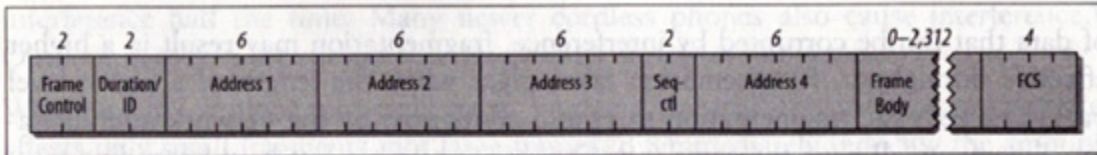


Figure 3-9. Generic 802.11 MAC frame

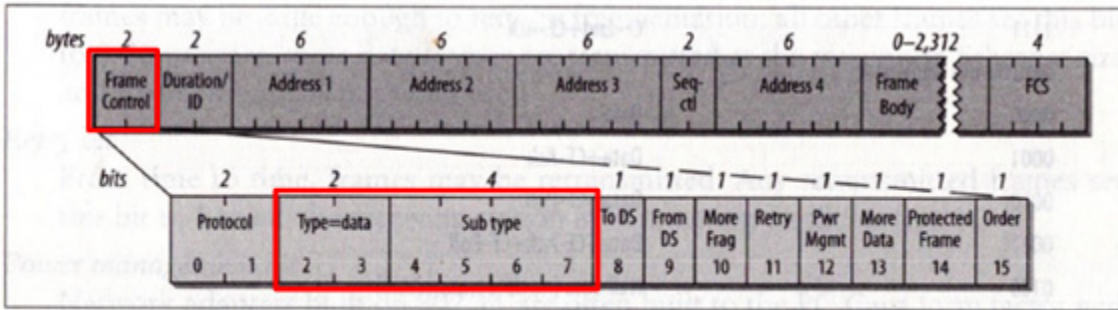


Figure 3-10. Frame control field

Gast, FIGS. 3-9, 3-10 (showing MAC header and Frame Control Field)

The different control and data subtypes are shown below, including RTS, CTS, ACK, and QoS-null subtypes:

subtype codes for
RTS, CTS, ACK,
and QoS-null

Table 3-1. Type and subtype identifiers (continued)

Subtype value	Subtype name
1000	Beacon
1001	Announcement traffic indication message (ATIM)
1010	Disassociation
1011	Authentication
1100	Deauthentication
1101	Action (for spectrum management with 802.11h, also for QoS)
Control frames (type=01) ^a	
1000	Block Acknowledgment Request (QoS)
1001	Block Acknowledgment (QoS)
1010	Power Save (PS)-Poll
1011	RTS
1100	CTS
1101	Acknowledgment (ACK)
1110	Contention-Free (CF)-End
1111	CF-End+CF-Ack
Data frames (type=10)	
0000	Data
0001	Data+CF-Ack
0010	Data+CF-Poll
0011	Data+CF-Ack+CF-Poll
0100	Null data (no data transmitted)
0101	CF-Ack (no data transmitted)
0110	CF-Poll (no data transmitted)
0111	CF-Ack+CF-Poll (no data transmitted)
1000	QoS Data ^c
1001	QoS Data + CF-Ack ^c
1010	QoS Data + CF-Poll ^c
1011	QoS Data + CF-Ack + CF-Poll ^c
1100	QoS Null (no data transmitted) ^c
1101	QoS CF-Ack (no data transmitted) ^c
1110	QoS CF-Poll (no data transmitted) ^c
1111	QoS CF-Ack+CF-Poll (no data transmitted) ^c

(Frame type 11 is reserved)

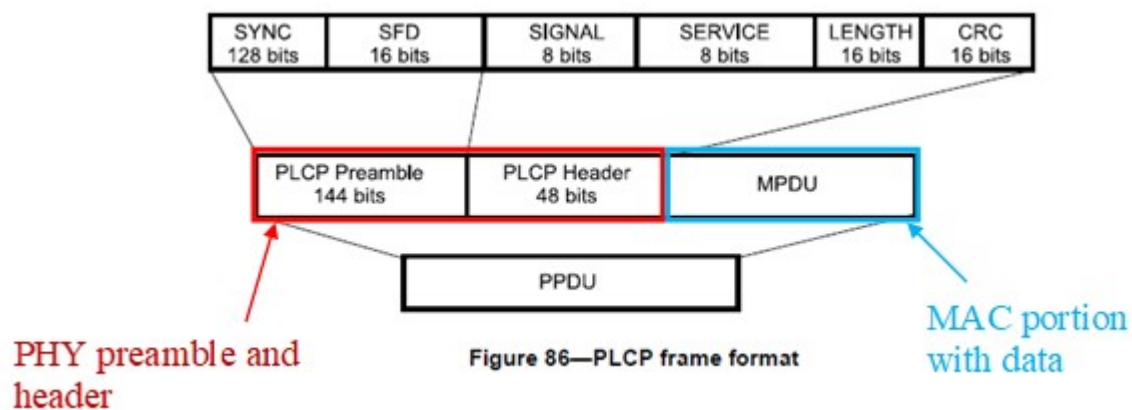
Gast, Table 3-1 (showing RTS, CTS, ACK, and QoS-null subtypes)

As early as November 2003, the QoS-null subtype was known, and was included in the 802.11e-2005 release. 802.11e-D6.0, §7.1.3.1.2; 802.11e, §7.1.3.1.2, Table 1.

32. For wireless transmission, the MPDU is prepended with a physical layer convergence procedure (PLCP) Preamble and Header to create the physical layer protocol data unit (PPDU). 802.11-1999, §15.2. A physical layer convergence function, which adapts the capabilities of the physical medium dependent (PMD) system to the PHY service. 802.11-1999, §15.1.1 Scope. This function is supported by the physical layer convergence procedure (PLCP), which defines a method of mapping the IEEE 802.11 MAC sublayer protocol data units (MPDUs) into a

framing format suitable for sending and receiving user data and management information between two or more STAs using the associated PMD system. 802.11-1999, §15.1.1 Scope. This clause provides a convergence procedure in which MPDUs are converted to and from PPDU. During transmission, the MPDU shall be prepended with a PLCP Preamble and Header to create the PPDU. At the receiver, the PLCP Preamble and header are processed to aid in demodulation and delivery of the MPDU. 802.11-1999, 15.2 (including Overview).

33. The PPDU generated by the PHY layer is shown below:



802.11-1999, FIG. 86 (annotated) 802.11-1999 PHY Protocol Data Unit – Based on Figure 86 with expansion of the MPDU to show the MAC header fields.

The figure above illustrates a complete transmission or PPDU (PLCP protocol data unit or physical layer convergence protocol data unit) from a device that follows the 802.11-1999 protocol. 802.11-1999, §15.2.2 (PLCP frame format). The transmission includes a PHY preamble, PHY header, and a MAC frame or MPDU.

802.11-1999, §15.2; *cf.* Gast, 48, 53. The MAC frame is contained within the data portion of the PPDU. *See, e.g.,* Gast, 25, 48, 53. It will typically contain address information, including a receiver address (RA) and a transmitter address (TA) in the MAC header. 802.11-1999, §7.1.3.3. If it is a data frame, the data payload from the upper layers will follow the MAC header in the Frame Body. The FCS (frame check sequence) field is used by the receiver to determine that the frame has been received without errors.

34. The PPDU (or PHY packet) thus includes a PHY preamble and PHY header, and an MPDU, which includes the frame control and address information for all frames (including control and QoS null frames) and the higher layer data for data frames. Without the PHY data portion, where the MPDU is located, the PPDU would only include the PHY preamble and PHY header.

B. Channel Contention

35. In 802.11-based wireless local area networks, stations vie for access to the wireless medium using channel contention. *See, e.g.,* Gast, 17. The stations first use carrier-sensing to determine whether the medium is busy or available. *See, e.g.,* Gast, 13-14. However, carrier sensing does not always prevent transmission collisions between stations because some stations may not be able to receive the signals transmitted by others. To help minimize collisions, a transmitting station

can use RTS/CTS to secure the medium for a transaction *See, e.g.,* Gast, 12-15.

An example is shown in Figure 3-5 below:

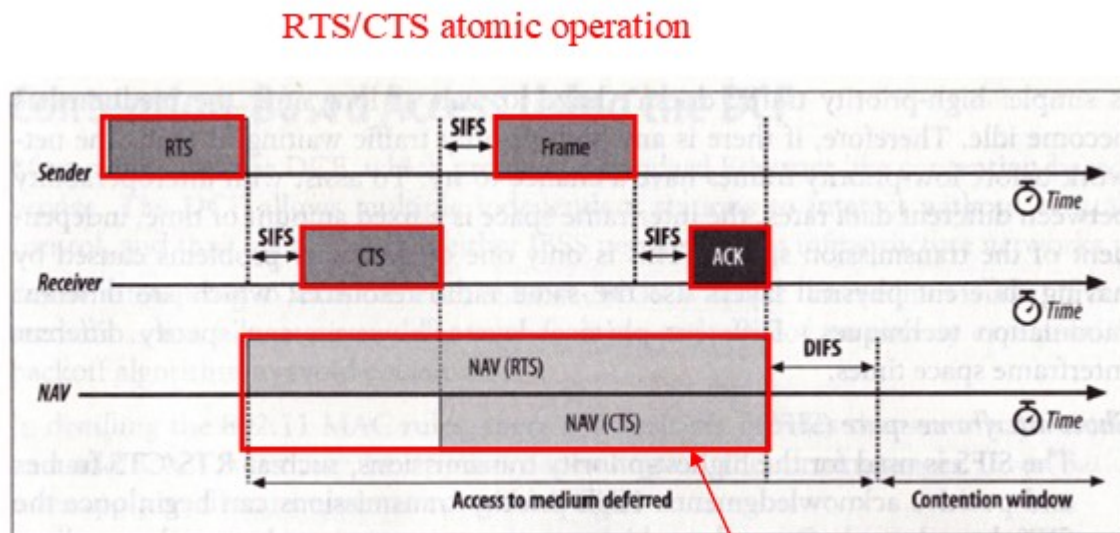


Figure 3-5. Using the NAV for virtual carrier sensing

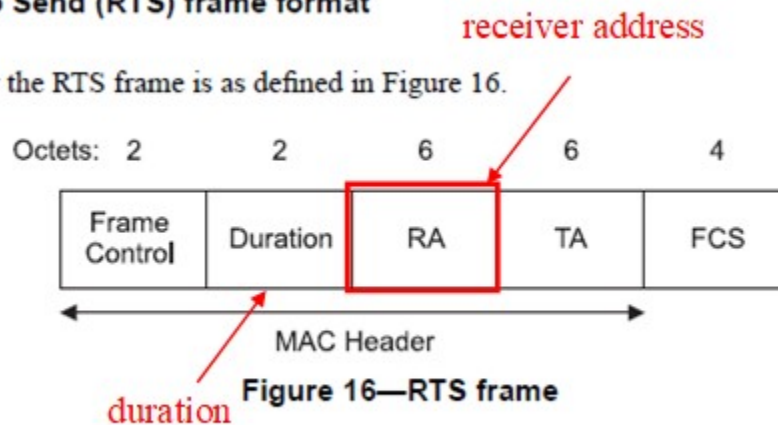
Gast, FIG. 3-5 (annotated).

The RTS, CTS, transmitted frame(s), and positive acknowledgement (ACK) are all considered part of the same dialog (or atomic operation). *See, e.g.,* Gast, 12-15. A Network Allocation Vector (NAV) is a timer that indicates an amount of time that the medium is occupied. *See, e.g.,* Gast, 12-15. The NAV timer is determined based on the amount of time expected to complete the transaction. *See, e.g.,* Gast, 12-15. After the expiration of the NAV timer, the contention window begins again. *See, e.g.,* Gast, 12-15. Thus, during the RTS/CTS dialog, the medium is secured for the transaction of the frame(s) between the sender and the receiver. *See, e.g.,* Gast, 12-15.

36. The RTS frame is a MAC frame that includes an address of the receiving station, as shown below:

7.2.1.1 Request To Send (RTS) frame format

The frame format for the RTS frame is as defined in Figure 16.



802.11-1999, FIG. 16 (annotated)

The duration field can be used to set the expected duration for the medium reservation. *See, e.g.,* Gast, 14, 22; 802.11-1999, §7.1.3.2. Unaddressed stations can use the duration field to set their own NAV timers so that they are aware of the amount of time the medium is occupied. *See, e.g.,* Gast, 12-15, 22, 30, 37. Thus, during this amount of time, unaddressed stations would not expect to receive any transmissions (and any transmissions they do receive are discarded). *Id.* A POSITA would have recognized that during the known time period the channel is occupied and when the NAV timer is set, it would not have been necessary for frames to include a receiver address. This is because the first message (e.g., RTS) indicated that the medium was to be reserved for a single station, which is alerted to expect

the forthcoming transaction(s) and to reserve the amount of time it will take to complete the transactions.

C. Interframe Spacing

37. The 802.11 standard, as early as 1999, defined the time interval between frames, referred to as interframe spacing. *See, e.g.*, 802.11-1999, §9.2.3. Short interframe spacing (SIFS) is the shortest of the interframe spaces. 802.11-1999, §9.2.3. “SIFS shall be used when STAs have seized the medium and need to keep it for the duration of the frame exchange sequence to be performed.” *Id.* More specifically, “SIFS *shall* be used for an ACK frame [and] a CTS frame.” *Id.* (emphasis added); *see also* Gast, 16 (“The SIFS is used for the highest-priority transmissions, such as RTS/CTS frames and positive acknowledgements.”). The SIFS period is shown in Figure 3-5 below for both RTS/CTS:

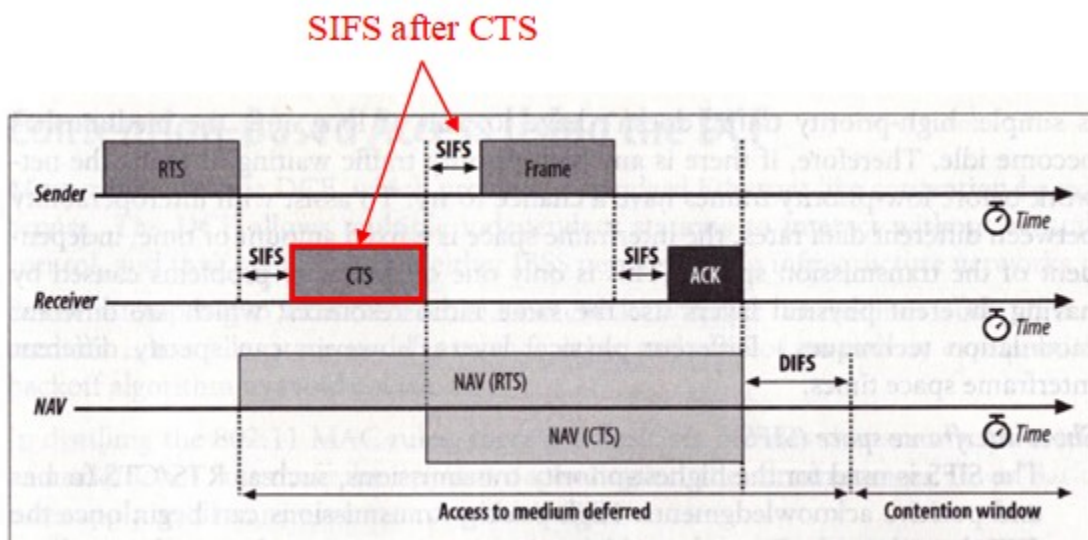


Figure 3-5. Using the NAV for virtual carrier sensing

Gast, FIG. 3-5 (annotated)

D. Channel Sounding

38. The 802.11n amendment introduced MIMO (multiple input multiple output) technology to the 802.11 family of standards. *See, e.g.,* Hansen, [0010]. With MIMO, multiple antennas are used at the transmitter, receiver, or both sides to improve the achievable data rate and reliability of communication. *See, e.g.,* Gu, 1:22-24. When the transmitter has multiple antennas, the level of improvement is optimized when the transmitter applies beamforming to its transmissions. *See, e.g.,* Hansen, [0085]-[0108]. With beamforming, the transmitter employs precise phase and amplitude adjustments that complement the specific transmission paths between each transmit antenna and each receive antenna. *See, e.g.,* Trainin, 3:4-31.

39. To beamform effectively, the transmitter needs knowledge of the radio paths from its antennas to the receiver. *See, e.g.,* Trainin, 2:14-23. This information is called channel state information and it is determined by channel sounding. *See, e.g.,* Trainin, 6:65-67. In channel sounding, the transmitter sends a known sounding signal to the receiver. *See, e.g.,* Gu, 1:40-54; Hansen, [0085]-[0108]. The receiver then computes the channel state from the received sounding signal and sends that information back to the transmitter. *See, e.g.,* Trainin, 7:1-3.

E. Overview of the '122 patent

40. The '122 patent is directed to “systems and methods for transmission announcement indication” in the context of “wireless network communications.”

'122 patent, Abstract, 1:13-15. The '122 patent purports to “provide a system of transmission announcement indication.” *Id.*, 2:7-8. According to the '122 patent, a transmitting client station (STA) sends a transmission announcement indication (TxA indication) to a receiving client station to alert the STA that another transmission intended for the STA will follow. *Id.*, 4:49-53. The TxA indication “can be a bit inside a MAC header field, such as *the* HT-control field.” *Id.*, 5:15-16 (emphasis added to show that HT-control field was a known field inside MAC header). A TxA indication could be present in “data frames, null frames, management frames, control frames, QoS frames, etc.” *Id.*, 6:1-3. In addition, the TxA indication can be sent with a request to send (RTS). *Id.*, 5:18-31. The '122 patent contemplates the transmitting and receiving client stations to be part of an independent basic service set (IBSS). *Id.*, 4:9-14.

41. “The transmission indicated by the TxA indication could be a PHY header without MAC portion, which may also be referred to as a zero-length frame (ZLF) or Null Data Packet (NDP).” '122 patent, 4:57-61. A ZLF may be transmitted to sound the channel. *Id.* Also according to the '122 patent, the indicated transmission may start after “a short interframe space (SIFS).” *Id.*, 4:67-5:1. SIFS “is the minimum inter frame space.” *Id.*, 5:4. As was known in the art at the time, a SIFS was used to “separate transmissions belonging to a single dialog.” *Id.*, 5:2-3; *see also* Larsson, [0085]; 802.11-1999, §9.2.3. The '122 patent describes that

the “transmission indicated by the TxA indication may start after the receiver sends a possible response frame to the frame where the TxA indication is included.” ’122 patent, 4:61-64.

42. For example, when using RTS, the transmission indicated is sent after the transmitter receives a clear to send (CTS) from the receiver. *Id.*, 5:18-31. This RTS/CTS implementation is illustrated by FIG. 3, reproduced below:

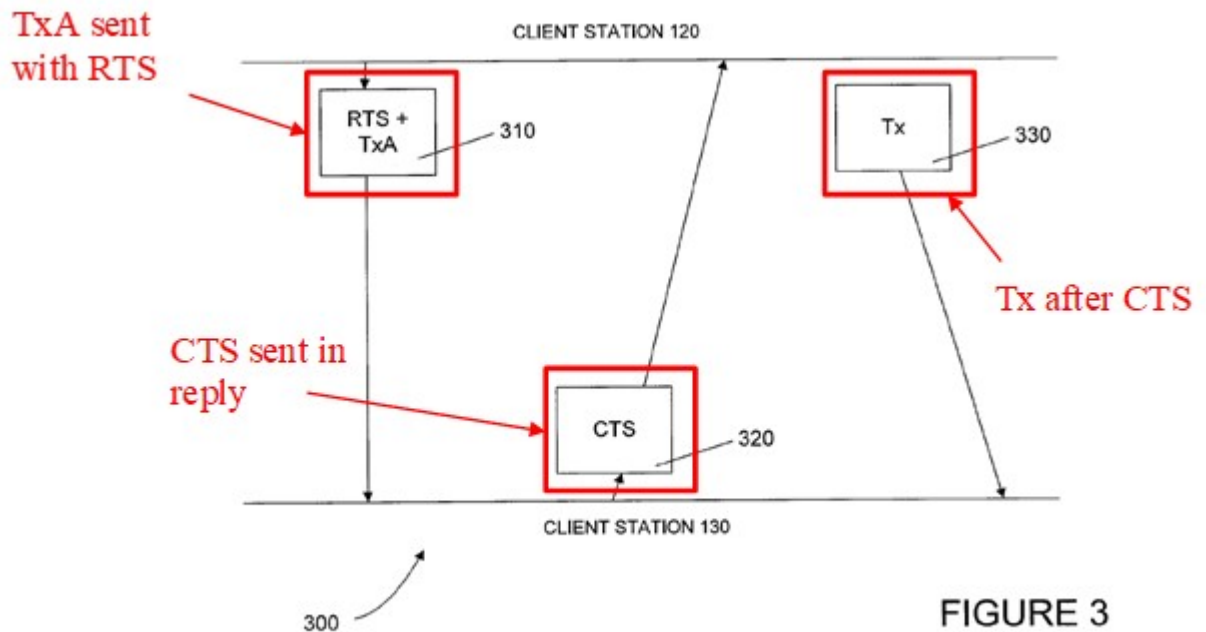


FIGURE 3

’122 patent, FIG. 3 (annotated)

In this scenario, a POSITA would have recognized that the announced transmission (TX) would be sent after a SIFS *following* the CTS.

43. The ’122 patent also describes an embodiment where the TxA indication is included with a QoS-null, which is followed by a positive acknowledgement (ACK). ’122 patent, 5:32-44, FIG. 4. This embodiment is shown in Figure 4:

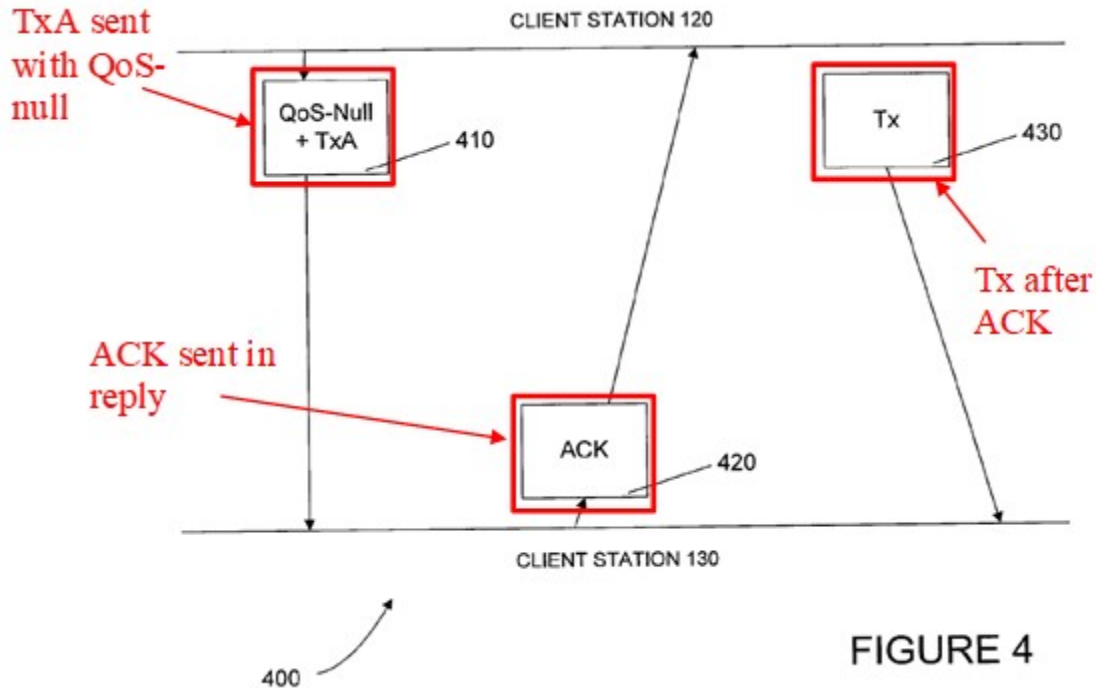


FIGURE 4

'122 patent, FIG. 4 (annotated)

44. When using “a QoS-null with HT-control field,” for the TxA, the “ZLF follows within an SIFS for no ACK or **SIFS after the ACK for immediate ACK.**” '122 patent, 6:19-23 (emphasis added).

F. Prosecution History of the '122 Patent

45. The '122 patent claims the benefit of priority to U.S. Provisional Patent Serial No. 60/762,425, filed on January 25, 2006. '122 patent, face. The provisional patent includes an email identified as a disclosure of the claimed concepts on December 21, 2005:

The concept of ZLF Announcement was proposed by undersigned in an email to the EWC technical reflector on December 21, 2005:

'122 patent provisional application, 3.

For the purposes of prior art, this Petition considers January 25, 2006, as the Critical Date. The prior art that I analyze and apply to the claim limitations predates both the Critical Date and the December 21, 2005 disclosure date.

46. During prosecution, the claims were rejected in view of Larsson. '122 patent file history, 665, 560-561. Larsson teaches RTS/CTS and includes a SIFS period.

See, e.g., Larsson, [0087], FIG. 5. FIG. 5 shows the RTS/CTS scheme using SIFS:

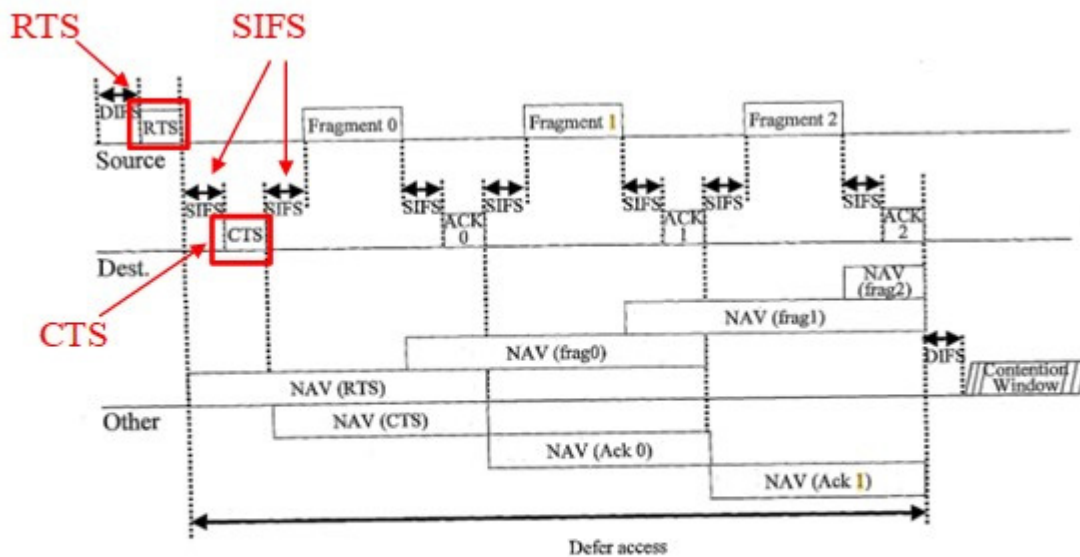


Fig. 5

Larsson, FIG. 5 (annotated)

Despite the teaching of SIFS in Larsson, the examiner erroneously allowed the claims after including SIFS in the independent claims. '122 patent file history, 38-48 (describing examiner's amendment to include SIFS and allowability).

47. The amendment to the first independent claim is shown below:

wherein the first communication frame comprises an address of the second station and a transmit announcement indication indicating that a second communication frame intended for the second station will follow the first communication frame and that the second communication frame will not include the address of the second station, and wherein the second communication frame follows after a short inter frame space (SIFS) after the first communication frame with the transmit announcement indication.

'122 patent file history, 41

48. The examiner's amendment did not cancel dependent claims that recite that the TxA indication is transmitted with an RTS frame (e.g., claim 3) and the subsequent reception of a CTS frame (e.g., claim 4). *Id.* Likewise, the examiner's amendment did not cancel dependent claims that recite that the TxA indication is transmitted with a QoS-null frame (e.g., claim 6) and the subsequent reception of a positive acknowledgement (ACK) frame (e.g., claim 7).

49. For these dependent claims to make sense, the SIFS limitation should be interpreted to include transmitting the second communication frame following a SIFS after receiving a CTS (e.g., claim 5) or ACK (e.g., claim 8). For example, for RTS/CTS, three SIFS were discussed by the standard, as early as 1999. 802.11-1999, §7.2.1.1-7.2.1.2; *see also* Gast, FIG. 3-5 (showing SIFS for RTS/CTS):

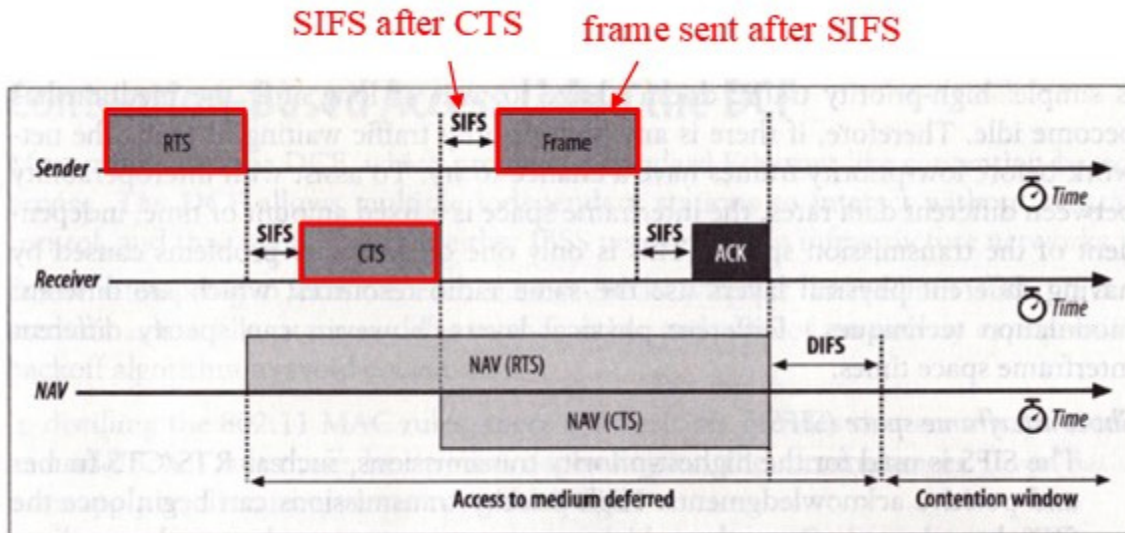


Figure 3-5. Using the NAV for virtual carrier sensing

Gast, FIG. 3-5 (annotated)

In addition, for QoS-null frames, the 802.11e standard required a “Normal ACK” policy. *See, e.g.*, 802.11e-2005, §7.1.3.5.3. Therefore, a SIFS was required after the reception of the ACK, as per 802.11-1999 standard. 802.11-1999, §9.2.3 (teaching that “SIFS *shall* be used for an ACK frame”) (emphasis added).

V. RELEVANT CLAIM CONSTRUCTIONS

50. I have been informed by counsel that, for purposes of my analysis in this *inter partes* review proceeding, the terms appearing in the patent claims should be interpreted according to their “ordinary and customary meaning.” In determining the ordinary and custom meaning, the words of a claim are first given their plain meaning that those words would have had to a POSITA. In that regard, I understand that the best indicator of claim meaning is its usage in the context of the patent specification as understood by a POSITA. I also understand that the words

of the claims should be interpreted as they would have been interpreted by a POSITA at the time of the invention was made (not today). I have used the so-called Critical Date of the '122 patent as the point in time for claim interpretation purposes. That date was December 21, 2005. I have been asked to provide my interpretation of the following terms and phrases of the '122 patent set forth below.

Claim 1 recites:

1. A method comprising:

transmitting a first communication frame from a first station to a second station;

wherein the first communication frame comprises an address of the second station and a transmit announcement indication indicating that a second communication frame intended for the second station will follow the first communication frame and that the second communication frame will not include the address of the second station, and wherein the second communication frame follows after a short inter frame space (SIFS) after the first communication frame with the transmit announcement indication.

51. Claim 1 and other independent claims were allowed after an amendment adding the underlined portion above. My understanding is that dependent claims reciting sending a transmission announcement (TxA) indication in a request-to-

send (RTS) frame and sending the second communication frame after a clear-to-send (CTS) frame were not cancelled; likewise, dependent claims reciting sending a transmission announcement (TxA) indication in a QoS-null frame and sending the second communication frame after a positive acknowledgement (ACK) frame were not cancelled. It is my understanding, therefore, that the independent claims should be interpreted broadly to still encompass the dependent claims.

52. The following are terms that I have interpreted and my reasoning for my conclusions as to how a POSITA would have interpreted these terms at the time.

A. “the second communication frame follows after a short interframe space (SIFS) after the first communication frame with the transmit announcement indication”

53. The term “the second communication frame follows after a short interframe space (SIFS) after the first communication frame with the transmit announcement indication” should be construed to have its plain and ordinary meaning in light of the specification. The plain and ordinary meaning is broad enough to encompass claimed embodiments in which the transmission indicated by the transmit announcement indication follows after a response to the frame with the transmit announcement indication. This construction is consistent with the intrinsic record, and is required for the dependent claims to make sense. It comports with the express plain language because the indicated transmission that follows the

responsive frame in a single dialog would follow “after a SIFS after the first communication frame.”

54. Turning first to the written description of the '122 patent, the specification provides sufficiently broad disclosure to interpret the SIFS term of claim 1 broadly. For example, the '122 patent states:

The transmission indicated by the TxA indication may start after the receiver sends a possible response frame to the frame where the TxA indication is included. The transmission indicated by the TxA indication may also start after the frame where the TxA indication is included, before the receiver sends a possible response frame.

'122 patent, 4:61-67. Here, the '122 patent provides alternative embodiments for when the second communication frame is to start. The '122 patent also clarifies that the “indicated transmission may start after a short interframe space (SIFS), but there is no strict requirement on the timing.” *Id.*, 4:67-5:2. The '122 patent correctly states that “SIFS is used to separate transmissions belonging to a single dialog.” *Id.*, 5:2-3. And as described elsewhere in this report, SIFS was required by the 802.11 standard for both RTS/CTS dialogs and for positive acknowledgements. *See, e.g., supra*, §IV.C; Larsson, [0087]; 802.11-1999, §9.2.3.

55. Furthermore, the '122 patent specification expressly states that the “transmission indicated by the TxA indication may start after the receiver sends a

possible response frame to the frame where the TxA indication is included.” ’122 patent, 4:61-64. But more generally, the ’122 patent states that the “indicated transmission may start after a short inter frame space (SIFS), but there is no strict requirement on the timing.” *Id.*, 4:67-5:2. The ’122 patent states that “SIFS is used to separate transmissions belonging to a single dialog,” which is consistent with the prior art and the 802.11 standard. Larsson, [0087]; 802.11-1999, §9.2.3. Examples of a “single dialog” include the request-to-send / clear-to-send dialog and the QoS-null / ACK dialog, both of which are described below. *See, e.g.,* Gast, 14 (describing RTS/CTS as an atomic operation).

56. For example, claims 3-5 (among others) recite the request-to-send (RTS) / clear-to-send (CTS) schema illustrated by Figure 3, reproduced below:

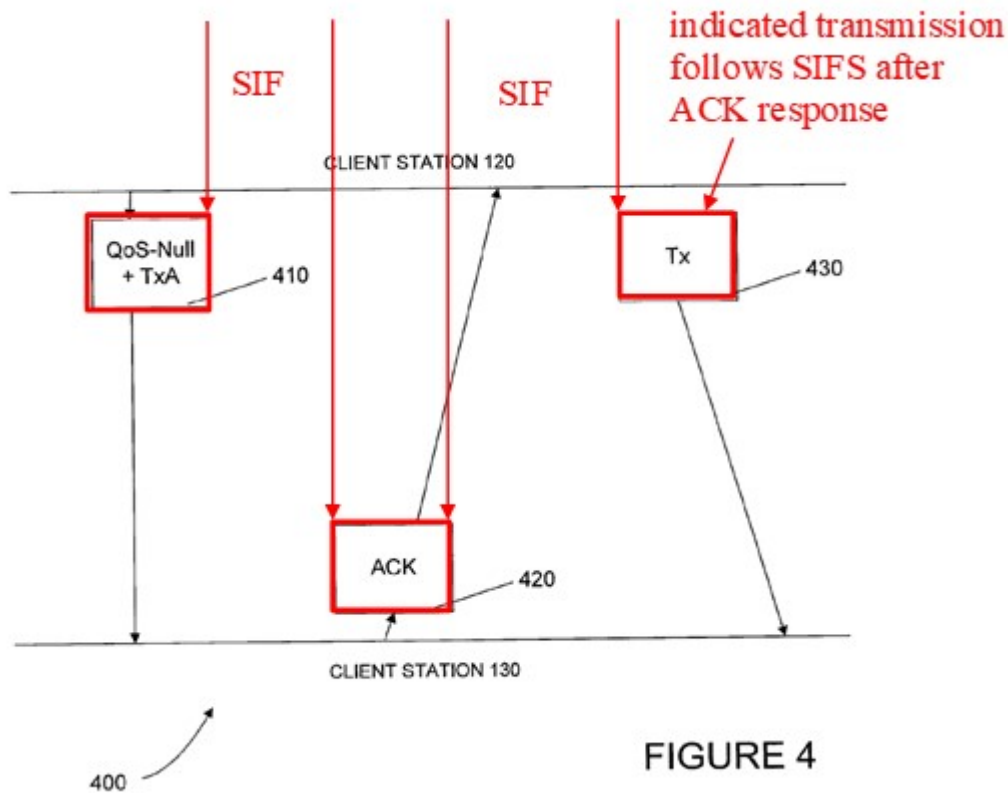


FIGURE 4

'122 patent, Figure 4 (annotated)

Figure 4 represents an embodiment where a “QoS-null with TXA indication is followed by an acknowledgement (ACK) response, after which the announced transmission follows.” ’122 patent, 5:33-35. In FIG. 4, station 120 sends a QOS-null with a TxA indication to station 130. *Id.*, 5:38-43. Station 130 sends an ACK in response to the QOS-null. *Id.* Station 130 receives the next transmission 430 as announced by the TxA indication. *Id.*

58. To be consistent with independent claim 1 and claims 6-9, the announced transmission (TX in the figure) must follow after a SIFS following the ACK, which is the response to the QoS-null frame carrying the transmit announcement

indication. This interpretation is supported by the specification: “a QoS-null with HT-control field . . . is used to indicate that this is a TxA announcement [and] the ZLF follows . . . SIFS *after the ACK* for immediate ACK.” Note that a SIFS is required for the ACK under 802.11. 802.11-1999, §9.2.3. And, a QoS-null frame requires an ACK. *See, e.g.,* 802.11e-2005, §7.1.3.5.3.

59. I also note that the ’122 patent acknowledges that the precision of the timing is not important. ’122 patent, 5:1:2 (“there is no strict requirement on the timing.”). It recognizes that using a longer spacing such as a “point coordination inter frame space (PIFS)” may risk another station transmitting a frame, which would get misinterpreted as the announced transmission. *Id.* at 5:7-17. A POSITA would recognize that interpreting a “after a short inter frame space (SIFS) after the first communication frame” to allow for a mandatory response after SIFS in the dialog initiated by the first frame (such as a CTS or an ACK) to be consistent with addressing these concerns.

60. To summarize, because the ’122 patent claims RTS/CTS and QoS-null/ACK dialogs, the SIFS term in the independent claims should be interpreted broadly such that the second frame is transmitted after a SIFS after a response frame is received.

B. “RTS frame”

61. The term “RTS frame” should be construed to include any frame that is used to initiate an RTS/CTS dialog. First, the ’122 patent does not restrict the RTS frame to a specific frame structure. Instead, the ’122 patent merely states that the RTS (also referred to as an RTS frame) and TxA indication “may be followed by a clear to send (CTS)” (also referred to as a CTS frame). ’122 patent, 5:21-23. The ’122 patent does not provide any details as to how the TxA bit(s) would be included into the RTS frame. At best, the ’122 patent states that the TxA “can be a bit inside the HT-control field,” *Id.*, 5:15-16.

62. The term “RTS frame” should be construed to include any frame that is used to initiate an RTS/CTS dialog. First, the ’122 patent does not restrict the RTS frame to a specific frame structure. Instead, the ’122 patent merely states that the RTS (also referred to as an RTS frame) and TxA indication “may be followed by a clear to send (CTS)” (also referred to as a CTS frame). *Id.*, 5:21-23. The ’122 patent does not provide any restrictions as to how the TxA bit(s) would be included into the RTS frame. At best, the ’122 patent states that the TxA “can be a bit inside the HT-control field,” *Id.*, 5:15-16. A POSITA would have known that, at the time, the 802.11n working group had contemplated redefining the original 802.11 MAC frame structure (including the RTS frame), such as by including an HT-control field. *Id.*, 2:22-33; 802.11-1999, §§7.1.3-7.2.1.3; Trainin, 4:20-30, FIG.

3 (discussing HTC field and RTS+HTC frame). Indeed, without a clear teaching from the '122 patent, a POSITA would have known that an TxA bit would not be implemented as part of the original RTS subtype frame since each bit of the original RTS frame was already used. 802.11-1999, §§7.1.2-7.2.3.1. For the claimed RTS embodiment to make sense to a POSITA, as the definition of an “RTS frame” was then in flux, the term “RTS frame” should therefore be construed broadly enough to include any frames that were used to initiate an RTS/CTS dialog.

63. Construing RTS frame broadly to include a frame that initiates an RTS/CTS dialog was consistent with the understanding of 802.11 at that time. For example, Gu incorporates by reference a TGn Sync Proposal Technical Specification that indicates that the LAC frame becomes an RTS frame when the RTS flag is set. *See, e.g.,* TGn Sync Proposal, §6.2.1.2.1; Gu, 2:7-9 (“The LAC frame is described in detail in IEEE 802.11-04/0889r7, “TGn Sync Proposal Technical Specification,” incorporated herein by reference.”), 2:14-21 (LAC mask includes RTS field).

C. “CTS frame”

64. Claim 4, among others, recites “a clear to send (CTS) frame.” The term “CTS frame” should be construed to include any frame that is used to respond to an RTS as part of an RTS/CTS dialog. The '122 patent merely states, “Station 130 sends CTS 320 in response to the RTS+TxA 310.” '122 patent, 5:26-27. Indeed, in

one claimed embodiment, the '122 patent includes the TxA in a CTS frame. *See, e.g., id.*, 5:49-51, cl.9. The '122 patent does not provide any details as to how the TxA bit(s) would be included into the CTS frame. A POSITA at that time would have understood that the CTS frame from IEEE 802.11-2019 would not have included an HT-control field, nor any other fields available for adding the TxA. *See, e.g.*, 802.11-1999, §§7.1.2-7.2.3.1. Instead, a POSITA would have understood that another frame serving as a CTS frame would have been needed to perform that function. *See, e.g.*, TGN Sync Proposal, §6.2.1.2.1; Gu, 2:14-21 (LAC mask includes CTS field).

D. “zero-length frame”

65. The term “zero-length frame” should mean a “PHY frame that does not include a MAC portion.” The inventor defined the term: “[T]he TxA indication could be a *PHY header without MAC portion, which may also be referred to as a zero-length frame (ZLF) or Null Data Packet (NDP).*” ’122 patent, 4:58-60. This would have been consistent with the understanding of a POSITA. A POSITA would have understood that a PHY frame refers to a PPDU (PLCP protocol data unit or physical layer convergence protocol data unit) containing a PLCP Preamble and Header and an MPDU portion. A frame containing a PHY preamble and header but without a MAC portion refers to an empty MPDU portion that would otherwise comprise the MAC frame (i.e., “zero-length” MAC frame). The MPDU

typically contains address information, such as a receiver address (RA) and a transmitter address (TA) in the MAC header. A PPDU with a zero-length MDPU would not contain an address of the receiving station for that PPDU.

VI. OVERVIEW OF PRIOR ART REFERENCES

A. Gu

66. Gu is titled, “Method for Selecting Antennas and Beams in MIMO Wireless LANs,” and claims the benefit of priority to PCT/US2005/042358 filed on November 21, 2005. Gu is directed to “selecting antennas and beams” in “multiple-input, multiple-output wireless local area networks.” *See, e.g.*, Gu, 1:16-18. “To perform antenna/beam selection, the complete channel matrix is estimated by sending training (sounding) frames that enable the antenna selection station to measure the complete channel state information (CSI).” *Id.*, 1:40-47.

67. Gu was filed within the context of the development of the 802.11n standards. *Id.*, 1:55-62 (describing WLAN IEEE 802.11n standard development). By July 2005, a proposal had been submitted to the Task Group n (“TGn”) of the IEEE 802.11 Wireless Local Area Networks (“WLAN”) working group describing a new link adaptation control (LAC) control frame for supporting MIMO training requests and exchange of link adaptation information. *Id.*, 1:55-2:9. Gu incorporated this proposal by reference. *Id.*, 2:7-9.

68. Gu describes the proposed structure for the LAC frame. *Id.*, Fig. 2, 2:14-21.

Gu proposed an extension of the LAC frame that uses an antenna/beam selection indicator (ASI). *See, e.g., Id.*, 6:10-37. FIG. 5C illustrates the LAC frame structure:

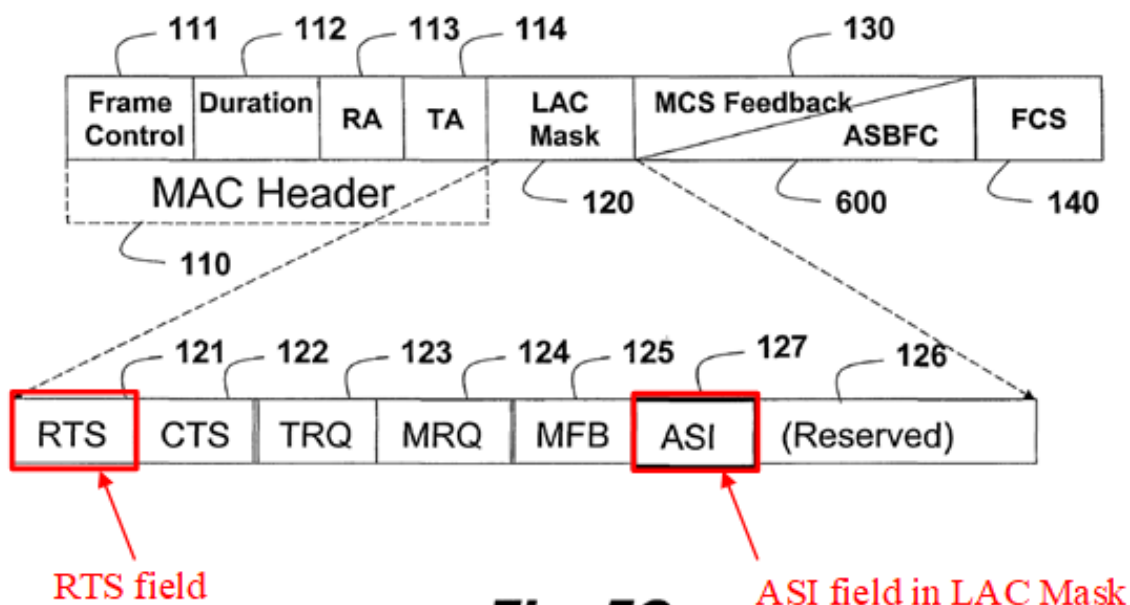


Fig. 5C

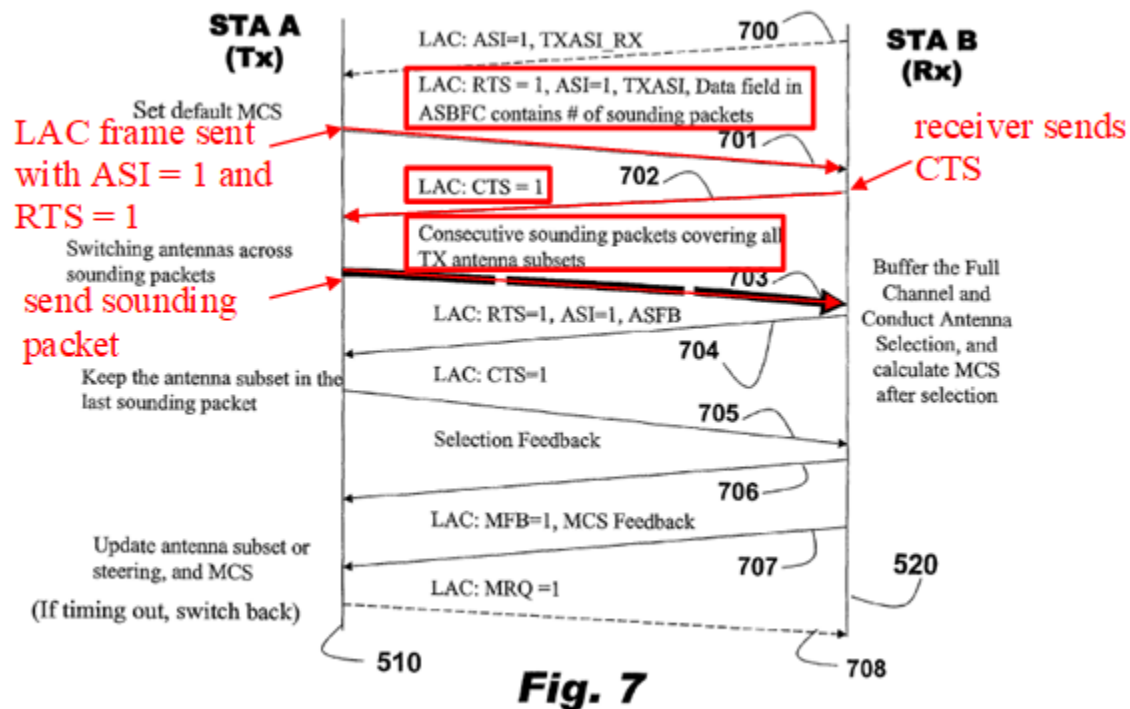
Gu, FIG. 5C (annotated)

When the ASI bit 127 is set to 1 (and MFB is not set to 1), then field 130 is used for antenna/beam selection transmitter beam forming control (ASBFC). *See, e.g., id.*, 6:11-17.

69. The ASBFC field 600 includes a command field and a data field. *Id.*, 6:24-27. The command field specifies an antenna/beam selection command. *See, e.g., id.*, Table A. “The Data part of the field indicates the number of consecutive sounding packets that will be transmitted for training” *See, e.g., id.*, 7:49-51.

70. A sounding packet “is a specific PHY layer packet, which contains the training information for all the available data streams in the MIMO channel.” *Id.*, 2:49-51. Gu describes that “the sounding packet can be limited to a preamble and header, and exclude any data” so as to “decrease the time required for sounding” by minimizing the size of the sounding packet. *Id.*, 5:9-12. A POSITA would have understood that the absence of data in the sounding packet meant that the sounding packet did not include an address for the receiver because it would include no MAC frame containing addresses.

71. Gu’s FIG. 7 shows the details of the training method with LAC frame:



Gu, FIG. 7 (annotated)

The transmitter (STA A) sets default MCS, and then “sends 701 a LAC frame with ASI=1 and the command TXASI . . . with RTS=1 in the LAC mask field 120” to the receiver (STA B). Gu, 7:46-51. The receiver sends a LAC frame with CTS=1, which indicates that the receiver is ready for receive the sounding packets. *Id.*, 7:52-54. Upon receiving the LAC frame with CTS=1, the transmitter sends 703 consecutive sounding packets. *Id.*, 7:60-61. Gu teaches that the receiver estimates the channel matrix from the sounding packets and reports feedback to the transmitter. *Id.*, 5:13-15 (“A channel matrix 564 is estimated 563 from the sounding packets, and a subset of antennas 566 is selected 565 according to the channel matrix), 8:18-24. Gu teaches that the transmitting station receives feedback from the receiving station pertaining to the channel matrix and the antenna / beam selection, which the transmitter uses. *Id.*, 8:22-35.

72. Beyond this specific embodiment of a LAC frame, Gu describes that the “LAC functionality can be realized either by a single control frame defined as LAC, or the single control frame can be a High Throughput (HT) Control frame, or a HT-control Field can be incorporated into *any MAC layer frame.*” *See, e.g., id.*, 1:62-65 (emphasis added); *see also id.*, 2:22-35, 6:52-7:10, 13:5-18, FIG. 12. FIG. 12 is reproduced below:

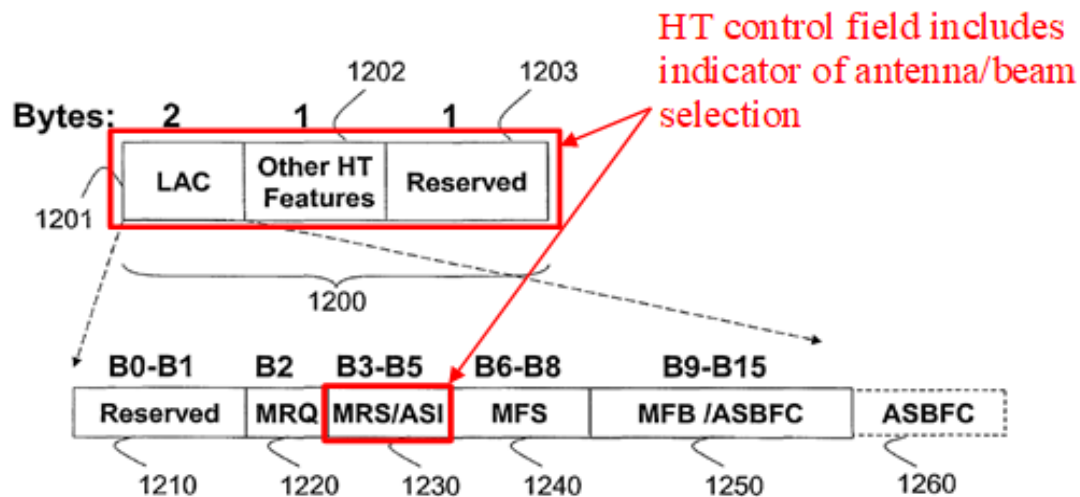
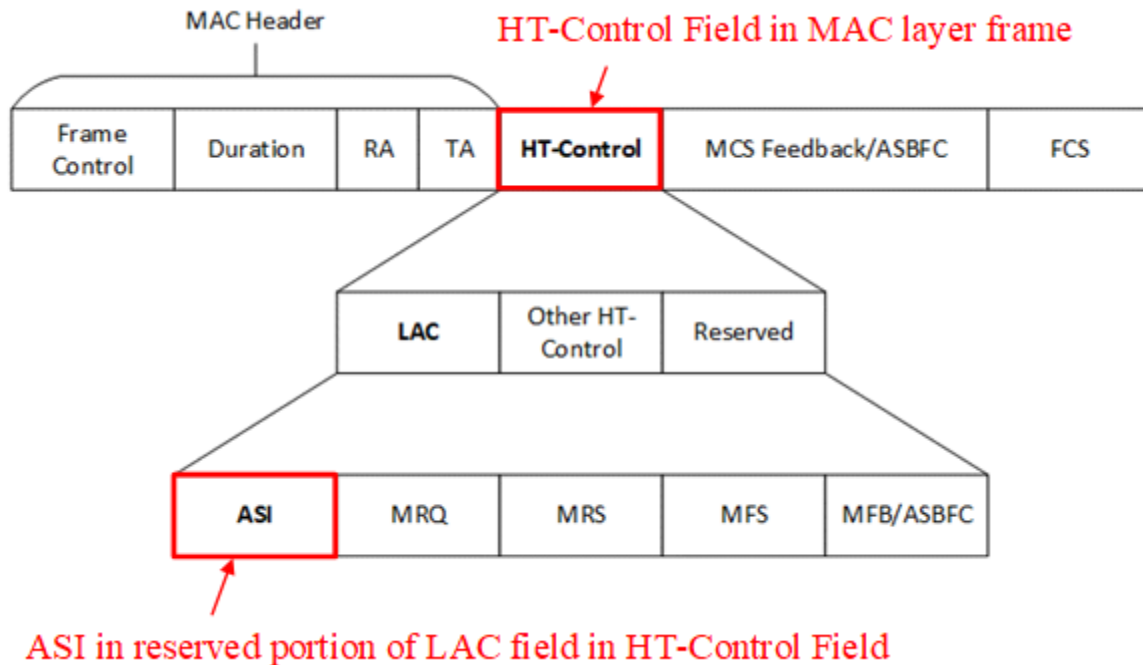


Fig. 12

73. In one example, when using the HT-control field instead of a LAC frame, in FIG. 7, “LAC’ should be replaced by ‘HT-control Field’; ‘ASI=1’ should be replaced by ‘MRS=111’ or ‘ASI = 1’ for the case ASI is used to indicate a reuse of the MFB field.” *Id.*, 10:5-8, 7:1-3 (describing using “one reserved bit as ASI, either in the LAC field, or in one of the reserved portions in HT-control Field”). The resulting frame would be structured as follows:



Gu, MAC Layer Frame with LAC functionality in HT-Control Field, Gu, 1:60-65, 6:52-7:10, 10:4-8, FIGS. 5C, 7, 12.

Gu also teaches that the indication of “antenna/beam selection training frame” “can be used for any similarly defined signaling frame in a MAC layer that allows a fast communication between the transmitter and receiver.” *Id.*, 13:6-10; *see also* Gast, 16 (“The SIFS is used for the highest-priority transmissions, such as RTS/CTS frames and positive acknowledgements.”). When other MAC signaling is used, the communication frame need only include “one bit or bit combination is used to indicating an antenna/beam selection training frame, and any suitable field with a length of at least 7 bits in the control frame can be used for exchanging the selection training information.” *Id.*, 13:9-12 (emphasis added). (In this way, Gu makes it clear that the ASI bit (or MRS definition) is an indication of forthcoming

sounding frames.)

74. Gu incorporates by reference the TGn Sync Proposal. *Id.*, 2:7-9. The TGn Sync Proposal teaches that when the RTS flag is set in the LAC frame, the frame becomes an RTS frame. *See, e.g.*, TGn Sync Proposal, §6.2.1.2.1. In addition, TGn Sync Proposal also discusses SIFS for various implementation purposes, including in the context of RTS/CTS. *Id.*, §7.1.5.1, 44:29-31.

B. Trainin

75. Trainin, titled, “Wireless Communication System, Associated Methods and Data Structures,” was filed on December 1, 2005. Trainin describes a wireless device and associated method “to establish a wireless communications channel with one or more remote device(s) by generating and/or receiving a protocol data unit(s) (PDU) including a control field including one or more of link adaptation control information.” Trainin, Abstract. Trainin teaches that “[p]erformance improvement in wireless communications systems may be achieved if the channel characteristics are known by the transmitter, or source, of a wireless communication signal.” *See, e.g.*, Trainin, 1:14-23. Trainin also describes that in a “MIMO (or, beamforming) system a data signal is modified by a beamforming matrix” that is “developed from information . . . fed back from a remote receiver.” *See, e.g., id.*, 3:4-32; *see also id.*, 2:67-3:3 (describing MIMO devices).

76. Trainin describes “a feedback generation mechanism” at a receiver station to “support the communication of the channel state information” to a transmitter station. *See, e.g., id.*, 3:39-42, 3:66-4:4. According to Trainin, “the feedback generation mechanism uses a data structure to “respond and/or convey channel state information, e.g., in support of dynamic link adaptation, beam forming, etc.” *Id.*, 3:43-47.

77. Trainin describes that the data structure “may be implemented within the physical layer convergence protocol (PLCP), e.g., within PLCP protocol data unit(s) (PPDU).” *See, e.g., id.*, 3:47-50. For example, Trainin describes a data structure with “an HT-control field [that] maybe included in any HT frame except a non-QoS Data frame.” *See, e.g., id.*, 4:19-25. “The presence of the HT-control field in frames carried in a HT physical layer convergence procedure (PLCP) protocol data unit (PPDU) may be indicated by setting an order bit in a MAC header.” *See, e.g., id.*, 4:22-26. Trainin also teaches that the HT-control field “is last in the MAC header.” *Id.*, 4:25-26. Included in the HT-control field is link adaptation control (LAC) information. *See, e.g., id.*, 4:20-67 (B0-B15 of HT-control field for LAC). Tables reproduced below show the LAC definitions in the HT-control field:

30

TABLE

Example HT Control field format

35	B0-B15 Link Adaptation Control	B16-19 Calibration Control	B20-21 Feedback request	B22-31 Reserved
	#Bits 16	4	2	10

40

TABLE

Link Adaptation Control field

	B0 XT	B1 TRQ	B2 MRQ	B3-B5 MRS	B6-B8 MFS	B9-15 MFB
45	#Bits 1	1	1	3	3	7

Subfields of the Link Adaptation Control Field May Include:

50

TABLE

Link Adaptation Control Subfields

Field	Meaning	Definition
XT	Extension	'1' = body of QOS data + HTC is used for calibration or CSI feedback.
55	TRQ	Sounding Request '1' = Request to responder to transmit a sounding PPDU
	MRQ	MCS Request '1' = Request for MCS feedback
	MRS	MRQ Sequence Identifier Set by sender to any value in the range '000'-'110' to identify MRQ. Invalid if MRQ = '0'
60	MFS	MFB Sequence Identifier Set to the received value of MRS. See note. Set to '111' for unsolicited MFB
	MFB	MCS Feedback Also, set to '111' when MFB is all-ones Link adaptation feedback containing recommended MCS
65		Default "all-ones" value indicates no feedback or not available

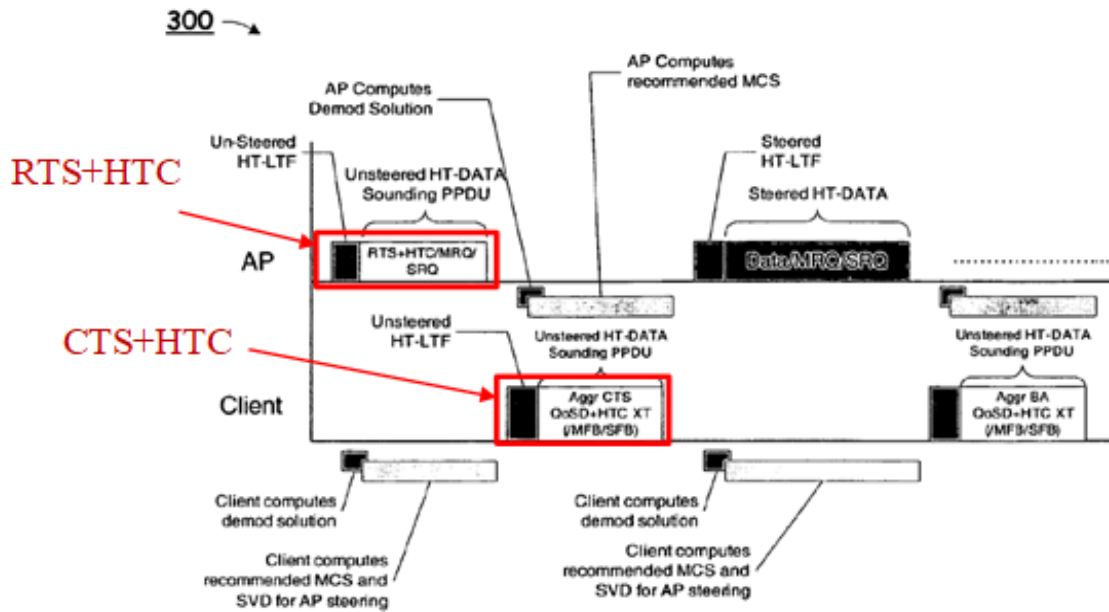
MRS = 111 undefined

Trainin, 4:30-67 (annotated)

Trainin teaches that the LAC field includes an MRS subfield, where MRS=111 is undefined. *Id.*, 4:30-67, above Table.

78. Among the frames that Trainin teaches as including an HT-control field is an RTS frame. *See, e.g., id.*, FIG. 3. As shown in FIG. 3, a transmitter can send an RTS + HTC frame to a receiver:

FIG. 3



Trainin, FIG. 3 (annotated)

A POSITA would recognize from this disclosure that “RTS+HTC” refers to the RTS subtype MAC frame, but with a MAC header that includes the HT-control field (+HTC) taught by Trainin. Request to Send (RTS) was one of the well-known valid control frame subtypes, specifically subtype code 1011. 802.11-1999, Table 1, §7.2.1.1, And, as I explain above, Trainin discloses +HTC teaches an HT-control field in the MAC header of the frame As seen above, Trainin also teaches that the well-known CTS subtype frame, 1100, includes an HT-control field.

Trainin, FIG. 3.

C. The 802.11e-2005 Standard Specification

79. The 802.11e-2005 specification (“802.11e”) was published on November 11, 2005, but was in development dating back to at least November 2003. 802.11e-2005, 1; 802.11e-D6.0, 1. The release of 802.11e included MAC Quality of Service (QoS) enhancements as amendments and additions to 802.11-1999.

802.11e-2005, 1. The amendments included an additional field in the MAC header for QoS Control. 802.11e-2005, §7.1.2, Figure 12. The QoS Control field would be present in QoS data subtypes. *Id.*, §7.1.3.1.2 (defining QoS data subtypes, including QoS-null (no data)); 802.11e-D6.0, §7.1.3.1.2.

80. The QoS Control field was an additional 16 bits added to the MAC frame used to identify the traffic category or traffic stream to which the frame belongs.

Id., §7.1.3.5. “The QoS Control field is present in all data frames in which the QoS subfield is set to 1.” *Id.* The QoS Control field also included a field for setting ACK policy. *Id.* For QoS-null frames, the “Normal Ack” was the only permissible ACK policy. *Id.*, §7.1.3.5.3.

81. The *QoS (+)Null frame* refers to all three QoS data subtypes with “no data”: the QoS-null (no data) frame, subtype 1100; the QoS CF-Poll (no data) frame, subtype 1110; and the QoS CF-Ack+CF-Poll frame, subtype 1111. 802.11e-2005, §7.1.1.

82. 802.11e-2005, as well as the original 802.11-1999 specification, were well-known and widely used documents in the field of wireless networks. 802.11e-2005 was approved and made available to the general public around November 11, 2005. Its public availability as of November 11, 2005, is evident from the document itself which bear copyright notices, copyright dates, publication dates, and ISBN numbers. 802.11e-2005, 1, 4-5. This publication date is corroborated by, for example, the IEEE Standards Association webpage for the standard. IEEE 802.11e-2005 website, <https://standards.ieee.org/ieee/802.11e/3131>. It was the practice of the IEEE Standards Association that, once approved by voting members, to distribute the approved standards to voting members and to make the standard obtainable to the general public at least through its website promptly upon the indicated publication date. I was a voting member of the balloting committee that voted on approval of 802.11e-2005. I personally obtained an electronic copy of 802.11e-2005 in November 2005 shortly after it was approved. The IEEE makes its approved standards, including 802.11-1999 and 802.11e-2005 (as well as some unapproved drafts), available for purchase and download by the public at the home page for the IEEE Standards Association, <http://standards.ieee.org/>. The IEEE also offered pre-paid online subscription access that allowed any individual to download any approved standard, as well as some unapproved drafts that members of the ballot committee voted to make available to the general public. The IEEE

Standards Association maintained at its website a catalog for pre-paid users of its online subscription access where the approved standards and publicly available drafts were available for download by the public. Except for the requirement of payment, there were no other restrictions on who could obtain a copy of approved standards. POSITA researching wireless networks widely understood that IEEE adopted standards could be obtained through the IEEE Standard Association's home page.

D. Hansen

83. Hansen is titled "Transmitting High Rate Data Within a MIMO WLAN," and was filed on October 26, 2004. I am the first named inventor on this patent application. Hansen is directed to wireless communication system that operate in accordance with IEEE 802.11, among other technologies. *See, e.g.,* Hansen, [0005]. Hansen provides a summary of 802.11 technology, and an overview of how wireless communications devices communication with each other in independent basic service set networks. *See, e.g., id.,* [0006]-[0011], [0032]-[0046]. Hansen describes the wireless communications devices (also referred to as host devices 18-32) can be "a cellular telephone, two-way radio, personal digital assistant (PDA), personal computer (PC), laptop computer, home entertainment equipment, etc." *Id.,* [0006], [0032]. "For each wireless communication device to participate in wireless communications, it includes a built-in radio transceiver . . .

.” *Id.*, [0007], [0036] (describing that each host device 18-32 includes an associated radio 60, which can be built-in), [0038] (describing radio interface for sending and receiving data by the radio). The radio includes a baseband processing module 64 and memory 66. *See, e.g., id.*, [0039]. “The baseband processing module 64, in combination with operational instructions stored in memory 66, execute digital receiver functions and digital transmitter functions, respectively.” *Id.* Hansen describes the memory device as being “a read-only memory, random access memory, volatile memory, non-volatile memory, static memory, dynamic memory, flash memory, and/or any device that stores digital information.” *Id.*

84. Hansen describes that part of the evolution of 802.11 devices was the introduction of multiple input / multiple output configurations that employ a number of transceiver antennas. *See, e.g., Hansen*, [0012]-[0013]. To employ MIMO devices, Hansen describes beam forming considerations and channel sounding. *See, e.g., Hansen*, [0085]-[0108].

VII. MANNER IN WHICH THE PRIOR ART REFERENCES RENDER THE CHALLENGED CLAIMS UNPATENTABLE

A. Ground 1A: Claims 1-5, 16-20, 22-30, 38-41 are obvious in view of Gu & Trainin

1. The Gu-Trainin Combination

85. Gu teaches the LAC functionality for indicating forthcoming PHY sounding frames is located in a LAC frame or in the HT-control field of any MAC layer frame.

86. In the combination, the HT-control field of Gu, which includes the LAC functionality for indicating forthcoming PHY sounding frames, is located in a MAC header field of any MAC layer frame, in a manner similar to that taught by Trainin.

87. In addition, the HT-control field of Gu, which includes the LAC functionality for indicating forthcoming PHY sounding frames, can also be located in a MAC header of an RTS frame. This is also performed in a manner similar to that taught by Trainin.

2. Motivation to Combine Gu & Trainin

88. A POSITA would have been motivated to combine the teachings of Gu with those of Trainin to provide Gu with details for its embodiment including LAC functionality in the HT-control field. Gu teaches that the LAC field can be in the HT-control field of “any MAC layer frame.” Gu, 1:62-65. But Gu does not provide complete details about the HT-control field or disclose specific MAC layer frames that may be useful with the HT-control field for indicating PHY sounding packets. By the time of the filing of Gu, practitioners developing the 802.11n standard had made proposals to extend the MAC header to include a High Throughput (HT) control field to enable new functionality. Gu attempted to incorporate by reference a proposal for the HT-control field uploaded to the IEEE servers, but Gu did not set out the details directly within its specification. Gu, 2:31-

33. Trainin discloses missing details from these proposals. *See, e.g.*, Trainin, 4:19-

65. A POSITA would have recognized that Gu’s teachings of transmitting an indication of the antenna / beam selection sounding frames would have benefited from details disclosed by Trainin.

89. A POSITA would have found it obvious to combine Gu and Trainin. First, both Gu and Trainin are in the same field of endeavor. Both teach improvements to 802.11 arising from the development of the 802.11 standard. Gu describes antenna / beam selection techniques for MIMO wireless LANs, and in particular, methods for indicating and transmitting sounding packets. *See, e.g.*, Gu, 1:16-54, 2:36-42, 3:44-4:4. Likewise, the devices contemplated by Trainin are MIMO devices that perform beam forming using channel sounding techniques. *See, e.g.*, Trainin, 1:54-61, 2:67-3:31.

90. The teachings of Gu and Trainin regarding the HT-control field are complementary. A POSITA would have had a reasonable expectation of success combining the indication of PHY sounding of Gu with the HT-control field of Trainin because Trainin also teaches a MAC header with an HT-control field that has a LAC field. Trainin, 4:30-67. Trainin’s LAC field includes an MRS subfield, where MRS=111 is undefined. *Id.*; *see also* Gu, 6:64-67 (“The prior art HT-control field does not define the bit combination of “111” in MRS. . . . “111” in MRS functions as the ASI in LAC frame.”). Therefore, a POSITA would have been able

to define the MRS=111 as the indication of PHY sounding packets, as taught by Gu, into the LAC field of Trainin without any undue experimentation. And since Trainin also teaches that the HT-control field is included in “any” HT frame, a POSITA would have understood that the ASBFC payload could have been encoded into the frame body. Gu also teaches reuse of the existing MRS field for ASI. *See, e.g.*, Gu, 6:10-23, 10:4-8; Thus, a POSITA would have had a reasonable expectation of success reusing the MRS field of either Gu or Trainin to define an ASI bit as an indication of forthcoming PHY sounding frames. *See, e.g., id.*, 6:10-23. A POSITA would have found it obvious to implement new functionality by providing a new meaning to reserved bits in a MAC header field.

91. Trainin explains that the HT-control field was intended to be a possible extension to the fields of the 802.11 MAC header. Trainin teaches that a station would understand that an HT-control field was present by the setting of the order bit, which is a flag in the MAC header of a HT PPDU. Trainin, 4:22-26; 802.11-1999, §7.1.3.1. This further shows that a POSITA would have reasonable expectation of success implementing the HT-control field in the header of any MAC frame in Gu. Gu does not specify where the HT-control field is located. A POSITA would have turned to other teachings to identify where the HT-control field bits were in the MAC frame so that they would be decoded accurately. The MAC frame’s data payload in Gu was occupied by other information, Gu, 6:15-16,

so a POSITA would have found it obvious to include the HT-control field in the MAC header. Adding the HT-control field to the MAC header would have been met with a reasonable expectation of success because that was a bit encoding that was an available and accepted option for constructing the MAC layer frame. *See* 802.11e-2005, §7.1.2, FIG. 12 (showing expanding the MAC header with additional bit mapping for optional QoS Control information).

92. A POSITA would have expected to be successful in adding a field to existing MAC frame headers to support important new functionality like this. For example, the IEEE 802.11e standard previously successfully incorporated a new “QoS Control” field in the MAC header to support important quality of service (QoS) requirements for the transport of voice, audio, and video. 802.11e, §§1.2, 7.2.2, Fig. 22. A focus of the 802.11n working group was modifications to the MAC layer for “supporting MIMO training requests and exchange of link adaptation information.” Gu, 1:57-62. Thus, as Gu recognizes, by the time of its filing, the addition of an HT-control field to MAC frames (and specifically, MAC headers) to support link adaptation training had already been proposed. *Id.*, 2:22-33, 6:64-67 (“prior art HT-control field”); *see also* Trainin, 4:20-23 (describing that “an HT-control (HTC) field may be included in any HT frame except a non-QoS Data frame”).

93. Additionally, although Gu teaches that “any MAC layer frame” can be used for its method, it only provided an example of a new LAC frame and did not provide any examples of previously known subtypes. A POSITA would have known of the various available subtypes for a MAC layer frame with which Gu could be implemented, and that RTS was a known MAC layer frame. *See, e.g.*, 802.11-1999 at 36 (Table 1). Trainin provides this specific example. A POSITA would have found it obvious that the “any MAC layer frame” of Gu could specifically be an RTS frame, as taught by Trainin. A POSITA would have found it obvious to include the transmit announcement indication (ASI bit) of Gu in “any MAC layer frame,” such as an the well-known RTS frame subtype. Trainin, FIG. 3; 802.11-1999, §7.1-7.2.1.3; Gast, 36-37. A POSITA would have recognized an RTS subtype frame to be one of the well-known MAC layer frames. Gu already contemplates using RTS/CTS in its antenna/beam selection method. Gu teaches that LAC functionality can be realized by an HT-control Field incorporated into any MAC layer frame. Gu, 1:60-65. Given that Gu already contemplates using RTS/CTS for its antenna/beam selection method, a POSITA would have found it obvious to modify an RTS subtype frame of “any MAC layer frame” to include an HT-control field, as described expressly by Gu. Gu provides motivation for this modification by an explicit instruction to modify any MAC layer frame. *Id.*, 1:62-65, 13:5-18. Trainin likewise teaches that the HT-control field can be in the MAC

header of any MAC frame. *See, e.g.,* Trainin, 4:19-29. Considering the teaching of both Gu and Trainin, a POSITA would have had a reasonable expectation of success including the LAC functionality with the indication of PHY sounding packets of Gu in the RTS+HTC frame of Trainin.

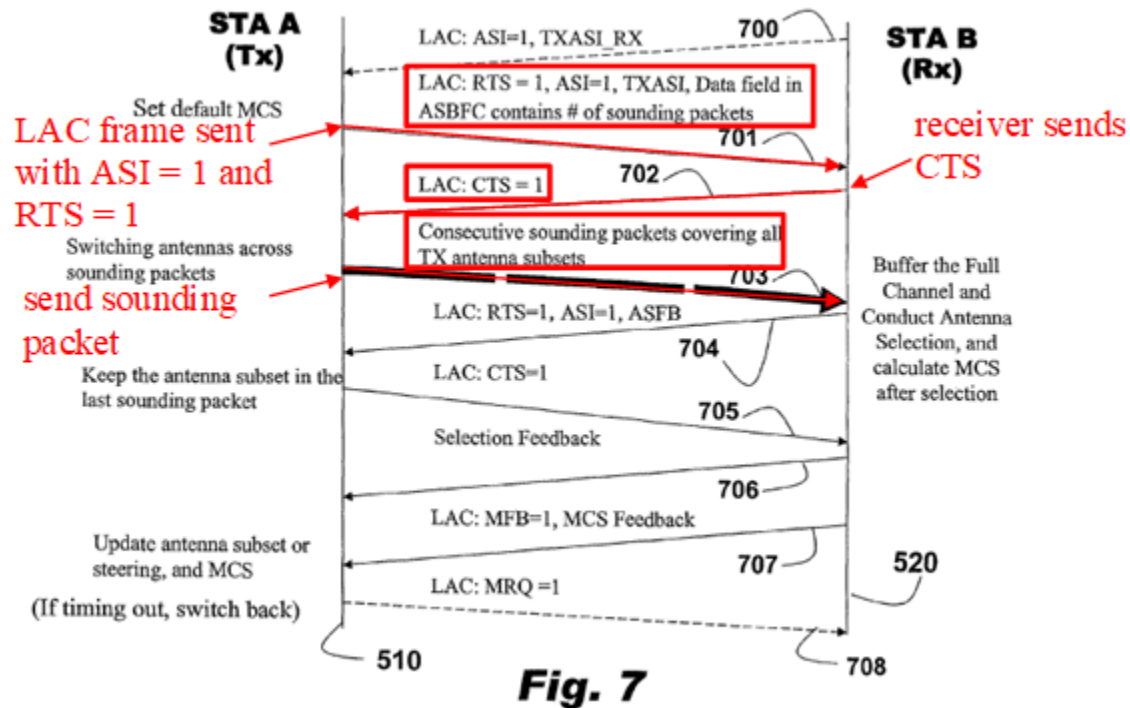
94. Gu further teaches that the ASI bit “indicating an antenna/beam selection training frame” can be used in “any similarly defined signaling frame in a MAC layer that allows a fast communication between the transmitter and receiver.” Gu, 13:6-8. A POSITA would have recognized an RTS frame to be a “highest-priority” transmission. *See, e.g.,* Gast, 16. Accordingly, a POSITA would find a frame of RTS subtype to be an ideal candidate for Gu’s teaching and would have found it obvious from the teachings of Gu to include an HT-control field in an RTS frame, as described expressly by Gu.

3. Analysis

[1.pre] A method comprising:

95. Gu teaches a transmit antenna/beam selection training method. *See, e.g.,* Gu, 3:44-46, 4:1-4, 7:11-67, FIG. 7. In a specific embodiment, “Figure 7 shows the details of the training method with [fast link adaptation control] LAC frame according to an embodiment of the invention.” *Id.*, 7:38-39; *also id.*, 4:23-25 (“Figure 7 is a flow diagram of the training for transmit antenna/beam selection

according to an embodiment of the invention.”). Gu’s FIG. 7 shows the details of the training method with LAC frame:



Gu, FIG. 7 (annotated)

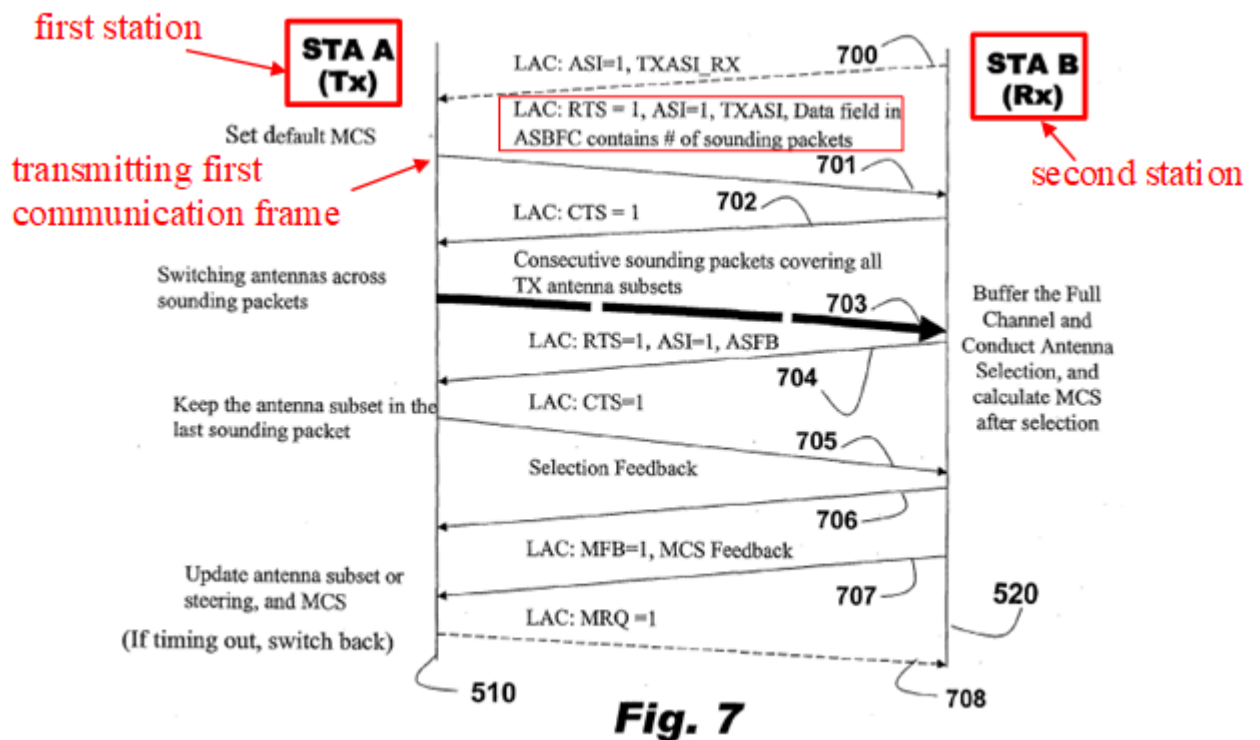
96. Gu also expressly teaches that the indication of at least one antenna/beam selection training frame can be realized by an HT-control Field in “any MAC layer frame,” and the “extension to training using the HT-control field is straightforward.” *Id.*, 1:62-65, 10:4-5. In the context of FIG. 7 above, “LAC” should be replaced by ‘HT-control Field’; ‘ASI=1’ should be replaced by “MRS=111” or ‘ASI=1’ for the case ASI is used to indicate a reuse of the MFB field.” *Id.*, 10:4-8. Thus, Gu expressly teaches a transmit antenna / beam selection

training method that uses “any MAC layer frame,” where the LAC functionality is encoded in the HT-Control Field.

[1.1] transmitting a first communication frame from a first station to a second station;

97. Gu describes transmitting a first communication frame (LAC frame or any MAC layer frame) from a first station (STA A) to a second station (STA B).

Specifically, Gu teaches that the transmitter “sends 701 a LAC frame with ASI = 1 and the command TXASI.” Gu, 7:46-51. “The Data part of the field indicates the number of consecutive sounding packets that will be transmitted for training, with RTS = 1 in the LAC mask field 120.” *Id.*



Gu, FIG. 7 (annotated)

The LAC frame is shown in [1.2], *infra*.

98. For “any MAC layer frame,” in FIG. 7 above, “‘LAC’ should be replaced by ‘HT-control Field’; ‘ASI=1’ should be replaced by ‘MRS=111’ or ‘ASI=1’ for the case ASI is used to indicate a reuse of the MFB field.” *Id.*, 10:4-8.

99. Note that the receiver station STA B can request a LAC frame to initiate the antenna/beam selection process, after having monitored channel quality. *Id.*, 7:40-

45. A POSITA would have recognized that such a request would mean that the receiver station STA B should then expect the LAC frame and subsequent sounding.

[1.2] wherein the first communication frame comprises an address of the second station and a transmit announcement indication indicating that a second communication frame intended for the second station will follow the first communication frame and

100. Gu’s transmitter sends a first communication frame (LAC frame or any MAC layer frame). The LAC frame includes a receive address (RA) 113 (address of the second station). According to Gu, “The LAC frame supports control of MIMO training requests and exchange of link adaptation information.” Gu, 2:10-11. “Figure 5C shows the structure of a link adaptation control (LAC) frame according to an embodiment of the invention.” *Id.*, 6:10-12. Figure 5C is shown below:

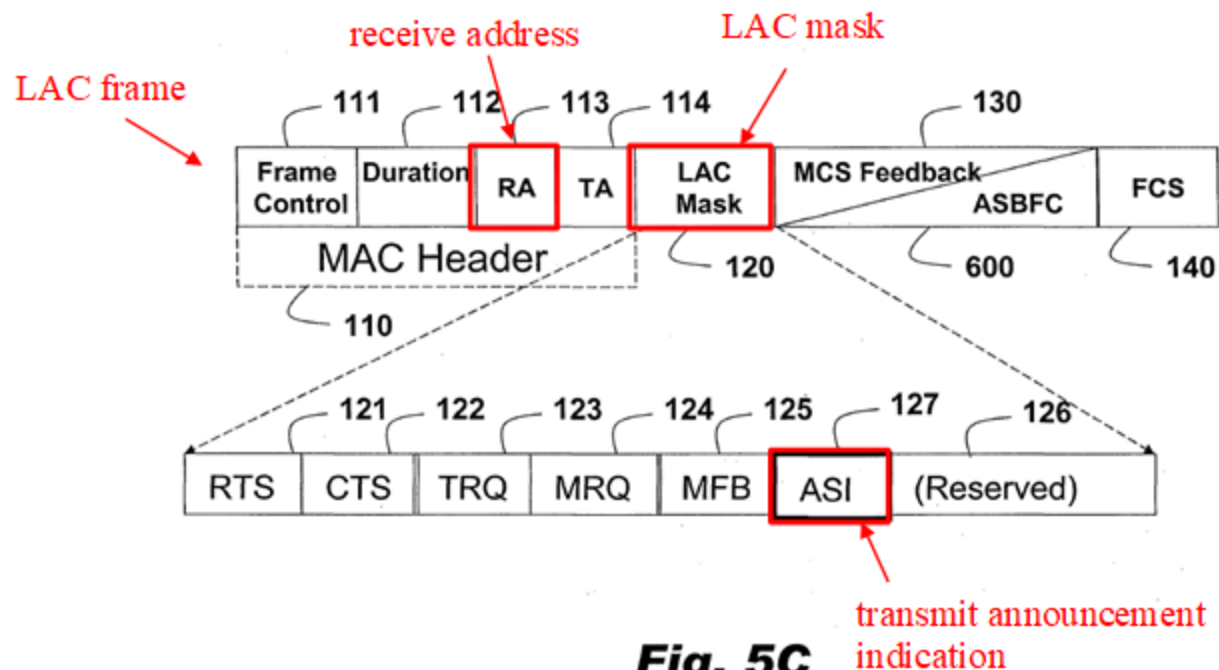


Fig. 5C

Gu, FIG. 5C (annotated)

The LAC frame includes a receive address (RA) 113. The receive address (RA) 113 is the address of the second station.

101. The transmit announcement indication is the ASI field 127. *See, e.g., id.*, 7:46-54. When ASI is set to 1, then field 130 is used for antenna/beam selection/transmitter beam forming control (ASBFC). *Id.*, 6:14-18. Thus, the ASI bit set to 1 indicates to the second station to expect sounding packets.

102. The LAC mask has an ASBFC Command 610 and a Data portion 620, as shown in FIG. 6 below:

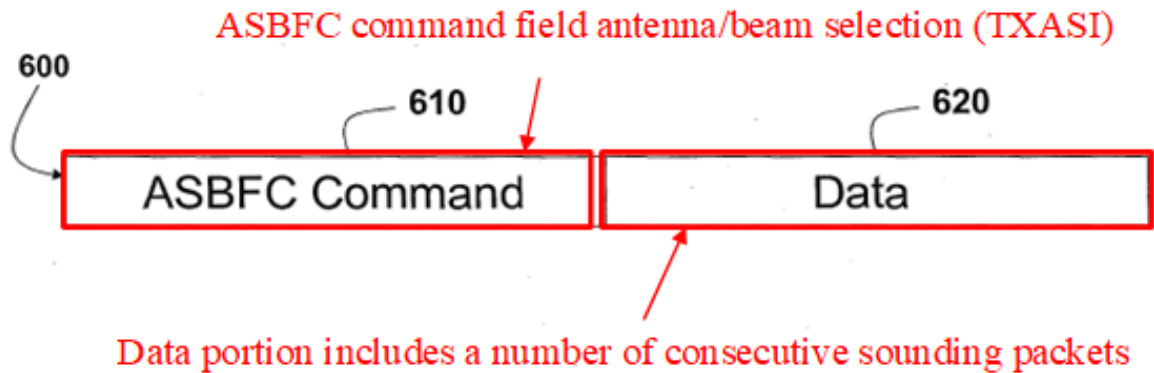
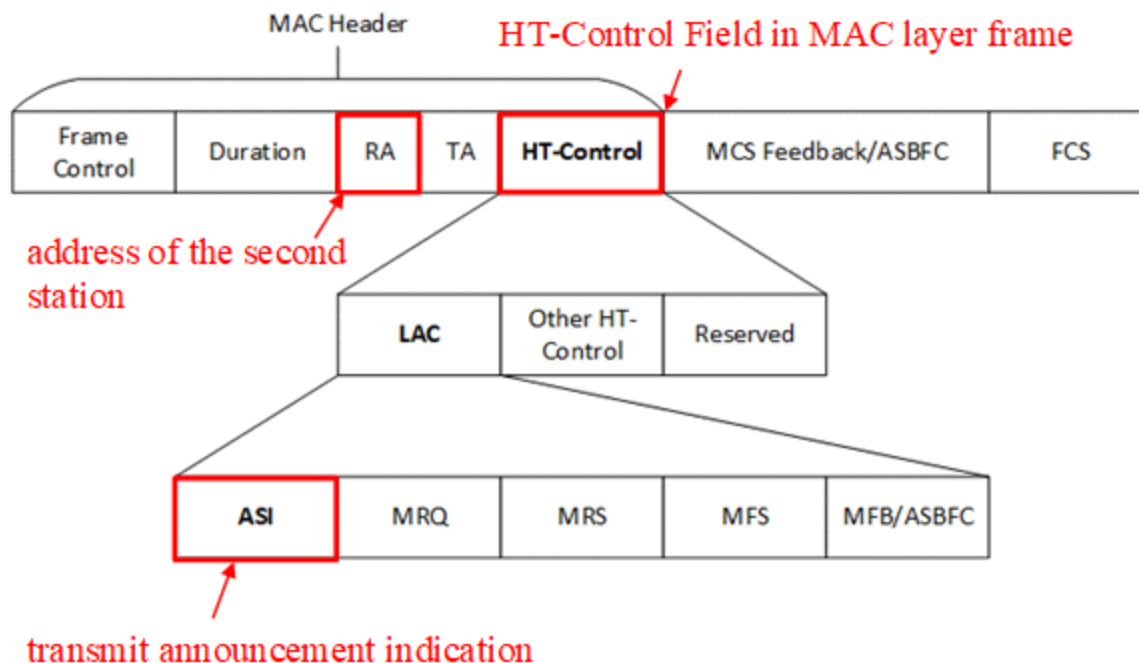


Fig. 6

Gu, FIG. 6 (annotated).

When ASI is set to 1, the second station (STA B) decodes the ASBFC field, which indicates how many consecutive sounding packets that are forthcoming. *See, e.g., id.*, 6:9-11, 6:14-18, 6:44-46, 7:46-54. Therefore, ASI set to 1 is a transmit announcement indication indicating that one or more second communication frames intended for the second station will follow the first communication frame. *Id.*, 6:9-11. The data portion of the ASBFC field indicates the number of multiple consecutive sounding packets that the second station will receive. *See, e.g., id.*, 6:9-11, 6:14-18, 6:44-46, 7:46-54.

103. For any MAC layer frame, the first communication frame can include the following frame structure:



Gu, MAC Layer Frame with LAC functionality in HT-Control Field, Gu, 1:60-65, 6:52-7:10, 10:4-8, FIGS. 5C, 7, 12.

The ASI is set to 1 when reusing the MFB field for the ASBFC. Gu, 10:4-8.

Alternatively, the MRS field set to 111 provides the same indication. *Id.* The

Frame Control field can indicate the RTS subtype. *See, e.g.,* Gast, 19-20, 36-37.

[1.3] that the second communication frame will not include the address of the second station, and

104. Gu's teachings render [1.3] obvious. First, the ASI bit is set to indicate to the second station (STA B) that a second communication frame (a sounding frame) intended for the second station will follow the first communication frame (the LAC frame or any MAC layer frame). *See, supra*, [1.2]. It would have been obvious to a POSITA from the teachings of Gu that the ASI bit acting as a transmit

announcement indication indicates that the second communication frame will not include the address of the second station (STA B).

105. First, as already discussed, the ASI bit being set indicates to the second station that it should expect sounding packets. *See, supra*, [1.2]. In addition, Gu expressly teaches that the sounding packets can be PHY packets that are limited to a preamble and header without a data portion. *See, e.g., id.*, 5:11-12 (“For example, the sounding packets can be limited to a preamble and a header, and exclude any data.”). A POSITA would have understood that a PHY packet without data would include a PHY header but not include a MAC portion or MPDU, which is the part of the packet that would contain the receiver address. *See, e.g.*, 802.11-1999, §7.3.3.6; *see also*, Gu, FIGS. 1, 5C; *see also* ’122 patent, 4:57-60 (describing a “PHY header without MAC portion . . . may also be referred to as a zero-length frame or Null Data Packet (NDP)). First, because Gu already alerts the second station of sounding, an address is not needed in the sounding packets. In addition, Gu teaches that such sounding packets (without data) are advantageous for decreasing the time required for sounding by minimizing the size of the sounding packet. Gu, 5:9-12.

106. Next, Gu expressly teaches that the sounding packets are PHY layer packets that are “limited to a preamble and header, and exclude any data.” *Id.*, 5:11-12. A POSITA would have understood that a PHY layer packet without a data portion

would have excluded a MAC portion, which included the receiver address. Thus, Gu describes an alternative embodiment where sounding packets are zero-length frames. *Id.*, 9:24-25 (“If the sounding packets contain no data, which is an alternative option”). A POSITA would have understood that in Gu’s embodiment where only zero length frames are transmitted for sounding, the ASI bit set indicates that the sounding packets are zero-length frames, which naturally do not include the address of the receiver. Sounding frames employ a format that is known to both the transmitter and the receiver, typically as described in a standard. The transmitter will transmit the sounding frames according to the standard format, and the receiver will use its understanding of the format for interpreting the signals in the received sounding frame. Thus, the expectation of receiving zero-length frames for sounding could be understood by both the transmitter and receiver from the ASI bit being set.

107. I note that the meaning of the “transmit announcement indication” here, as well as in other claim limitations where it appears in the ’122 patent, does not have any effect upon the claimed methods or apparatuses. At best, the claims recite how practitioners should define in a standard the meaning of certain bits in a frame. *See, e.g.*, ’122 patent, 6:8-17 (defining a bit in the HT control field to represent a TxA). The claims do not contain any requirement that any station behave in particular any way in response to the transmission of a frame containing the claimed “transmit

announcement indication.” For claim 1 (and the other independent claims), what matters is that the second communication frame is a ZLF (e.g., a PHY frame without MAC portion) and does not include the address of the second station. In Gu, the second communication frame (sounding packet) meets the definition of a ZLF because it is a PHY frame without a data (e.g., MAC) portion. *See, e.g.,* Gu, 5:11-12. When the second station (STA B) receives the first communication packet (LAC frame in Gu), the second station expects to receive one or more sounding packets, which will not include the address of the second station.

[1.4] wherein the second communication frame follows after a short inter frame space (SIFS) after the first communication frame with the transmit announcement indication.

108. Gu teaches or renders obvious [1.4]. In Gu, the LAC frame is transmitted by the first station (i.e. the transmitter) with a request-to-send (RTS) field set. *See, e.g.,* Gu, 7:46-51, FIG. 5C (RTS 121), FIG. 7 (701 LAC: RTS=1, ASI=1). In response, the second station (STA B) transmits a clear-to-send (CTS) message. *See, e.g., id.,* 7:52-54, FIG. 7 (702 CTS=1). After receiving the CTS=1, “the transmitter sends 703 consecutive sounding packets.” *Id.,* 7:60-63, FIG. 7 (703 consecutive sounding packets).

109. Because Gu uses RTS/CTS, a POSITA would have known or found it obvious to separate transmissions belonging to the link adaptation dialog using SIFS. *See, e.g.,* Larsson, [0085]. Using SIFS in the RTS/CTS dialog was a well-

known, standard practice at the time. *See, e.g.,* Larsson, [0085], 802.11-1999, §9.2.3 (“The SIFS shall be used for . . . a CTS frame”); Gast, 16-17. My understanding is that an obviousness analysis requires an assessment of background knowledge possessed by a POSITA. Here it is evident that a POSITA would have recognized SIFS for RTS/CTS dialogs; and specifically that the transmission indicated by an RTS frame was sent after a SIFS following the CTS. Specifically, it was well known at the time that “SIFS is used for the highest-priority transmissions, such as RTS/CTS frames” Gast, 16. Thus, a POSITA would have known that the sounding packets (second communication frame) are transmitted after a SIFS following the transmission of the LAC frame (the first communication frame).

110. A POSITA would have also found it obvious to wait for a SIFS prior to transmitting the second communication frame when the ASI transmit announcement indication was encoded in any MAC layer frame. As mentioned already, the use of SIFS was a well-known and standard practice at the time. Specifically, IEEE 802.11 had standardized and required that “SIFS *shall* be used when STAs have seized the medium and need to keep it for the duration of the frame exchange sequence to be performed.” 802.11-1999, §9.2.3 (emphasis added). It would have been obvious to a POSITA that the multiple consecutive sounding packets would have been transmitted after a SIFS following the “MAC

layer frame” so that the antenna/beam selection procedure could be completed before another STA would sense the medium and vie for channel contention.

111. Gu also teaches that the “invention can be used for any similarly defined signaling frame in a MAC layer that allows a fast communication between the transmitter and receiver.” Gu, 13:6-8. “Preferably, the sounding packets are transmitted with a relatively short delay.” *Id.*, 5:8-9. Thus, a POSITA implementing such MAC layer signaling would have found it obvious to transmit sounding packets following a SIFS, which a POSITA would have known was “the shortest of the interframe spaces.” 802.11-1999, §9.2.3. Thus, the general embodiment where Gu encodes the transmit announcement indication in “any MAC layer frame,” a POSITA would have found it obvious to transmit sounding packets after a SIFS.

[2]² The method of claim 1, wherein the transmit announcement indication comprises a zero-length frame.

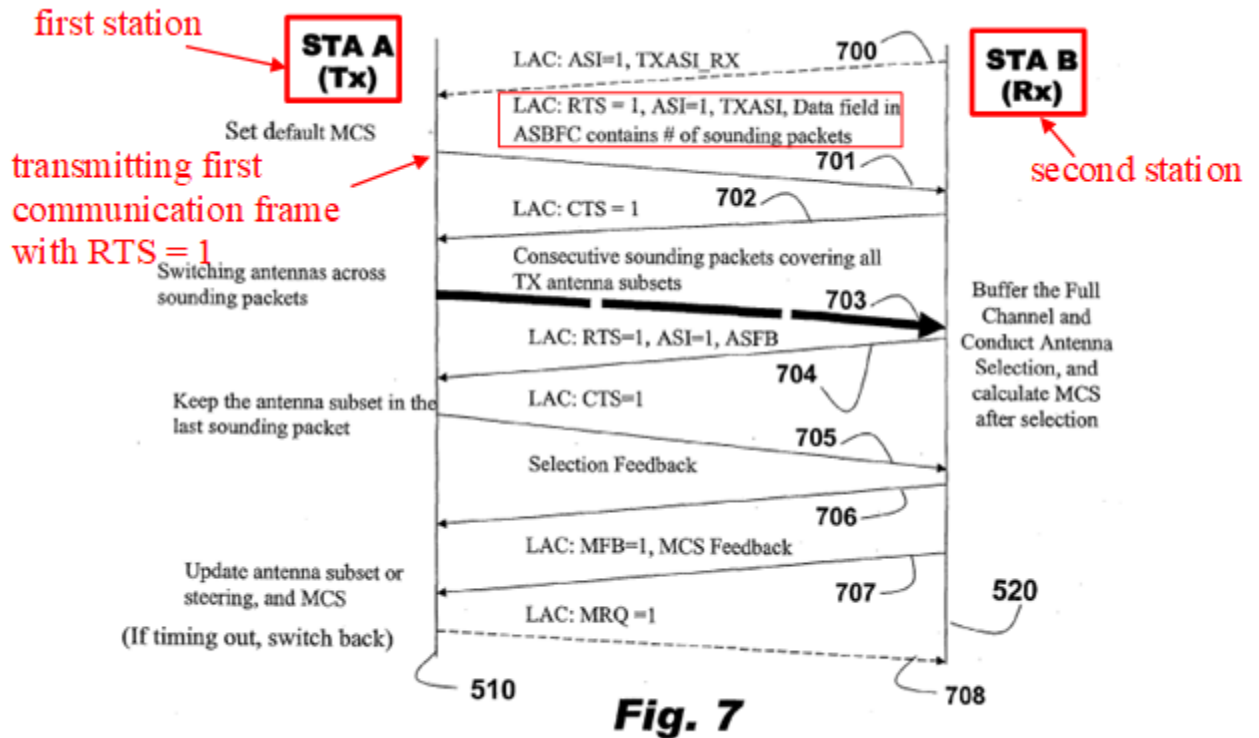
² Should the Board determine that this limitation requires that the “indication” itself be a ZLF, claims 2 and similar claims 12, 17, 28, 35, and 39 are indefinite. The first communication frame cannot include an address of the second station (as required by the independent claim) and also comprise a ZLF because a ZLF is

112. Gu teaches that the frames indicated by the transmit announcement indication comprise zero-length frames because the sounding packets are PHY layer packets that do not include a MAC portion. *See, e.g.*, '122 patent, 4:57-60 (defining a ZLF as “a PHY header without MAC portion”); Gu, 2:49, 5:11-12 (describing the sounding packets as “a specific PHY layer packet” that “can be limited to a preamble and header, and exclude any data”).

[3] The method of claim 1, wherein transmitting the first communication frame comprises providing the transmit announcement indication with a request to send (RTS) frame.

113. *See, supra*, [1.1]-[1.4]. Applying the petitioner’s construction for RTS frame, Gu satisfies this limitation. For example, Gu teaches that the first station (STA A) sends, and the second station (STA B) receives, the first communication frame (LAC frame) that includes a transmit announcement indication (ASI bit set) and a request-to-send (RTS) bit set. Specifically, Gu teaches that the transmitter “sends 701 a LAC frame with ASI = 1 and . . . with RTS = 1 in the LAC mask field 120.” Gu, 7:46-51, FIG. 7 (701):

defined as a PHY header without a MAC portion. The MAC header is where the frame would include the address of the second station that is the intended recipient.



Gu, FIG. 7 (annotated)

Setting RTS=1 in the LAC frame results in an RTS frame because the RTS field indicates “request to send,” and the RTS being set silences unaddressed stations and causes the second station (STA B) to return a “clear to send” (CTS) message. Gu, 2:14-19; 7:52-53, FIG. 7 (702). An RTS frame is a frame sent by a transmitter that indicates “ready to send” request, which may be followed by a “clear to send” response (which is a CTS frame), gaining control over the medium and silencing other stations. ’122 patent, 5:19-31; Gast, 13; *see also* TGn Sync Proposal, §6.2.1.2.1 (RTS set turns LAC frame into RTS).

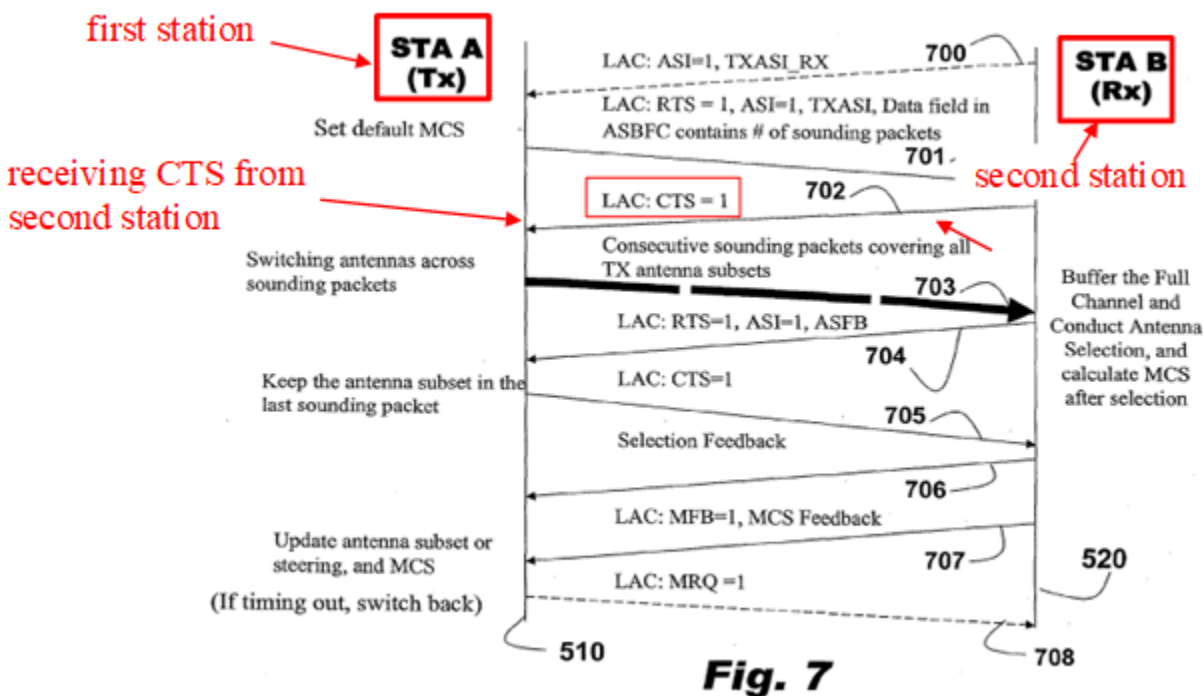
114. Furthermore, Gu teaches that the LAC frame (like other MAC layer frames) includes a MAC header with a duration field 112. Gu, 2:4-9. A POSITA would have recognized that the duration field of a MAC header is used for setting a NAV timer, as is done when receiving RTS frames. *See, e.g.*, Gast, 14. In addition, as mentioned already, the MAC header includes a receive address (RA) field 113. Gu, 2:4-9. A POSITA would have recognized that the RA field 113 would address a specific station. A POSITA would have understood that a frame that includes an RTS bit set that also includes a duration field for the NAV timer and an RA field to identify a receiver were used to initiate an RTS/CTS dialog with the identified receiver. *Id.* In addition, these fields were also sufficient for unaddressed receivers to set their NAV timers and wait for the end of the RTS/CTS dialog before contending for the medium. *Id.*

115. Applying a narrower construction of the RTS frame term (where the RTS frame is an RTS subtype frame), the Gu-Trainin combination renders this limitation obvious. In the Gu-Trainin combination, the LAC functionality with the indication of PHY sounding packets of Gu is provided in an HT-control field of a MAC header of an RTS subtype frame, as taught by Trainin. Gu teaches that the “LAC functionality can be realized either by a single control frame defined as LAC, or the single control frame can be a High Throughput (HT) Control frame, or a HT-control Field can be incorporated into any MAC layer frame.” *Id.*, 1:60-65.

Trainin teaches that the HT-control field “is last in the MAC Header.” Trainin, 4:25-27. Trainin also teaches an RTS subtype frame with an HT-control field. *Id.*, FIG. 3.

[4] The method of claim 3, further comprising receiving, by the first station, a clear to send (CTS) frame from the second station after the first station has transmitted the transmit announcement indication with the RTS frame.

116. See, *supra*, [1.1]-[1.4], [3]. Under the proposed constructions, Gu teaches claim [4]. Gu teaches that the first station (STA A) receives a CTS frame sent from the second station (STA B). Gu, 7:52-53 (“Upon receiving the LAC frame, the receiver sends 702 a LAC frame with CTS=1.”); FIG. 7 (701, 702).



Gu, FIG. 7 (annotated)

Setting CTS=1 results in a CTS frame because the CTS field indicates “clear to

send,” establishing the RTS/CTS dialog for gaining control over the medium. ’122 patent, 5:19-31.

117. Under a narrower construction of CTS frame, the Gu-Trainin combination renders this limitation obvious. A POSITA would have recognized that, upon receiving an RTS subtype frame from the first station, the second station would respond with a CTS subtype frame. *See, e.g.*, Gast, 36-39. The RTS/CTS technique was well known at the time for reserving the wireless medium for a transaction. *See, e.g.*, Gast, 36-39; 802.11-1999, §§9.1-9.2.3.

[5] The method of claim 4, further comprising transmitting the second communication frame from the first station to the second station, wherein the second communication frame does not include the address of the second station.

118. *See, supra*, [1.3]. Gu teaches [5]. In Gu, after receiving the CTS frame from the second station (STA B), the first station (STA A) sends consecutive sounding packets. *See, e.g.*, Gu, 7:60-63, FIG. 7 (703). As discussed above, Gu expressly teaches that, in some embodiments, the sounding packets are PHY packets without data. *See, e.g., id.*, 5:11-12 (“For example, the sounding packets can be limited to a preamble and a header, and exclude any data.”). A POSITA would have understood that a PHY packet without data would not include a MAC frame, which is the portion of the packet that includes the receiver address. *See, e.g.*, 802.11-1999, §7.1.3, FIGS. 12, 86; *see also* Gu, FIGS. 1, 5C; *see also* ’122 patent, 4:57-60 (describing a “PHY header without MAC portion . . . may also be referred

to as a zero-length frame or Null Data Packet (NDP)). Gu teaches that such sounding packets are advantageous for decreasing the time required for sounding by minimizing the size of the sounding packet. Gu, 5:9-12.

119. A POSITA would have recognized that the second communication frame was transmitted after a SIFS. Gast, 36-39 (describing that RTS/CTS exchange “requires three SIFS periods”), FIG. 3-5.

[16.pre] A system comprising:

120. Gu teaches a system that includes a transmitter and a receiver. *See, e.g.*, Gu, 2:10-13 (“The LAC frame supports control of MIMO training requests and exchange of link adaptation information. The LAC frame can be sent by either an initiator station (transmitter) or a recipient station (receiver).”), 7:46-51 (“The transmitter sets its MCS selection to a reliable one, e.g., default MCS, and then sends 701 a LAC frame with ASI=1 and the command TXASI.”), FIG. 7 (showing STA A (transmitter) and STA B (receiver)).

[16.1] a transmitter configured to: transmit a first communication frame from a first station to a second station;

121. *See, supra*, [1.1], [16.pre]. Gu teaches a transmitter to transmit a first communication frame (LAC frame) from a first station (STA A) to a second station (STA B). *See, e.g.*, Gu, 7:40-45 (characterizing STA A as a transmitter), 2:10-13, 7:46-51, FIG. 7.

[16.2]-[16.4]

122. *See, supra*, [1.2]-[1.4].

[17] The system of claim 16, wherein the transmit announcement indication comprises a zero-length frame.

123. *See, supra*, [2].

[18] The system of claim 16, wherein the transmitter is further configured to provide the transmit announcement indication with a request to send (RTS) frame.

124. *See, supra*, [3].

[19] The system of claim 18, further comprising a receiver configured to receive, by the first station, a clear to send (CTS) frame from the second station after the first station has transmitted the transmit announcement indication with the RTS frame.

125. *See, supra*, [4].

[20] The system of claim 19, wherein the transmitter is further configured to transmit the second communication frame associated with the transmit announcement indication.

126. *See, supra*, [5].

[22] The method of claim 1, wherein the second communication frame comprises a physical layer (PHY) header without a media access control (MAC) portion.

127. *See, supra*, [1.3]. Gu teaches [22]. For example, Gu expressly teaches that

the sounding packets can be PHY packets without data. *See, e.g.*, Gu, 5:11-12

(“For example, the sounding packets can be limited to a preamble and a header,

and exclude any data.”). A POSITA would have understood that a PHY packet

without data would not include a MAC frame, which is the portion of the packet

that included the receiver address. 802.11-1999, §7.1.3, FIGS. 12, 86; *see also* Gu,

FIGS. 1, 5C; *see also* '122 patent, 4:57-60 (describing a “PHY header without MAC portion . . . may also be referred to as a zero-length frame or Null Data Packet (NDP)). Gu teaches that such sounding packets are advantageous for decreasing the time required for sounding by minimizing the size of the sounding packet. Gu, 5:9-12.

[23] The method of claim 1, wherein the transmit announcement indication comprises a bit inside a MAC header field.

128. In the Gu-Trainin combination, the transmit announcement indication (ASI bit of Gu in HT-control field) is a bit inside a MAC header field, as taught by Trainin. In Trainin, “the HT-control Field is the last in the MAC header.” Trainin, 4:25-26.

[24] The method of claim 23, wherein the bit comprises an high throughput-control field.

129. In the combination, the transmit announcement indication (ASI bit of Gu) is in the HT-control field, as taught by Gu. Gu, 10:4-8; *see, supra*, [1.pre] (discussing ASI bit in HT-control field).

[25] The method of claim 1, wherein the transmit announcement indication is located within one of a data frame, a management frame, or a control frame.

See, supra, [1.2]. In the combination, Gu’s LAC frame is a control frame. *See, e.g.*, Gu, 1:62-65 (In general, the LAC functionality can be realized either by a single control frame defined as LAC, or a the single control frame can be a High Throughput (HT) Control frame . . .”). Gu also teaches that the HT-control field

can be “incorporated into any MAC layer frame,” and a POSITA would know that MAC frames are defined as data, management or control frames.

130. In addition, or in the alternative, in the combination, Trainin teaches an RTS+HTC frame, which is also a control frame. Trainin, FIG. 3.

131. Note that in the Gu-Trainin-802.11e combination, the QoS-null frame is a data type frame. *See, e.g., infra*, §VII.B. Thus, the Gu-Trainin-802.11e combination renders claim 25 obvious. *Id.*

[26] The method of claim 1, wherein the transmit announcement indication precedes a zero-length frame.

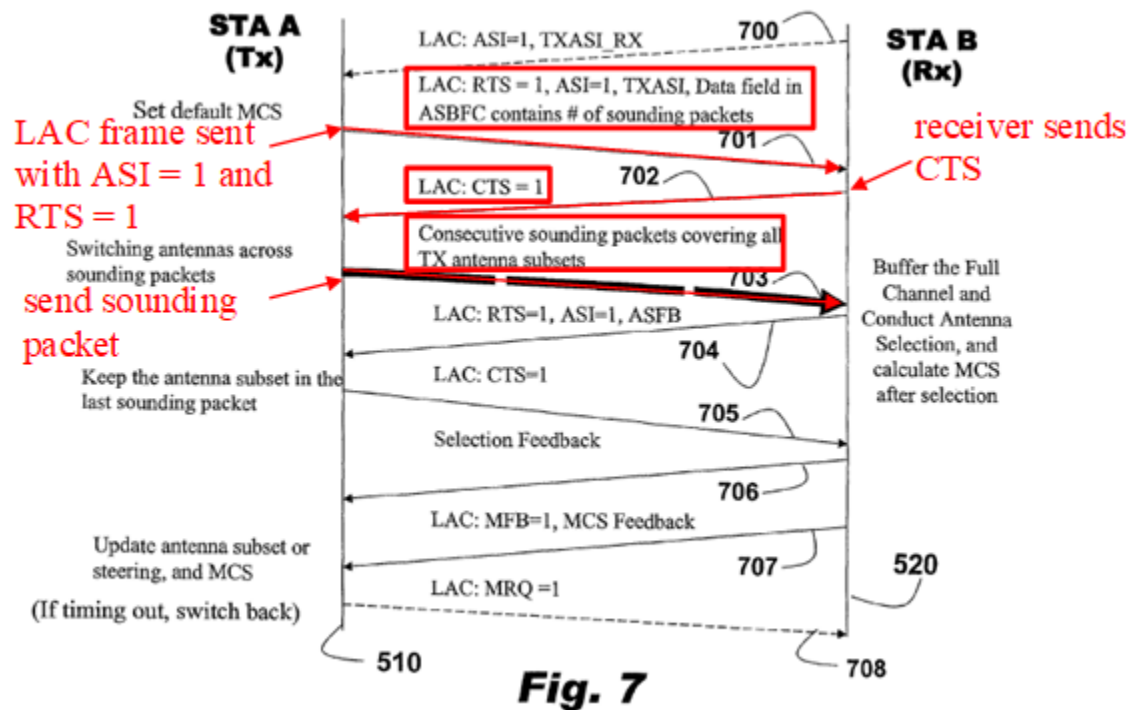
132. *See, supra*, [1.3]. In the combination, Gu teaches that the LAC frame or any MAC frame with the HT-control field (transmit announcement indication) precedes the sounding packets (zero-length frame). Gu expressly teaches an embodiment where the sounding packets are PHY packets without data (the so-called zero-length frame). *See, e.g.,* Gu, 5:11-12 (“For example, the sounding packets can be limited to a preamble and a header, and exclude any data.”). A POSITA would have understood that a PHY packet without data would not include a MAC header, which is the portion of the packet that included the receiver address. *See, e.g.,* 802.11-1999, §§7.1.3.3, 15.2; *see also*, Gu, FIGS. 1, 5C; *see also* ’122 patent, 4:57-60 (describing a “PHY header without MAC portion . . . may also be referred to as a zero-length frame or Null Data Packet (NDP)). Gu teaches

that such sounding packets are advantageous for decreasing the time required for sounding by minimizing the size of the sounding packet. Gu, 5:9-12.

[27.pre] A method comprising:

133. In the combination, Gu teaches a transmit antenna / beam selection training method. *See, e.g.*, Gu, 3:44-46, 4:1-4, 7:11-67, FIG. 7. “Figure 7 shows the details of the training method with [fast link adaptation control] LAC frame according to an embodiment of the invention.” *Id.*, 7:38-39, 4:23-25 (“Figure 7 is a flow diagram of the training for transmit antenna/beam selection according to an embodiment of the invention.”).

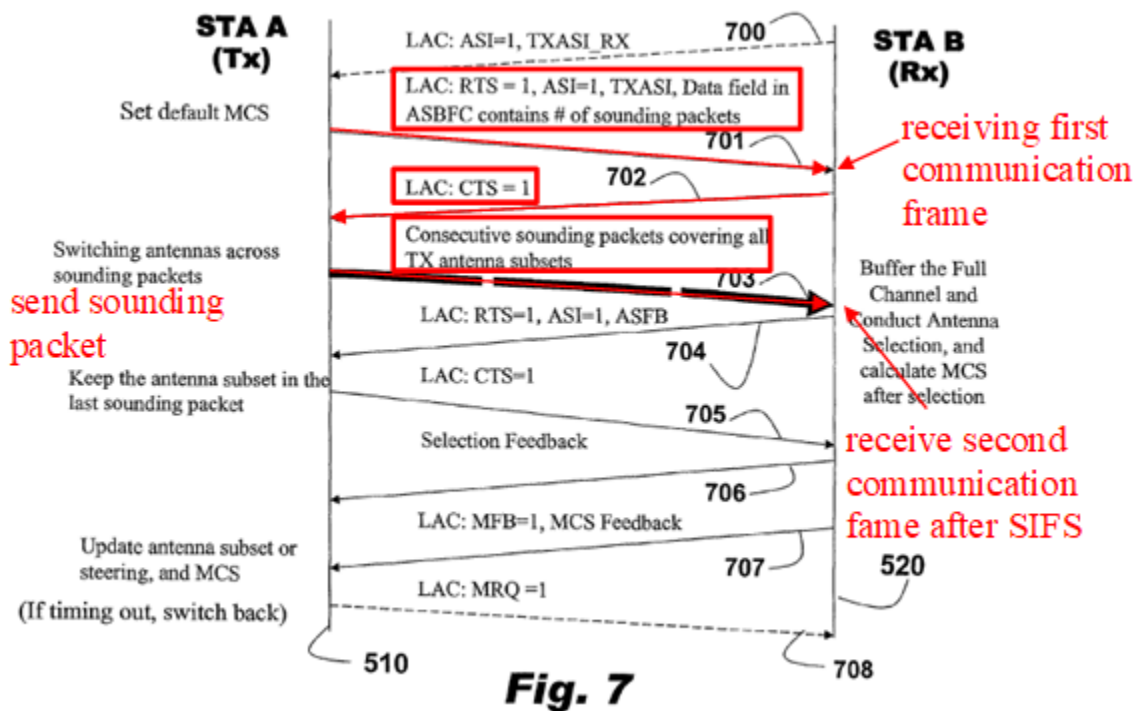
134. Gu’s FIG. 7 shows the details of the training method with LAC frame:



Gu, FIG. 7 (annotated)

[27.1] receiving a first communication frame from a first station at a second station,

135. See, *supra*, [1.1]. Gu teaches receiving a first communication frame (LAC frame) from a first station (STA A) at a second station (STA B). See, e.g., Gu, 3:44-46, 4:1-4, 7:11-67, FIG. 7. Gu's FIG. 7 shows the details of the training method with LAC frame:



Gu, FIG. 7 (annotated)

[27.2] wherein the first communication frame includes an address of the second station and a transmit announcement indication that indicates that a second communication frame intended for the second station will follow the first communication frame and

136. See, *supra*, [1.2].

[27.3] that the second communication frame will not include the address of the second station; and

137. *See, supra*, [1.3].

[27.4] receiving, at the second station, the second communication frame after a short inter frame space (SIFS) that follows the first communication frame.

138. *See, supra*, [1.4]. Under Petitioner's constructions, in the combination, Gu teaches that the LAC frame is received by the second station (STA B) with a request-to-send (RTS) field set. *See, e.g.*, Gu, 7:46-51, FIG. 5C (RTS 121), FIG. 7 (701 LAC: RTS=1, ASI=1). In response, the second station (STA B) transmits a clear-to-send (CTS) message. *See, e.g., id.*, 7:52-54, FIG. 7 (702 CTS=1). After receiving the CTS=1, "the transmitter sends 703 consecutive sounding packets." *Id.*, 7:60-63, FIG. 7 (703 consecutive sounding packets). Thus, the second station (STA B) receives the sounding packets (second communication frames) after a SIFS after sending CTS. *Id.*

139. In addition, or in the alternative, under a narrower construction of RTS frame, the Gu-Trainin combination teaches the RTS+HTC frame is received by the second station. *See, e.g.*, Trainin, FIG. 3. In response, the second station transmits a CTS+HTC frame. *Id.* In the combination, after receiving this response, the first station transmits sounding packets, and thus the second station (STA B) receives the sounding packets (second communication frames) after a SIFS after sending CTS.

140. Because Gu uses an RTS/CTS exchange, a POSITA would have known or found it obvious to separate transmissions belonging to the link adaptation dialog using SIFS. *See, e.g.*, Larsson, [0085]. Using SIFS in the RTS/CTS dialog was well known and standard practice at the time. *See, e.g.*, 802.11-1999, §9.2.3; Larsson, [0085]. Thus, a POSITA would have known that the sounding packets (second communication frame) are received after a SIFS following the reception of the LAC frame (the first communication frame).

[28] The method of claim 27, wherein the transmit announcement indication comprises a zero-length frame.

141. *See, supra*, [2].

[29] The method of claim 27, wherein receiving the first communication frame comprises receiving the transmit announcement indication with a request to send (RTS) frame.

142. *See, supra*, [3], [27.4]. In the combination, under Petitioner's broad construction of RTS frame, Gu teaches that the LAC frame is received with RTS indicated. *See, e.g.*, Gu, 7:46-51. In addition, or in the alternative, under a narrower construction, the Gu-Trainin combination teaches a receiver receiving an RTS subtype frame that includes an HT-control field in a MAC header that includes the LAC functionality for indication forthcoming PHY sounding packets.

[30] The method of claim 29, further comprising transmitting a clear to send (CTS) frame from the second station to the first station in response to receiving the RTS frame.

143. *See, supra*, [4], [27.4]. The prior art teaches that the second station (STA B) transmits a frame with CTS=1 to the first station (STA A) in response to receiving the frame indicating RTS, whether it be the LAC frame of Gu alone (broader construction) or the CTS frame in the Gu-Trainin combination (narrower construction). *See, e.g.*, Gu, 7:52-54.

[38.pre] A system comprising:

144. *See, supra*, [16.pre].

[38.1] a receiver configured to: receive a first communication frame from a first station at a second station,

145. *See, supra*, [27.1]. In the combination, Gu teaches a second station (STA B), which is the receiver. *See, e.g.*, Gu, 7:40-45 (characterizing STA B as a receiver). The first station (STA A / transmitter) sends a LAC frame (or any MAC frame) to the second station (STA B / receiver). *Id.*, 46-53. “Upon receiving the LAC frame, the receiver sends 702 a LAC frame with CTS=1.” *Id.*

[38.2]-[38.4]

146. *See, supra*, [1.2]-[1.4].

[39] The system of claim 38, wherein the transmit announcement indication comprises a zero-length frame.

147. *See, supra*, [2].

[40] The system of claim 39, wherein the receiver is further configured to receive the transmit announcement indication with a request to send (RTS) frame.

148. *See, supra*, [3], [29].

[41] The system of claim 40, further comprising a transmitter configured to transmit a clear to send (CTS) frame from the second station to the first station in response to the RTS frame.

149. *See, supra*, [4], [30].

B. Ground 1B:

1. The Gu-Trainin & 802.11e Combination

150. The HT-control field of the Gu-Trainin combination that includes the LAC functionality to indicate forthcoming PHY sounding frames is part of a QoS-null frame, as described by the 802.11e-2005 specification.

2. Motivation to Combine Gu-Trainin & 802.11e

151. A POSITA would have found it obvious to combine the teaching of Gu-Trainin with the teachings of the 802.11e standard. A POSITA would naturally consult and conform to previous adopted standards when implementing MAC layer functionality. In particular, a POSITA would have consulted and conformed to the 802.11e-2005 standard because it describes enhancements to the 802.11 MAC layer for improving quality of service (QoS). *See, e.g., supra*, §IV.A & VI.C.

152. A POSITA would have been motivated to use a QoS-null frame to “realize” the LAC functionality described by Gu because the QoS-null frame was a frame that carried no data that could be sent quickly to the receiving station, and could contain the HT-control field with the LAC functionality, as described by Gu. Gu expressly teaches that the “invention can be used for any similarly defined signaling frame in a MAC layer that allows a fast communication between the

transmitter and the receiver.” Gu, 13:5-12. A POSITA would have recognized that the QoS-null frame was an ideal choice for realizing the LAC functionality because the QoS-null frame included a MAC header to carry the HT-control field but did not include any data overhead, so the QoS-null frame could be transmitted efficiently between the first station and the second station.

153. A POSITA would have had a reasonable expectation of success combining Gu-Trainin with the 802.11e standard to place the HT-control field with LAC functionality into the QoS-null frame. First, Gu teaches that the “LAC functionality can be realized either by a single control frame defined as LAC, or the single control frame can be a High Through-put (HT) Control frame, or a HT-control Field can be incorporated into any MAC layer frame.” Gu, 1:60-65. A POSITA would have recognized that a MAC layer frame included a Frame Control field that included a subtype subfield where the subtype of control field was defined. *See, e.g.,* Gast, FIGS. 3-9–3-10:

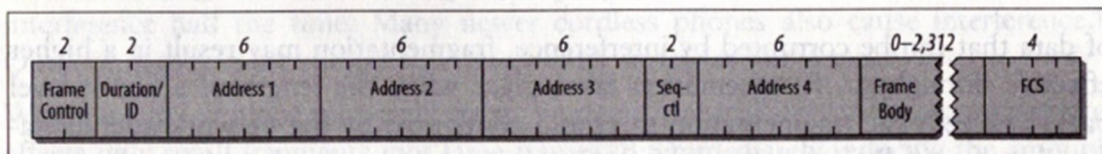


Figure 3-9. Generic 802.11 MAC frame

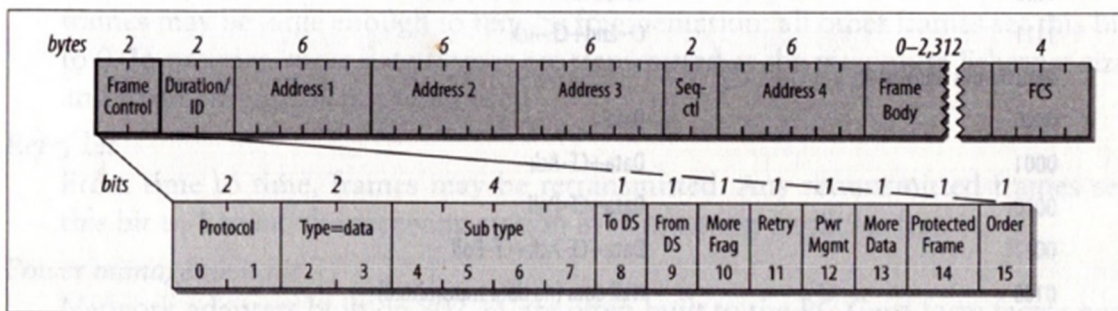


Figure 3-10. Frame control field

Gast, FIGS. 3-9, 3-10 (showing MAC frame and Frame Control Field)

1100	QoS Null (no data transmitted)
1101	QoS CF Ack (no data transmitted)

Gast, Table 3-1 (showing QoS-null subtype definition)

The QoS-null subtype was defined as early as 2003 as a proposal for the 802.11e specification. *See, e.g.*, 802.11e-2005, §§7.1.1-7.1.3.5.4; Gast, Table 3-1; 802.11e-D6.0, §§7.1.1-7.1.3.5.4. The QoS-null data frame included a MAC header that could include an HT-control field, but did not include data. *See, e.g.*, 802.11e-2005, §§7.1.1-7.1.3.5.4; Gast, FIGS. 3-9 & 3-10, Table 3-1; *see also* Trainin, 4:20-23 (describing that “an HT-control (HTC) field may be included in any HT frame except a non-QoS Data frame”). A POSITA would have understood that the HT-control field in Gu included both the indication of upcoming PHY sounding frames as well as the ASBFC payload. *See, e.g.*, Gu, 6:51-7:10, 13:5-18, FIG. 12. Thus, adding the HT-control field with LAC functionality, as taught by Gu-Trainin, into

MAC header of a QoS-null frame would have been well within the skills of a POSITA and would have been met with a reasonable expectation of success.

154. Also, Gu expressly teaches using the HT-control field to realize the LAC functionality, so a POSITA would have been able to implement the LAC functionality in a QoS-null frame without undue experimentation. Because QoS-null was known for many years prior to Gu, a POSITA would have been familiar with defining a frame as QoS-null by using the frame subtype definitions shown above.

3. Analysis

[6] The method of claim 1, wherein transmitting the first communication frame comprises providing the transmit announcement indication in a quality of service null (QoS-null) frame.

155. The Gu-Trainin-802.11e combination renders [6] obvious. The MAC header with HT-control field and LAC functionality, as taught by Gu-Trainin, is in a QoS-null frame that was standardized by the 802.11e specification.

[7] The method of claim 6, further comprising receiving, by the first station, an acknowledgement (ACK) frame from the second station after the first station has transmitted the transmit announcement indication with the QoS-null frame.

156. The Gu-Trainin-802.11e combination renders [7] obvious. As described above, Gu renders obvious the use of a QoS-null frame for realizing LAC functionality and for transmitting an indication of antenna/beam selection training frame. *See, supra*, [6]. A POSITA would have known that a transmitter of a QoS-null frame was required by 802.11e to set the QoS Control field in the packet to

indicate normal ACK policy. 802.11e-2005, §7.1.3.5.3 (ACK Policy subfield). For QoS-null (no data) frames, the only permissible value for the ACK policy subfield directs the recipient to return an ACK. 802.11e-2005, §7.1.3.5.3 (Ack Policy subfield).

[8] The method of claim 7, further comprising transmitting the second communication frame associated with the transmit announcement indication.

157. The Gu-Trainin-802.11e combination renders [8] obvious. A POSITA would have found it obvious to transmit the one or more sounding packets (second frame) of Gu after receiving the ACK from the second station to complete the atomic operation. A POSITA would have also found it obvious that the one or more sounding packets were transmitted after a SIFS. *Id.* As early as 1999, the 802.11 standard required SIFS for ACK frames. 802.11-1999, §9.2.3 (“The SIFS shall be used for an ACK frame . . .”). Thus, a POSITA would have known or found it obvious that the one or more sounding packets were transmitted after the first station received the ACK from the second station and after a SIFS.

[31] The method of claim 27, wherein receiving the first communication frame comprises receiving the transmit announcement indication in a quality of service null (QoS-null) frame.

158. *See, supra*, [6].

[32] The method of claim 31, further comprising receiving an acknowledgement (ACK) frame at the second station from the first station.

159. *See, supra*, [7].

[33] The method of claim 27, wherein receiving the first communication frame comprises receiving the transmit announcement indication with a clear to send (CTS) frame.

160. *See, supra*, [8].

C. Ground 1C: Claims 11-15, 21, 34-37, & 42 are obvious in view of Gu-Trainin and Hansen

1. The Gu-Trainin-Hansen Combination

161. Gu teaches a first station that sends a LAC frame (or other MAC layer frame with LAC functionality) to a second station, the LAC or other MAC frame including an ASI field that serves as a transmit announcement indication, alerting a second station of a forthcoming sounding packet that does not include an address of the second station. *See, supra*, [1.pre]-[1.4]. Gu also teaches that the antenna selection method is “computer implemented,” implying to a POSITA that one or both of the first station and the second station include a computer or a computer processor. Gu, Abstract. However, Gu does not specify the exact type of devices for the first station and second station. Gu also does not specifically state that the computer-implemented antenna / beam selection training methods described therein are implemented by instructions stored on a non-transitory, computer-readable medium. The transmission of the LAC or other MAC frame that includes the ASI transmit announcement indication and the subsequent transmission of sounding packets is performed by a wireless communications device that has a radio with a baseband processor and a memory, like that described by Hansen. *See,*

e.g., Hansen, [0039]. And as described by Hansen, in the combination, the first station and the second station of Gu are one of a wireless radio, cellular telephone, personal digital assistant, laptop, or personal computer. *See, e.g., id.*, [0032]-[0034].

2. Motivation to Combine

162. A POSITA would have found it obvious to combine Gu and Hansen. First, both Gu and Hansen are in the same field of endeavor. Gu describes antenna / beam selection techniques for MIMO wireless LANs, and in particular, methods for indicating and transmitting sounding packets. *See, e.g.*, Gu, 1:16-54, 2:36-42, 3:44-4:4, *supra* [1.pre]-[1.4]. Likewise, Hansen MIMO devices that perform beam forming using channel sounding techniques. *See, e.g.*, Hansen, [0036], [0085]-[0108]. A POSITA would have recognized that Hansen's channel sounding techniques to support MIMO operations would have benefitted from Gu's transmitting an indication of the antenna / beam selection training frames. A POSITA would have recognized that providing a training request indication, like that of Gu, would have allowed the wireless communications devices of Hansen to perform channel sounding without interrupting normal transmissions and without interference from other stations in the WLAN.

163. Second, Gu describes a "computer-implemented method." A POSITA would have found it obvious that a computer-implemented method, as taught by

Gu, would have been implemented by a device (such as a personal computer, laptop computer, PDA, etc.) as taught by Hansen. *See, e.g.*, Hansen, [0032]-[0033]. A POSITA would also have recognized that such devices included memory (non-transitory, computer-readable storage media) for storing instructions that when executed, cause a computing device to execute operations, as was standard practice even for “one of *average* skill in the art.” *See, e.g., id.*, [0037], [0039], [0046] (emphasis added).

164. Third, a POSITA would have recognized that Hansen’s channel sounding process would have benefited from Gu’s use of PHY layer sounding packets excluding data. *See, e.g.*, Gu, 5:8-12. Gu teaches that preferably, “the sounding packets are transmitted with a relatively short delay,” and teaches reducing the size of the sounding frames by using a PHY preamble and header and excluding data. *Id.* A POSITA would have found it advantageous to use the PHY sounding packets of Gu that include the preamble and header, but exclude data, as the sounding packets in Hansen to reduce the time it takes to transfer the sounding packets and perform sounding.

165. A POSITA would have had a reasonable expectation of success combining the teachings of Gu with the teachings of Hansen. First, Hansen provides sufficient teachings for “one of average skill in the art” to implement an access point and/or a wireless communications device in either a basic service set (BSS) or an

independent basic service set (IBSS). *See, e.g.*, Hansen, [0032]-[0046], FIGS.1-2. Likewise, Gu provides sufficient details of the MAC frame structure and the process for exchanging MAC layer frames and sounding frames for a POSITA to implement Gu's teachings into those of Hansen. *See, e.g.*, Gu, 4:47-10-9, FIGS. 5C, 7, 12. Also, both Gu and Hansen are directed to the same technology – namely, channel sounding for MIMO WLAN. *See, e.g.*, Gu, [3:44-65]; Hansen, [0085]-[0108]; *see also* Gu, 2:36-42 (discussing 802.11n); Hansen, [0036] (discussing 802.11n).

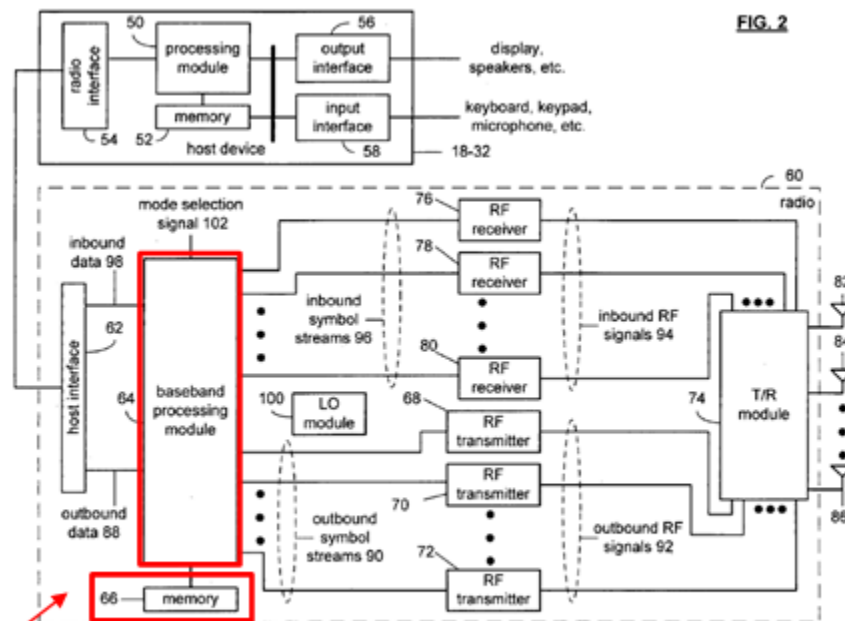
3. Analysis

[11.pre] A non-transitory computer-readable medium having instructions stored thereon that, if executed by a computing device, cause the computing device to perform operations comprising:

166. The Gu-Hansen combination renders [11.pre] obvious. Gu describes a “computer implemented method” for performing channel sounding. *See, e.g.*, Gu, Abstract. The channel sounding scheme uses the OSI model, including PHY and MAC layers, which imply that operations are performed by instructions stored on a non-transitory computer-readable medium. *Id.*, 3:61-64.

167. The computer-implemented method of Gu is performed by a wireless communications device (first station) that has a baseband processor and memory storing instructions, as taught by Hansen. *See, e.g.*, Hansen, [0036]-[0039], [0046]. Hansen describes the wireless communications device (first station) has a radio 60

for sending and receiving data. *Id.*, [0036]-[0039]. The radio includes a baseband processor and a memory. *Id.*, [0036]-[0039]. “The baseband processing module 64, in combination with operational instructions stored in memory 66, execute digital receiver functions and digital transmitter functions, respectively.” *Id.* And the “memory device may be a read-only memory, random access memory, volatile memory, non-volatile memory, static memory, dynamic memory, flash memory, and/or any device that stores digital information.” *Id.* FIG. 2 illustrates the host device 18-32 and radio 60:

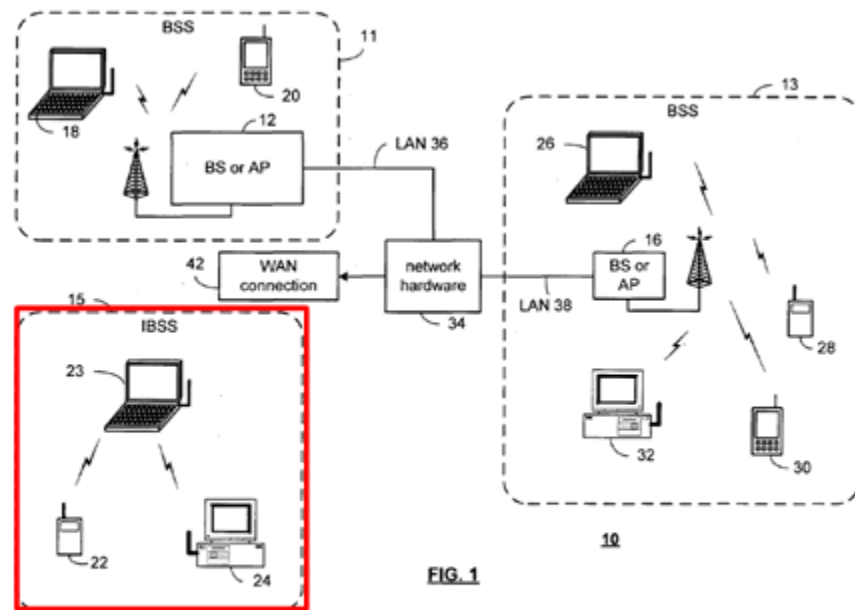


first station has a baseband processor and memory for storing instructions

Hansen, FIG. 2 (annotated)

[11.1]-[11.4]

168. *See, supra*, [1.1]-[1.4]. The first station is a wireless communications device (also called host device 22, 23, or 24), as taught by Hansen. The wireless communications device transmits the first communication frame to a second station, which is also a wireless communications device. *See, e.g.*, Hansen, [0035], [0039] (describing that baseband processing module performs digital transmitter functions and digital receiver functions). Hansen teaches wireless communications devices in communication with each other in an IBSS WLAN. *See, e.g., id.*, [0035], FIG. 1:



first station exchanging wireless messages with a second station

Hansen, FIG. 1 (annotated)

The '122 patent also contemplates the stations 120 and 130 to be part of a “wireless ad hoc network (IBSS).” '122 patent, 4:9-14.

169. The wireless communications device (first station) executes instructions stored in memory to send a LAC frame or other MAC layer frame with LAC functionality in an HT-control field to another wireless communications device (second station). *See, e.g.,* Hansen, [0039], [0044]-[0046]. Also, the wireless communications device (first station) sends multiple consecutive PHY layer sounding packets to the other wireless communications device (second station) by executing instructions stored in memory. *See, e.g., id.,* [0085]-[0108].

[12] The computer-readable medium of claim 11, wherein the transmit announcement indication comprises a zero-length frame.

170. *See, supra,* [2].

[13] The computer-readable medium of claim 11, wherein transmitting the first communication frame comprises providing the transmit announcement indication with a request to send (RTS) frame.

171. *See, supra,* [3].

[14] The computer-readable medium of claim 13, wherein the operations further comprise receiving a clear to send (CTS) frame from the second station after the first station has transmitted the transmit announcement indication with the RTS frame.

172. *See, supra,* [4].

[15] The computer-readable medium of claim 14, wherein the operations further comprise transmitting the second communication frame associated with the transmit announcement indication.

173. *See, supra,* [5].

[21] The system of claim 16, wherein the first station comprises one of a wireless radio, desktop computer, portable computer, lap-top computer, multi-media players, personal digital assistant (PDA), printer, fax machine, scanner, hub, switch, router, set-top box, and television with communication capability.

174. *See, supra*, §IV.C.1, [11.pre]-[11.4]. In the Gu-Trainin-Hansen combination, Hansen teaches a wireless communication device that includes a host device and an associated radio. *See, e.g.*, Hansen, [0036]. The host device can include a built-in radio. *Id.* The host device can be a personal digital assistant, laptop, or personal computer. *Id.*

[34.pre] A non-transitory computer-readable medium having instructions stored thereon that, if executed by a computing device, cause the computing device to perform operations comprising:

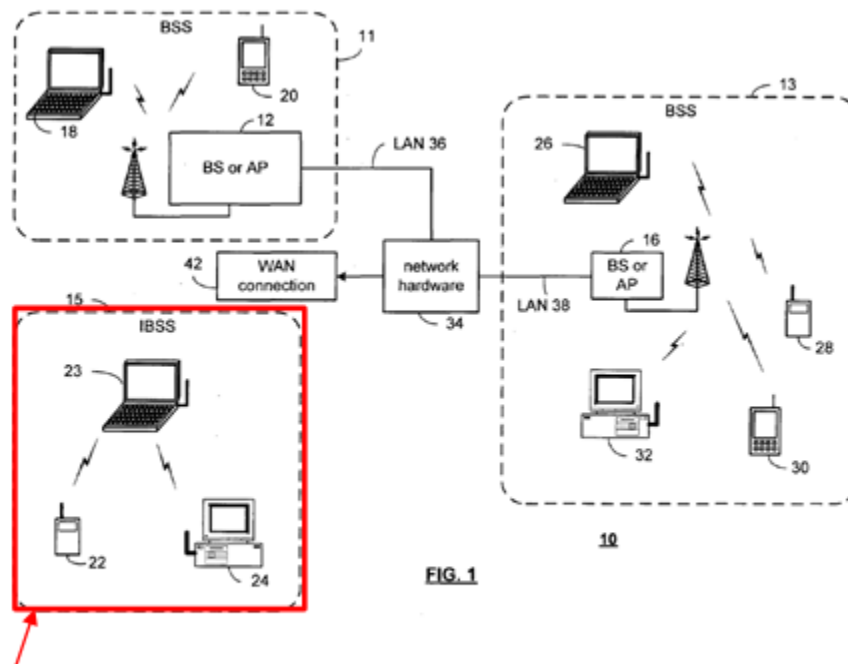
175. *See, supra*, [11.pre], [27.pre]. As discussed above, in the Gu-Trainin-Hansen combination, the first station and the second station are wireless communication devices that each include a radio with a baseband processor and a memory. Here, the second station is a wireless device that includes a baseband processor and a memory for performing “digital receiver functions.” *See, e.g.*, Hansen, [0039].

[34.1]-[34.4]

176. *See, supra*, [1.1]-[1.4], [11.pre]-[11.4], [27.1]-[27.4]. In the Gu-Trainin-Hansen combination, the second station is a wireless communications device (also called host device 22, 23, or 24), as taught by Hansen. The wireless communications device (second station) receives the first communication frame from another wireless communication device (first station). *See, e.g.*, Hansen,

[0035], [0039] (describing that baseband processing module performs digital transmitter functions and digital receiver functions). Hansen teaches wireless communications devices in communication with each other in an IBSS WLAN.

See, e.g., *id.*, [0035], FIG. 1:



first station exchanging wireless messages with a second station

Hansen, FIG. 1 (annotated)

The '122 patent also contemplates the stations 120 and 130 to be part of a “wireless ad hoc network (IBSS).” '122 patent, 4:9-14.

177. In the Gu-Trainin-Hansen combination, the wireless communications device (second station) executes instructions stored in memory to receive a LAC frame or other MAC layer frame with LAC functionality in an HT-control field to another

wireless communications device (second station). *See, e.g., Hansen, [0039]-[0043].*

Also, the wireless communications device (first station) sends multiple consecutive PHY layer sounding packets to the other wireless communications device (second station) by executing instructions stored in memory.

[35] The computer-readable medium of claim 34, wherein the transmit announcement indication comprises a zero-length frame.

178. *See, supra, [2].*

[36] The computer-readable medium of claim 34, wherein the receiving the first communication frame comprises receiving the transmit announcement indication with a request to send (RTS) frame.

179. *See, supra, [3], [29].*

[37] The computer-readable medium of claim 36, wherein the operations further comprise transmitting a clear to send (CTS) frame to the first station in response to the RTS frame.

180. *See, supra, [4], [30].*

[42] The system of claim 38, wherein the second station comprises one of a wireless radio, desktop computer, portable computer, laptop computer, multi-media players, personal digital assistant (PDA), printer, fax machine, scanner, hub, switch, router, set-top box, and television with communication capability.

181. *See, supra, §IV.C.1, [11.pre]-[11.4], [21].* In the Gu-Trainin-Hansen combination, Hansen teaches a wireless communication device that includes a host device and an associated radio. *See, e.g., Hansen, [0036].* The host device can include a built-in radio. *Id.* The host device can be a personal digital assistant, laptop, or personal computer. *Id.*

VIII. LEGAL STANDARDS

A. Terminology

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

Counsel has also informed me, and I understand that, the words of the claims should be interpreted as they would have been interpreted by one of ordinary skill at the time of the invention was made (not today). I have been informed by Counsel that I should use December 21, 2005, as the point in time for claim interpretation purposes.

B. Legal Standards

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

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

C. Anticipation

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

186. I understand that, once the claims of a patent have been properly construed, the second step in determining anticipation of a patent claim requires a comparison of the properly construed claim language to the prior art on a limitation-by-limitation basis.

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

D. Obviousness

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

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

merely by demonstrating that each of its elements was, independently, known in the prior art.

190. I am informed by Counsel and understand that when a patented invention is a combination of known elements, a court determines whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue by considering the teachings of prior art references, the effects of demands known to people working in the field or present in the marketplace, and the background knowledge possessed by a person having ordinary skill in the art.

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

192. I am informed by Counsel and understand that an obviousness inquiry requires consideration of the following factors: (1) the scope and content of the prior art, (2) the differences between the prior art and the claims, (3) the level of

ordinary skill in the art, and (4) any so called “secondary considerations” of non-obviousness, which include: (i) “long felt need” for the claimed invention, (ii) commercial success attributable to the claimed invention, (iii) unexpected results of the claimed invention, and (iv) “copying” of the claimed invention by others.

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

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

195. I have been informed by Counsel and understand that practical and common sense considerations should guide a proper obviousness analysis, because familiar

items may have obvious uses beyond their primary purposes. I have been informed by Counsel and understand that a person of ordinary skill looking to overcome a problem will often be able to fit together the teachings of multiple prior art references. I have been informed by Counsel and understand that obviousness analysis therefore takes into account the inferences and creative steps that a person of ordinary skill would have employed at the time of invention.

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

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

198. I have been informed by Counsel and understand that there must be a relationship between any such secondary considerations and the invention, and that contemporaneous and independent invention by others is a secondary consideration supporting an obviousness determination.

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

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

IX. CONCLUSION

201. For all the reasons I have noted in the foregoing paragraphs, claims 1-8 and 11-42 of the '122 Patent are obvious in view of the references discussed above.

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

EXHIBITS

UBIQUITI-1001	U.S. Patent No. 8,594,122 to Wentink (“the ’122 patent”)
UBIQUITI-1002	Excerpts from the Prosecution History of the ’122 patent (“the Prosecution History”)
UBIQUITI-1003	Declaration and Curriculum Vitae of Christopher Hansen, Ph.D.
UBIQUITI-1005	’122 Patent Provisional Specification Application Serial No. 60/762,425
UBIQUITI-1006	U.S. Pat. Pub. 2008/0298306 (“Larsson”)
UBIQUITI-1007	U.S. Patent No. 8,374,096 (“Gu”)
UBIQUITI-1008	U.S. Pat. Pub. 2005/0232208 (“Hansen”)
UBIQUITI-1009	GAST, 802.11 WIRELESS NETWORKS: THE DEFINITIVE GUIDE, (O’Reilly 2005)
UBIQUITI-1010	IEEE 802.11-1999 Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications
UBIQUITI-1011	U.S. Patent No. 8,200,164 (“Trainin”)
UBIQUITI-1015	Declaration of June Ann Munford
UBIQUITI-1016	PCT Publication WO 2007/040564
UBIQUITI-1017	802.11e/D6.0 Draft Amendment to STANDARD [for] Information Technology – Telecommunications and Information Exchange Between Systems – LAN/MAN Specific Requirements – PART 11: Wireless Medium Access Control (MAC) and Physical Layer (PHY) specifications: Medium Access Control (MAC) Quality of Service (QoS) Enhancements, November 2003
UBIQUITI-1019	IEEE 802.11-04/0889r7, “TGn Sync Proposal Technical Specification”

UBIQUITI-1020	IEEE 802.11e-2005 Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 8: Medium Access Control (MAC) Quality of Service Enhancements
UBIQUITI-1021	IEEE 802.11e-2005 website, https://standards.ieee.org/ieee/802.11e/3131/
UBIQUITI-1022	Archived copy of IEEE Standards Association homepage, https://web.archive.org/web/20051124063223/http://standards.ieee.org:80/ (archived Nov. 24, 2005)
UBIQUITI-1023	Archived copy of IEEE Online Subscription Access homepage, https://web.archive.org/web/20051201224002/http://standards.ieee.org/catalog/olis/about.html (archived Dec. 1, 2005)
UBIQUITI-1024	Archived copy of IEEE Online Subscription Catalog, https://web.archive.org/web/20051130033411/http://standards.ieee.org/catalog/olis/lanman.html (archived Nov. 30, 2005)
UBIQUITI-1025	Archived copy of IEEE Online Subscription Catalog, https://web.archive.org/web/20030619112803/http://standards.ieee.org:80/catalog/olis/lanman.html (archived June 19, 2003)

LISTING OF CLAIMS

Claim No.	Term
1.pre	A method comprising:
1.1	transmitting a first communication frame from a first station to a second station
1.2	wherein the first communication frame comprises an address of the second station and a transmit announcement indication indicating that a second communication frame intended for the second station will follow the first communication frame
1.3	that the second communication frame will not include the address of the second station, and
1.4	wherein the second communication frame follows after a short inter frame space (SIFS) after the first communication frame with the transmit announcement indication.
2	The method of claim 1, wherein the transmit announcement indication comprises a zero-length frame.
3	The method of claim 1, wherein transmitting the first communication frame comprises providing the transmit announcement indication with a request to send (RTS) frame.
4	The method of claim 3, further comprising receiving, by the first station, a clear to send (CTS) frame from the second station after the first station has transmitted the transmit announcement indication with the RTS frame.
5	The method of claim 4, further comprising transmitting the second communication frame from the first station to the second station, wherein the second communication frame does not include the address of the second station.
6	The method of claim 1, wherein transmitting the first communication frame comprises providing the transmit

	announcement indication in a quality of service null (QoS-null) frame.
7	The method of claim 6, further comprising receiving, by the first station, an acknowledgement (ACK) frame from the second station after the first station has transmitted the transmit announcement indication with the QoS-null frame.
8	The method of claim 7, further comprising transmitting the second communication frame associated with the transmit announcement indication.
11.pre	A non-transitory computer-readable medium having instructions stored thereon that, if executed by a computing device, cause the computing device to perform operations comprising:
11.1	transmitting a first communication frame from a first station to a second station;
11.2	wherein the first communication frame comprises an address of the second station and a transmit announcement indication indicating that a second communication frame intended for the second station will follow the first communication frame and
11.3	that the second communication frame will not include the address of the second station, and
11.4	wherein the second communication frame follows after a short inter frame space (SIFS) after the first communication frame with the transmit announcement indication.
12	The computer-readable medium of claim 11, wherein the transmit announcement indication comprises a zero-length frame.
13	The computer-readable medium of claim 11, wherein transmitting the first communication frame comprises providing the transmit announcement indication with a request to send (RTS) frame.
14	The computer-readable medium of claim 13, wherein the operations further comprise receiving a clear to send (CTS) frame

	from the second station after the first station has transmitted the transmit announcement indication with the RTS frame.
15	The computer-readable medium of claim 14, wherein the operations further comprise transmitting the second communication frame associated with the transmit announcement indication.
16.pre	A system comprising:
16.1	a transmitter configured to: transmit a first communication frame from a first station to a second station;
16.2	wherein the first communication frame comprises an address of the second station and a transmit announcement indication indicating that a second communication frame intended for the second station will follow the first communication frame and
16.3	that the second communication frame will not include the address of the second station, and
16.4	wherein the second communication frame follows after a short inter frame space (SIFS) after the first communication frame with the transmit announcement indication.
17	The system of claim 16, wherein the transmit announcement indication comprises a zero-length frame.
18	The system of claim 16, wherein the transmitter is further configured to provide the transmit announcement indication with a request to send (RTS) frame.
19	The system of claim 18, further comprising a receiver configured to receive, by the first station, a clear to send (CTS) frame from the second station after the first station has transmitted the transmit announcement indication with the RTS frame.
20	The system of claim 19, wherein the transmitter is further configured to transmit the second communication frame associated with the transmit announcement indication.

21	The system of claim 16, wherein the first station comprises one of a wireless radio, desktop computer, portable computer, laptop computer, multi-media players, personal digital assistant (PDA), printer, fax machine, scanner, hub, switch, router, set-top box, and television with communication capability.
22	The method of claim 1, wherein the second communication frame comprises a physical layer (PHY) header with out a media access control (MAC) portion.
23	The method of claim 1, wherein the transmit announcement indication comprises a bit inside a MAC header field.
24	The method of claim 23, wherein the bit comprises an high throughput-control field.
25	The method of claim 1, wherein the transmit announcement indication is located within one of a data frame, a management frame, or a control frame.
26	The method of claim 1, wherein the transmit announcement indication precedes a zero-length frame.
27.pre	A method comprising:
27.1	receiving a first communication frame from a first station at a second station,
27.2	wherein the first communication frame includes an address of the second station and a transmit announcement indication that indicates that a second communication frame intended for the second station will follow the first communication frame and
27.3	that the second communication frame will not include the address of the second station; and
27.4	receiving, at the second station, the second communication frame after a short inter frame space (SIFS) that follows the first communication frame.

28	The method of claim 27, wherein the transmit announcement indication comprises a zero-length frame.
29	The method of claim 27, wherein receiving the first communication frame comprises receiving the transmit announcement indication with a request to send (RTS) frame.
30	The method of claim 29, further comprising transmitting a clear to send (CTS) frame from the second station to the first station in response to receiving the RTS frame.
31	The method of claim 27, wherein receiving the first communication frame comprises receiving the transmit announcement indication in a quality of service null (QoS-null) frame.
32	The method of claim 31, further comprising receiving an acknowledgement (ACK) frame at the second station from the first station.
33	The method of claim 27, wherein receiving the first communication frame comprises receiving the transmit announcement indication with a clear to send (CTS) frame.
34.pre	A non-transitory computer-readable medium having instructions stored thereon that, if executed by a computing device, cause the computing device to perform operations comprising:
34.1	receiving a first communication frame from a first station,
34.2	wherein the first communication frame includes an address of a second station and a transmit announcement indication that indicates that a second communication frame will follow the first communication frame and
34.3	that the second communication frame will not include the address of the second station; and
34.4	receiving, at the second station, the second communication frame after a short inter frame space (SIFS) that follows the first communication frame.

35	The computer-readable medium of claim 34, wherein the transmit announcement indication comprises a zero-length frame.
36	The computer-readable medium of claim 34, wherein the receiving the first communication frame comprises receiving the transmit announcement indication with a request to send (RTS) frame.
37	The computer-readable medium of claim 36, wherein the operations further comprise transmitting a clear to send (CTS) frame to the first station in response to the RTS frame.
38.pre	A system comprising:
38.1	a receiver configured to: receive a first communication frame from a first station at a second station,
38.2	wherein the first communication frame includes an address of the second station and a transmit announcement indication that indicates that a second communication frame intended for the second station will follow the first communication frame and
38.3	that the second communication frame will not include the address of the second station; and
38.4	receive the second communication frame after a short interframe space (SIFS) that follows the first communication frame.
39	The system of claim 38, wherein the transmit announcement indication comprises a zero-length frame.
40	The system of claim 39, wherein the receiver is further configured to receive the transmit announcement indication with a request to send (RTS) frame.
41	The system of claim 40, further comprising a transmitter configured to transmit a clear to send (CTS) frame from the second station to the first station in response to the RTS frame.
42	The system of claim 38, wherein the second station comprises one of a wireless radio, desktop computer, portable computer, laptop computer, multi-media players, personal digital assistant (PDA),

	printer, fax machine, scanner, hub, switch, router, set-top box, and television with communication capability.
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APPENDIX A

CHRISTOPHER J. HANSEN

1701 Penny Way
Los Altos, CA 94024

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

I. SUMMARY

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

II. EXPERIENCE

Covariant Corporation, Los Altos, California

President

August 2013 – present

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

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

Apple, Cupertino, California

Senior Wireless System Architect

June 2012 – July 2013

- Analysis of 802.11 wireless networks for iOS products.

Broadcom Corporation, Sunnyvale, California

Associate Technical Director, Office of the CTO

March 2011 – May 2012

Senior Principal Scientist, Office of the CTO

March 2007 - March 2011

Principal Scientist, Office of the CTO

March 2006 - March 2007

Engineering Manager, Wireless LAN Business Unit

June 2004 - March 2006

Senior Staff Scientist, Wireless LAN Business Unit

January 2000 - June 2004

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

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

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

Principal Systems Engineer

1998–1999

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

Amati Communications Corporation (now Texas Instruments)

San Jose, California

Senior Research Engineer

1997-1998

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

AT&T Bell Laboratories, Whippany, New Jersey

Member of Technical Staff

1990-1992

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

MIT Lincoln Laboratory, Lexington, Massachusetts

Member of Technical Staff

1989-1990

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

III. LITIGATION EXPERIENCE

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

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

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

IV. EDUCATION

Ph.D., Electrical Engineering 1997
University of California, Los Angeles
Dissertation: *Probing Techniques for Multiuser Channels with Power Control*
Research Area: Wireless and Digital Communications
Advisor: Gregory J. Pottie

M.S., Electrical Engineering 1989
University of Massachusetts, Amherst
Concentration: Signal Processing and Microwave Systems

B.S., Electrical Engineering 1987
Rensselaer Polytechnic Institute

V. HONORS AND AFFILIATIONS

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

VI. SKILLS

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

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

VII. PUBLICATIONS

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

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

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

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

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

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

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

VIII. PATENTS

Named inventor on the following United States patents:

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

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

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

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

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

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