UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AT&T SERVICES, INC.,

Petitioners,

v.

USTA TECHNOLOGY, LLC,

Patent Owner.

IPR2025-01166
Patent No. RE47,720

DECLARATION OF MATTHEW B. SHOEMAKE, PH.D.

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EX1007	Walton	U.S. Patent App. Pub. No. 2003/0125040
EX1008	Hamabe	U.S. Patent App. Pub. No. 2001/0016499
EX1009	802.11a	IEEE-SA Standards Board, *IEEE Standard for Telecommunications and Information Exchange Between Systems - LAN/MAN Specific Requirements - Part 11: Wireless Medium Access Control (MAC) and physical layer (PHY) specifications: High Speed Physical Layer in the 5 GHz band*, December 30, 1999.
EX1010	USTA’s Infringement Contentions	USTA’s Amended Infringement Contentions, *USTA Technology, LLC v. AT&T Inc. et al*, No. 4-24-cv-00513 (E.D. Tex. June 7, 2024).
EX1011	RESERVED	RESERVED
EX1012	Shoemake Paper	Shoemake et al., *High-Performance Wireless Ethernet*, IEEE Communications Magazine, pgs. 64-73, Vol. 39, Issue 11, November 2001.

EX1013	ERC/DEC/(99) 23	European Radiocommunications Committee, *ERC Decision of 29 November 1999 on the harmonized frequency bands to be designated for the introduction of High Performance Radio Local Area Networks (HIPERLANs)*, November 29, 1999.
EX1014	US Department of Commerce DFS Adoption	United States Department of Commerce News, *Agreement Reached Regarding U.S. Position on 5 GHz Wireless Access Devices*, January 31, 2003.
EX1015	US FCC Notice of Proposed Rulemaking for DFS	Federal Communications Commission, *Notice of Proposed Rulemaking*, June 4, 2003.
EX1016	802.11h PAR	Approval of Project Authorization Request for 802.11 Task Group h, December 13, 2000.
EX1017	TGh Philips Proposal	S. Choi et al., *Transmitter Power Control (TPC) and Dynamic Frequency Selection (DFS) Joint Proposal for 802.11h WLAN*, May 16, 2001.
EX1018	Kasslin TGh PPT	M. Kasslin, *Reasons for DFS Requirement in Europe*, July 2001, https://mentor.ieee.org/802.11/dcn/01/11-01-0442-00-000h-reasons-for-dfs-requirements.ppt (last accessed May 22, 2025).
EX1019	RESERVED	RESERVED
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EX1024	Wi-Fi Alliance	*Securing Wi-Fi Wireless Networks with Today's Technologies*, Wi-Fi Alliance, February 6, 2003.

EX1025	802.11-1999	IEEE-SA Standards Board, *IEEE Standard for Telecommunications and Information Exchange Between Systems – Local and metropolitan area networks – Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications*, August 20, 1999.
EX1026	Walton 802.11n Proposal	Ketchum et al., *PHY Design for Spatial Multiplexing MIMO WLAN*, July 2004.
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EX1034	Salz	J. Salz et al, *The Capacity of Wireless Communication Systems Can Be Substantially Increased by the Use of Antenna Diversity*, *IEEE Universal Personal Communications Conference* (September 1992)
EX1035	Foschini	Gerard J. Foschini, *Layered Space-Time Architecture for Wireless Communication in a Fading Environment When Using Multi-Element Antennas*, Bell Laboratories Technical Journal, 1996
EX1036	Raleigh2	G. G. Raleigh, *Spatio-Temporal Coding for Wireless Communication*, IEEE Transactions on Communications, Vol. 46, No. 3, March 1998.
EX1037	802.11e Draft D1.0	IEEE-SA Standards Board, *Draft Supplement to STANDARD FOR 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) Enhancements for Quality of Service (QoS), March 2001.
EX1038	Atheros Dual-Band	McFarland et al, *A 2.4 & 5 GHz Dual Band 802.11 WLAN Supporting Data Rates to 108 Mb/s*, 2002 IEEE GaAs Digest, 2002.
EX1039	Fallon	U.S. Patent No. 6,195,024
EX1040	Greenberger	U.S. Patent No. 6,675,187
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EX1042	Murtagh	E. M. Murtagh et al, *Outdoor Walking Speeds of Apparently Healthy Adults: A Systematic Review and Meta-analysis*, Sports Medicine, Vol. 51, pp. 125-141, published October 8, 2020.

I. Introduction

1. My name is Dr. Matthew Shoemake. I have been retained by AT&T Services, Inc., AT&T Mobility LLC, and AT&T Mobility II LLC (collectively, "AT&T" or "Petitioners") as an independent expert consultant in this inter partes review ("IPR") proceeding before the United States Patent and Trademark Office ("PTO") regarding US Patent No. RE47,720 ("the '720 Patent").

II. My Background and Qualifications

2. All of my opinions stated in this Declaration are based on my own personal knowledge and professional judgment. In forming my opinions, I have relied on my knowledge and experience in designing, developing, and researching the technology referenced in this Declaration.

3. I am over 18 years of age and, if I am called upon to do so, I would be competent to testify as to the matters set forth herein. I understand that a copy of my current curriculum vitae, which details my education and professional and academic experience, is being submitted as EX1003. The following provides a brief overview of some of my experience that is relevant to the matters set forth in this Declaration.

A. Educational Background

4. I received Bachelor of Science degrees in Electrical Engineering and Computer Science with honors from Texas A&M University, College Station, Texas in 1994. I received a Master of Science degree in Electrical Engineering from

Cornell University, Ithaca, New York in 1997. I received a Ph.D. in Electrical Engineering from Cornell University, Ithaca, New York in 1999. My doctoral studies focused on communication and information theory with specific focus on error correction codes. My M.S. thesis and Ph.D. dissertation at Cornell both related to advanced error correction coding, including turbo codes.

B. Professional Background

5. From 1991 to 1995, I worked as an intern and engineer in the Digital Signal Processing Group at Texas Instruments, Inc. in Stafford, Texas. I worked on both product engineering and applications engineering projects. Processors that I worked on at Texas Instruments were used in a variety of applications, including, e.g., voice processing, image processing, fax machines, voiceband modems, wireless communications, digital radio receivers and anti-lock brakes on cars and aircraft. As a further example, these processors were used for OFDM-based communications systems, such as the Harris RF-5000 military wireless communication systems developed in the late 1980s and early 1990s.

6. From 1997 to 2000, I was a manager at Alantro Communications, Inc. in Santa Rosa, California. I managed the baseband systems team where I developed 802.11b compliant physical layer technology. I also led the first development of 802.11a OFDM technology at Alantro. Amongst other things, I was responsible for building and designing error correction encoders and decoders at Alantro. Alantro

Communications was later acquired by Texas Instruments. The 802.11 solutions that I built at Alantro and Texas Instruments shipped in numerous products, including Intel's Centrino brand of Wi-Fi products and in Dell, D-Link, Linksys, Nokia and many other products. The descendants of those products are still sold by Texas Instruments today.

7. From 2000 to 2003, I was the Director of Advanced Technology at Texas Instruments in Dallas, Texas. I worked in the Wireless Networking Business Unit, where I led the development of Bluetooth and Wi-Fi coexistence technology. I also led efforts at Texas Instruments to enhance the IEEE 802.11 standard with quality of service extensions and to develop a very low power Wi-Fi technology for mobile phones. During my time at Alantro and Texas Instruments, I also worked on error correction coding for 802.11 systems including but not limited to CCK, PBCC, BCC, concatenated Reed Solomon codes, turbo codes and LDPCs.

8. While at Texas Instruments and through my expert consulting, I worked on and managed a team of engineers that worked on MAC-layer Wi-Fi technologies such as quality-of-service and data unit aggregation technologies.

9. Additionally, while at Alantro, Texas Instruments and through my expert consulting, I have worked on, studied, and managed activities related to MIMO, space-time-block codes and beamforming.

10. Additionally, I have worked on Wi-Fi access points and wireless routers including while at Alantro and Texas Instruments. Still today I have in my possession early wireless routers from Linksys and US Robotics that used chips that I designed while at Alantro and Texas Instruments. At Texas Instruments, our business unit included broadband gateway chips as well as Wi-Fi. We designed reference designs for wireless gateways and routers that includes those broadband processors as well as Wi-Fi. We also built chips for wide area network communication such as but not limited to DSL and cable modems.

11. From 2003 to 2008, I was the CEO and Founder of WiQuest Communications, Inc. in Allen, Texas. I developed the world's first 1 Gbps ultra-wideband chipset. I also developed the world's first wireless VGA/DVI system for notebook computers. This technology was incorporated into products developed by several major computer and electronics manufacturers such as Dell, Toshiba, Lenovo, Belkin, D-Link, and Kensington. I built the company from inception to 120 employees. I managed a diverse group of employees that were located in Texas, India, California, Taiwan, and Japan.

12. In 2008, I founded and became the CEO of Biscotti, Inc. At Biscotti, I developed high-definition, Wi-Fi-based video calling systems for the home and office. During my time at Biscotti, I evaluated numerous Wi-Fi chip offerings for range, rate and robustness capabilities. Wi-Fi products that I evaluated were made

by manufacturers such as Broadcom, Atheros (now Qualcomm), Marvell and Texas Instruments. At Biscotti, we used Wi-Fi chips from Broadcom and Marvell based on our range, rate and performance testing. As with many applications, range, rate and robustness were important to Biscotti due to our need to operate reliably across the entire home, tolerate interference from other products operating in the unlicensed bands used by Wi-Fi and achieve speeds that were sufficient to move high-definition video. Biscotti's products incorporated MIMO capabilities.

13. Also, in about 2008, large companies began calling on me to serve as an expert and testifying witness in patent litigation cases. Thus, for about 17 years, I have served in an expert capacity in trials where my expertise in communication systems and standards were relevant. Clients that have used my services include 7-Eleven, Apple, AT&T, Blackberry, Broadcom, Caltech, Canon, Cisco, Dell, FujiFilm, Google, Harmon, Honda, HTC, Intel, Lyft, MediaTek, Mercedes-Benz, Mitsubishi, NXP, Qualcomm, Realtek, Samsung, Sharp, Sprint, Subaru, T-Mobile, Texas Instruments, Uber, Verizon, and Wistron.

14. After working in this capacity as a sole proprietor for many years, I incorporated Peritum LLC in 2015. Today, I continue providing expert engineering, consulting and technical services via Peritum.

C. Patents and Publications

15. I am a named inventor on over thirty patents, including patents related to wireless communications systems and various aspects of data communications systems, including encoding, decoding, and transmission of information.

16. I have authored, co-authored, and contributed to many academic papers and publications, most in the area of data communications.

17. I have presented, authored, co-authored and/or co-sponsored many submissions to the IEEE. I have also authored or co-authored numerous papers in IEEE publications, including "High Performance Wireless Ethernet," IEEE Communications Magazine, November 2001, and various other articles in IEEE publications.

D. Other Relevant Qualifications

18. I have been a member of the Institute of Electrical and Electronic Engineers (IEEE) since 1991. In 1999, I was the Chairperson of the IEEE 802.11g Study Group where I led a committee of twenty engineers to set project requirements for IEEE 802.11g. Subsequently, from 2000 to 2003, I was the Chairperson of the IEEE 802.11g Task Group where I led a committee of over 200 engineers to set standards for 54 Mbps data rates in the 2.4 GHz band in a way that was backward compatible with the IEEE 802.11b standard. From 2003 to 2004, I was the Chairperson of the IEEE 802.11n Task Group where I led a committee of over 300

engineers through the initial stages of standardization of data rate enhancements in excess of 100 Mbps. The IEEE 802.11n Task Group added features such as MIMO and compressed feedback of channel matrices to facilitate and optimize performance over multiple spatial streams.

19. I am also personally aware of the events related IEEE 802.11h including the regulatory drivers for the standard effort, the leadership of the IEEE 802.11h amendment, the features under consideration, the features adopted, and transmit power control and dynamic frequency selection, and the requirement to avoid primary users of certain bands such as radar systems in the 5 GHz band. I personally participated in and monitored the development of IEEE 802.11h. I also interacted with the chairperson of IEEE 802.11h, Mika Kasslin, as he was leading the development of the IEEE 802.11h amendment. I am listed on p. iii of IEEE 802.11h-2003 as the chairperson of IEEE 802.11g at the time of ratification as well as on p. vii as a member of the IEEE 802.11 Working Group at the time the amendment was approved.

20. I am familiar with basic spatial reuse techniques prior to MIMO used in IEEE 802.11 system such as (a) frequency division in which Wi-Fi networks were placed on non-overlapping channels, e.g. channels 1, 6 and 11 in the 2.4 GHz band; and (b) the use of directional antennas, e.g. to sectorize the coverage area of Wi-Fi

networks as was done by companies such as Vivato. I am also familiar with directional antennas being used in Wi-Fi networks since around 2000.

21. I am familiar with the RTS/CTS mechanisms that were included in IEEE 802.11-1997 and are still used today. I am familiar with enhancements made to the use of RTS/CTS mechanisms in various 802.11 amendments including the use of CTS-to-self and bandwidth signaling mechanisms.

22. I am familiar with addressing in 802.11 networks including the use of bandwidth signaling transmitter addresses.

23. I am familiar with the scrambler in 802.11, having first studied it circa 1998 and having implemented it in products. I am familiar with the scrambling seed. I personally realized the scrambling seed was a possible channel to communicate information since at least 2000. I am familiar with the original purpose of the scrambling in 802.11, i.e. to help mitigate high peak-to-average signal events during retransmissions.

24. I am familiar with mechanisms whereby an access point can communicate to stations that it will change channels to move to a channel with less interference.

25. I am familiar with filtering of signals in many contexts and via many means including digitally, analog, and RF. I am familiar with filtering in the frequency domain and time-domain.

26. I am familiar with spectral masks including limits placed on spectral emissions by regulatory agencies such as those in the US and Europe as well as limits included in standards such as IEEE 802.11. I am familiar with reasons such spectral masks are put in place including limiting adjacent channel interference, limiting interference range, preventing excessive levels of interference to other uses of the band including primary users when applicable, and limiting transmission power to avoid transmission of energy levels that would be harmful to humans.

27. I am familiar with the concept of optional features in the IEEE 802.11 standard as well as in Wi-Fi Alliance certification testing. I am familiar with how the IEEE 802.11 standard specifies optional features and how Wi-Fi Alliance certification testing is specified including whether a specific test is mandatory or optional.

28. I am familiar with the techniques used for decomposing matrices in linear algebra. I am familiar with matrix decomposition techniques used in Wi-Fi systems for decomposing matrix channels including singular value decomposition. I understand the theory around such operation and why certain components of the decomposition are feedback and why others are not. I am familiar with the compression techniques for the feedback matrices including the use of Givens rotations. I am familiar with many source coding techniques, i.e. compression techniques, as it is a primary subfield of information theory.

29. I also have personal knowledge of performance degradation experienced in Wi-Fi/IEEE 802.11 networks that are heavily loaded with traffic and/or users. I have calculated actual user level throughputs for 802.11 networks as long ago as the late 1990s. In the late 1990s, I also had the opportunity to perform testing in some of the first high-density Wi-Fi environments, IEEE 802.11 meetings themselves. There, I observed the negative consequences of having many devices on a network in older versions of the IEEE 802.11 standard. Either directly or through engineers that I directed and supervised, I have analyzed degradation in user experience on Wi-Fi networks using simulators such as OpNet and ns.

30. I am familiar with spatial diversity technology, techniques, and algorithms such as beamforming, MIMO and MU-MIMO, OFDM and MU OFDMA, SIMO, MISO, STBC, matrix channel estimation, matrix channel decomposition, beam steering, match filters, MMSE, zero-forcing (ZF), and gradient-descent algorithms.

31. I served on the External Advisory and Development Committee (EADC) of the Department of Electrical and Computer Engineering at Texas A&M University starting in 2006. I served on the EADC for over 15 years, and I hold emeritus status today.

32. I am familiar with the OSI and TCP/IP reference models for networking and communications. This includes knowledge of the physical layer and its

implementation as well as the data link layer including the MAC layer. I am also familiar with the network layer (e.g., IP layer) and transport layer (e.g., UDP and TCP). I am familiar with the concept of peer entities in network and communications systems. I am familiar with routing of packets.

33. I am familiar with analog and RF circuit design and architectures including those for Wi-Fi. I have designed Wi-Fi chips and processors during my career. I have designed analog circuitry. I have taken classes on analog and RF design. I am familiar with up conversion and down conversion of signals. I am familiar with digital and analog processing of signals as well as conversion between analog and digital signals. I am familiar with digital signal processing. I am familiar with modulation and coding techniques. I am familiar with RF mixers, local oscillators, analog and RF filtering, low noise amplifiers, power amplifiers, direct conversion, low-IF signals, and superheterodyne receivers.

34. I have worked on products during my career that are based on standards from the IEEE, ITU, and Wi-Fi Alliance, along with many others.

35. I am familiar with the implementation techniques for chips and modules within home gateways and wireless routers.

36. I am familiar with regulatory issues certifications required for products like Wi-Fi access points and home gateways.

III. Compensation

37. My work on this matter is being billed at my customary rate of $805 an hour. Also, I am being reimbursed for reasonable expenses I incur in relation to my services. I have no pecuniary interest in the outcome of this proceeding. I understand I will be paid regardless of the outcome of any proceeding in which my work is used.

IV. Legal Consideration

38. I am not an attorney. I have applied the legal standard below, which was provided by counsel for AT&T. .

A. Obviousness

39. I understand that a claimed invention is obvious and, therefore, not patentable if the subject matter claimed would have been obvious to a person of ordinary skill in the art as of the time of the earliest claimed priority date of the ’720 Patent (a “POSITA”), which I have been asked to treat as October 24, 2002.

40. I understand that a claim can be obvious in view of a single prior art reference (e.g., via modification of that prior art reference) or multiple prior art references (e.g., via a combination of two or more prior art references), if such a modification or combination was within the skill of a POSITA. I understand that there must be some articulated reasoning with some rational underpinning to support a conclusion of obviousness. I also understand that to establish a finding of obviousness one must show that one of ordinary skill in the art would have had a

motivation to combine the prior art references to produce the claimed invention and a reasonable expectation that the combination would be successful.

41. I further understand that exemplary rationales that may support a conclusion of obviousness include: (1) simply arranging old elements in a way in which each element performs the same function it was known to perform, and the arrangement yields expected results, (2) merely substituting one element for another known element in the field, if the substitution yields no more than a predictable result, (3) combining elements in a way that was "obvious to try" because of a design need or market pressure, where there was a finite number of identified, predictable solutions, (4) that design incentives or other market forces in a field would have prompted variations in a work that were predictable to a person of ordinary skill in the art, and (5) that there was some teaching, suggestion, or motivation in the prior art that would have led a POSITA to modify or combine prior art references to arrive at the claimed invention.

B. Claim Interpretation

42. I understand that a claim term is interpreted according to its ordinary and customary meaning as a POSITA would have understood the term in light of the surrounding claim language, other claims, the specification, and the patent's prosecution history, which are referred to as intrinsic evidence. I also understand that prior art references cited in the patent's prosecution history are considered

intrinsic evidence. I further understand that evidence outside the patent and its prosecution history (e.g., dictionaries and technical articles), may inform the context in which a POSITA would have understood the claims of a patent. I understand this ordinary and customary meaning applies absent unique circumstances, such as where a patent clearly expresses an intent to set forth a special meaning for a term.

V. Overview of Task & Basis for Opinions

43. I have been asked to review the ’720 Patent. I have been asked to provide opinions related to certain issues from the perspective of a person of ordinary skill, having knowledge of the relevant art, as of October 22, 2004, and—except where otherwise noted—the opinions stated in this declaration are from that perspective. The qualifications and abilities of such a person are described in Section VI below.

44. In preparing this declaration, I have considered the ’720 patent and its prosecution history, as well as the general knowledge of those familiar with the field of technology relating to wireless communications, which includes wireless local area network (WLAN) protocols, MIMO techniques, IEEE 802.11, also known as “Wi-Fi” technology and standards developments, modulation techniques, such as OFDM, and relevant governmental regulations surrounding wireless networks circa 2002.

45. My opinions are based on my education, training, and experience as well as items that I reviewed to prepare my opinions, including the Petition, the documents listed in the Exhibit List included with the Petition, and any other items that I reference in my below analysis.

46. I understand that other issues may arise that require further explanation, and I will provide that explanation if appropriate. As a result, I respectfully reserve the right to update and supplement this declaration and the information and opinions provided herein.

VI. Level of Ordinary Skill in the Art

47. A POSITA pertinent to the ’720 Patent would have had at least (1) a master’s degree in electrical engineering, computer engineering, computer science, or a similar field, and (2) at least two years of academic or industry experience designing physical and medium access control protocols for wireless network protocols. A POSITA would have been aware of major industry standards including IEEE 802.11 (Wi-Fi), IEEE 802.3 (Ethernet), cellular, and IETF (Internet). The prior art evidences this level of ordinary skill. Additional education might substitute for some experience, and vice versa.

48. Here, the background technology described in Section VII and the prior art described in Section X demonstrate that a POSITA would have been familiar with the underlying principles of wireless local area network (WLAN) protocols,

including wireless transceiver designs, MIMO technologies (which are not mentioned in the '720 Patent, but would have been within the knowledge of a POSITA at the time), the existing IEEE 802.11 (Wi-Fi) standards, and the active 802.11 task groups further developing Wi-Fi technology.

VII. A POSITA's Understanding of the Field of Technology

A. Multiple Input Multiple Output (MIMO) Wireless Technology

49. Well before 2002, the Multiple Input Multiple Output (MIMO) concept and advantages that "can be achieved by the use of spatial diversity (multiple antennas), and optimum combining" were known. EX1034, 2/6; EX1035, 1-2/19; EX1036, 1-3/10.

50. A POSITA would have been familiar with techniques for using multiple antennas non-simultaneously, such as antenna selection for transmission and reception.

51. A POSITA would also have been aware of techniques that use multiple antennas simultaneously at the transmitter or receiver while still transmitting a single stream of information. For example multiple simultaneous receive antennas would have been known to facilitate maximal ratio combining (MRC), which uses multiple antennas to simultaneously receive signals and improve reception quality. In addition, a POSITA would have understood the use of multiple antennas for

beamforming, where a single signal is transmitted in a directed manner to maximize signal quality at the receiver.

52. A POSITA would have been familiar with MIMO techniques involving the simultaneous transmission and reception of multiple spatial streams using multiple antennas at both the transmitter and receiver, thereby utilizing the resulting matrix channel. A POSITA would also have been familiar with signal processing techniques used to support such transmissions, including, but not limited to, matrix channel estimation based on training signals, matrix decomposition methods such as singular value decomposition (SVD), and channel inversion techniques applied at the transmitter and/or receiver. Additionally, a POSITA would have been familiar with the use of steering matrices at the transmitter to map a plurality of data streams onto independent eigenmodes of the matrix channel. A POSITA would also have understood that SVD yields unitary matrices, which perform signal rotation in an N-dimensional space without altering signal power. Moreover, a POSITA would have been familiar with applying these techniques in orthogonal frequency-division multiplexing (OFDM) systems on a per-subcarrier basis.

53. Also prior to 2002, it was understood that successfully transmitting multiple independent data streams over the same frequency channel required leveraging the matrix channel formed by multipath propagation. Such matrix channels often have a rank greater than one, thus allowing multiple data streams to

be transmitted independently. To achieve this, pre-processing techniques—commonly referred to as precoding or spatial steering—were known to provide sufficient spatial separation among the streams. These techniques enabled each spatial stream to be mapped to a distinct subspace or eigenmode of the matrix channel. It was recognized that without such separation, multiple data streams could overlap in the same subspace or dimension, rendering them indistinguishable at the receiver and preventing accurate recovery of the individual streams. EX1007, [0115]-[0124], [0168].

54. Generally speaking, MIMO works as follows. Assuming that the transmission path between the *j*th transmit antenna and the *i*th receiver antennas can be expressed in terms of amplitude and delay, the channel response matrix, **H**, (i.e., the channel's effect on signals transmitted from each of the transmit antennas to each of the receive antennas) may be derived based on all of the paths from each of the *j* transmit antennas to each of the *i* receive antennas, forming an *i*-by-*j* channel matrix. This channel matrix, **H**, may be referred to as a MIMO channel, or matrix channel, since it fundamentally arises from the use of multiple transmit antennas and receive antennas using the same frequency channel. There are not multiple, separable transmission paths unless multiple transmit or multiple receive antennas are used.

55. If the multiple data streams are transmitted on respective transmit antennas, mathematically, this can be expressed as a vector of transmit signals, **x**.

The received signal is a corresponding vector of signals, **y**, that results from the matrix-vector multiplication of **x** with the MIMO channel matrix: $\boldsymbol{y} = \mathbf{H}\boldsymbol{x}$. In this case, the receiver can perform processing to recover the transmitted signals. An obvious approach based on basic linear algebra is to multiply the receive signal, **y**, by the inverse of the channel matrix: $\mathbf{H}^{-1}\mathbf{y} = \mathbf{H}^{-1}\mathbf{H}\boldsymbol{x} = \mathbf{I}\boldsymbol{x} = \boldsymbol{x}$. Thus, the transmit signal vector, **x**, may be derived using this equation. This MIMO processing approach was known in the art by 2002.

56. Another approach to allow the transmitted signals to be derived at the receiver is to pre-multiply at the transmitter by the inverse of the channel matrix so that the effect of the physical transmission channel during transmission is negated. In effect the operation of the inverse matrix now occurs first: $\mathbf{y} = \mathbf{H}\mathbf{H}^{-1}\mathbf{x}$.

57. Both of the approaches describe above are known as zero-forcing solutions, as they aim to completely eliminate interference by inverting the MIMO channel matrix. The receiver-side approach is commonly referred to as zero-forcing equalization, while the transmit-side approach is commonly referred to as zero-forcing precoding (ZF beamforming).

58. Those of skill in the art understand that such zero-forcing approaches are basic to understand but are suboptimal in the sense that they ignore the reality of noise. Zero-forcing solutions can have severe noise amplification. Better approaches are known that do not completely cancel the interference between signals

but instead focus on objectives such as maximizing the signal-to-noise ratio at the receiver, which maximizes the matrix channel's data-carrying capacity.

59. The receiver must be involved in estimating the MIMO channel matrix, whether precoding and/or receive processing is used because the channel cannot easily be estimated except by sending a signal through it and measuring the channel's effect on that signal. Accordingly, a straightforward way to estimate the MIMO channel is to have the transmitter send a known signal (called a training, or pilot, signal) to the receiver. The receiver, knowing the received signal and the original, transmitted training signal, can then calculate (estimate) the MIMO channel matrix. For example, if there are two transmitter and two receiver antennas, then $\mathbf{H}$ is a 2x2 matrix. Let $\mathbf{x_1}$ and $\mathbf{x_2}$ be two known training signals that are sent sequentially. There are then two corresponding received vectors: $\mathbf{y_1 = Hx_1}$ and $\mathbf{y_2 = Hx_2}$. We can rewrite the two equations in matrix form as $\mathbf{Y = HX}$ and then solve for $\mathbf{H}$. This results in $\mathbf{H = YX^{-1}}$, which allows the receiver to solve for $\mathbf{H}$, then either use it for post-processing received signals, or send it to the transmitter to precode, or precondition, the signals before transmission.[1]

60. In line with the examples above, Walton discloses "a multiple-access communication system" for a "LAN," including "access point[s]" and "terminals,"

[1] For situations where H is not full rank it can be estimated using the pseudoinverse $H^+ = (H^TH)^{-1}H^T$. $H^+Y = ((H^TH)^{-1}H^T)(HX) = (H^TH)^{-1}(H^TH)X = IX = X$. This solution is known to be a least-squares estimate in linear algebra.

that "utilize[s] orthogonal frequency division multiplex (OFDM)" and sends channel state information (CSI) feedback that enables "adaptively process[ing] data prior to transmission, based on channel state information, to more closely match the data transmission to the capacity of the channel." EX1007, [0043]-[0047], [0055], Abstract. I discuss Walton further in §X.A.1 below.

B. 802.11 Wireless Local Area Network (WLAN) Standards and Regulatory Restrictions on Use of Shared Spectrum

61. "The IEEE 802.11 WLAN standard," "Wi-Fi," "is part of a family of IEEE local and metropolitan networking standards." EX1012, 3/11; EX1024, 4/10. Printed publications describing Wi-Fi developments included final standards as well as study items and proposals developed by IEEE 802.11 task groups.

62. By 2002, IEEE had published 802.11a-1999, which defined a "high-speed Physical Layer in the 5 GHz band" using "OFDM" that instructed the reader to "merge" the specification "into IEEE Std 280.11, 1999 Edition, to form the new comprehensive standard." EX1009, 9-11/90. "In IEEE 802.11, the addressable unit is a station (STA)." EX1025, 24/528. "An access point (AP) is a STA that provides access to the [distribution system (DS)] by providing DS services in addition to acting as a STA." *Id.*, 26/528. The '720 Patent recognizes IEEE 802.11a as prior art. EX1001, 19:42-45.

63. Wi-Fi is designed to operate in shared spectrum, including the 5 GHz Unlicensed National Information Infrastructure (U-NII) bands used by IEEE

802.11a. The MAC layer coordinates access to the shared medium. In prior art versions of Wi-Fi, devices on the same BSS shared the medium via time-division, i.e. only one device sending at a time. Prior art Wi-Fi allowed multiple BSSs to operate in the same location without sharing the medium via frequency division, i.e. operating on non-overlapping channels. If two or more BSS used the same channel, they would use time division to share the channel. In effect this time division, or sharing, the "fundamental access method of the IEEE 802.11 MAC is a [distributed coordination function] DCF known as carrier sense multiple access with collision avoidance (CSMA/CA)." EX1025, 85/528. "The exchange of [Request To Send] RTS and [Clear To Send] CTS frames prior to the actual data frame is one means of distribution of this medium reservation information." *Id.*, 88/528.

64. Additionally, as regulatory agencies permitted WLAN use of the 5 GHz band, they required WLAN transmission to avoid interference with existing government users already operating in those bands. EX1009, 3-4/90 EX1013, 3-4/7; EX1014, 1/2; EX1015, 4/28. For example, the European Radiocommunications Committee (ERC) permitted WLAN ("HIPERLAN") operation in the 5 GHz band for WLAN equipment "capable of ***avoiding*** occupied channels by employing a Dynamic Frequency Selection mechanism …." EX1013, 4/7, 6/7.

65. In light of the ERC regulations in the 5 GHz band and the potential adoption of similar regulations in the United States, 802.11 Task Group h (TGh) was

launched on December 13, 2000 to "provide Dynamic Channel Selection and Transmit Power Control mechanisms" for 802.11 that would "enabl[e] regulatory acceptance of 802.11 5 GHz products." EX1016, 5/7. The TGh members understood that "avoid[ing] co-channel operation," as required by the ERC meant that "DFS must be able to detect radars and change channel accordingly." EX1018, 3/3; *see also* EX1013, 6/7. Thus, by 2002, a POSITA implementing a Wi-Fi system was aware of the need to identify and avoid frequencies occupied by other systems. This need to avoid other systems manifested itself both in the absolute avoidance of radar and similar systems, as well as the desirable avoidance of adjacent WLAN systems such that nearby WLAN systems operate on different channels to minimize interference.

66. The '720 Patent recognizes the FCC's "adoption of a policy of 'Interference Protection,' which defines an acceptable level of interference to primary users from secondary users" as the "need[]" the '720 Patent was intended to address. EX1001, 1:35-63. A POSITA would have understood this as addressing a similar, if not the same, problem addressed by 802.11 Task Group h starting in 2000.

C. Detection and Avoidance of Occupied Frequencies

67. In part motivated by the challenges discussed above, methods for detecting and coordinating avoidance of occupied frequencies causing interference

were well known in the wireless space by 2002. For example, Hamabe discloses "an adjacent carrier frequency interference avoiding method" in which "the mobile station [] determines that the condition for changing the carrier frequency in order to avoid adjacent channel interference is satisfied" and "transmits the control information to the base station" reporting the determination. EX1008, [0097], [0119], [0127].

VIII. Overview of the '720 Patent

68. With the goal of "tak[ing] advantage of the proposed spectrum policies" "permit[ting] secondary (e.g., unlicensed) users to radiate" limited power where "primary (e.g., licensed)" users exist, the '720 Patent proposes "measur[ing] the local spectrum at a receiving node," "generat[ing] an optimal waveform profile specifying transmission parameters that will water-fill unused spectrum up to an interference limit," and employing "closed loop feedback control." EX1001, 1:35-63, Abstract. Water-filling allows for transmission of power such that the received power does not exceed a limit at any frequency. If the local power spectrum is measured as over the limit without any transmission, then no signal power can be transmitted at that frequency. If the local power spectrum at a frequency is below the limit, power can be transmitted at that frequency. The "water-filling" approach is known in the art to mean that power is gradually added at different frequencies such that the combined power of the noise and the transmitted signal at the receiver

(at frequencies to which power is allocated) is a constant. This can be visualized as adding "water" (transmit power) at different frequencies having different noise levels. The allocated transmit power thus goes to the frequencies with lowest noise level first and gradually "fills" from the frequencies with lowest noise level like water. This approach maximizes SNR and thus maximizes channel capacity (the maximum data rate at which data can be communicated through the channel with practically no errors). *See* EX1001, 12:59-65.

69. In one example provided in the '720 Patent, the receiver analyzes a received OFDM waveform and "narrow band (25 KHz) excision of spectral spikes are used to minimize interference produced by legacy systems." *Id.*, 10:56-64. The receiver then transmits an "instruction," which "may be embodied in or combined with [the] optimal waveform profile" identifying those excisions. *Id.*, 3:6-10, 4:15-20. Based on the instruction, the transmitting node performs "transmit excision" by "filtering a transmission signal to remove power at frequencies that should be avoided. *Id.*, 4:12-14; *see also id.*, 22:8-17.

70. The '720 Patent also discloses "closed loop power control" for "frequencies corresponding to positive power differentials so that the receiver receives transmissions from all of its neighbors at the same power level." *Id.*, 3:37-43; *see also id.*, 10:22-37. The closed loop power control is accomplished using "feedback," embodied in a "request to adjust (or limit) [another node's] transmission

power level," thus "minimiz[ing] the transmit power." *Id.*, 3:38-44. Closed loop power control was well known in the art of wireless communication design as a means for minimizing interference with nearby systems by reducing transmit power, if possible, to the lowest level at which the receiver can still receive the signal without an unacceptable error rate. This requires some sort of feedback mechanism because only the receiver knows at what power level it is currently receiving signals. Because there is a control signal sent from the receiver back to the transmitter, there is thus feedback to regulate the output of the system.

71. The Challenged Claims both as written and as interpreted by PO, bear little resemblance to the '720 Patent's disclosure. In parallel litigation, PO asserts the recited steps of receiving an "instruction" "to avoid using a plurality of frequencies," "filtering a transmission signal to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided," and "transmitting the filtered transmission signal to the second node" (e.g., [19.1]-[19.3]) are met by a parameter embedded in a CTS message selecting the bandwidth for subsequent data packets and complying with known transmit spectral masks to the selected bands as defined in prior art 802.11 standards. EX1010, 31, 48, 52-53, 56-

57/426.[2] This is far afield from the disclosures teaching of transmission of an "instruction" in the form of an "optimal power profile."

72. Next, PO asserts the recited steps of receiving "compressed feedback," decompressing the" "compressed feedback," "generating one or more data structures based on the decompressed" feedback, transmitting the "filtered first transmission signal" "using a first power that is based on at least one of the one or more data structures," and transmitting a "filtered second transmission signal" "using a second power that is based on at least one of the one or more data structures" (e.g., [19.4]-[19.10]) correspond to receiving beamforming feedback and performing multi-user MIMO as defined in later 802.11 standards published after 2002. EX1010, 58-71/426.[3] There is little if any evidence of disclosure of data structures associated with compression in the disclosure at all. There is certainly no disclosure of MIMO or feedback based on the channel matrix.

IX. IEEE Publication Practices Relevant to the Cited 802.11 Documents

73. In addition to my review of the '720 Patent and the Petition, I have been asked to attest to my experience with the Institute of Electrical and Electronics

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[2] This is despite the fact that the '720 Patent stating that the "present invention" "requires MAC protocol that is quite different from conventional carrier sense multiple access/collision detect (CSMA/CD) protocols, such as IEEE 802.11, which uses RTS/CTS exchanges." EX1001, 20:12-23.

[3] This is despite the fact that the '720 Patent does not mention MIMO or beamforming. EX1001, 20:12-23.

Engineers (IEEE) and their publication practices. Specifically, I have been asked to attest to my experience working in 802.11 task groups in the late 1990s and early 2000s, both as a working member and as the chairperson of multiple task groups.

74. With respect to the published standards themselves, 802.11a-1999 and 802.11-1999, for example, IEEE routinely published copies of each new standards document after it was ratified. 802.11-1999 was published in 1999. The version relied on by the Petition and identified as EX1025 was available to the public at least by August 20, 1999. *See* EX1025, 3/528. 802.11a-1999 was also published in 1999. The version relied on by the Petition and identified as EX1009 was available to the public at least by December 30, 1999. EX1009, 1/90. Not only were these documents publicly available before 2000, both of these documents were central to the development of Wi-Fi technologies. A POSITA working on WLAN at the time would have been intimately familiar with both 802.11-1999 and the 802.11a-1999 amendment, in addition to the other 802.11 amendments that were in development at the time (e.g., 802.11g, 802.11e, etc.). I personally obtained the IEEE 802.11-1999 standard in 1999 while working at Alantro Communications, Inc. It was purchased via the IEEE. I obtained purchasing approval from Eric Rossin, the President of Alantro Communications, Inc. Alantro also hosted the meeting in 1999 at which the IEEE 802.11a-1999 amendment's ratification was announced and celebrated. I not only attended that meeting but was the lead employee of Alantro

Communications, Inc. that hosted that meeting at the Hilton Sonoma County in Santa Rosa, California.

75. During the development of a new version of or addendum to the existing 802.11 standard, a task group composed of tens to hundreds of engineers meets regularly, with the members exchanging proposals for the implementation of the standard and voting on preferred solutions that are ultimately adopted as new versions of the 802.11 standard. I personally participated in the development of many of the early 802.11 standards, including 802.11a and 802.11-1999, which are the subject of the Petition. By 2000, all of the documents presented at any task group meeting were published soon after the in-person meeting on IEEE 802.11's public document server. In fact, there was a standing rule that documents must be uploaded to the group's private, temporary server before they were allowed to be presented at a meeting. Then, every document on the temporary server would be periodically uploaded to the public server. This publication process from the private to public server occurred within about one week of each 802.11 session. As a result, I believe the 802.11 documents cited in the Petition were publicly available as of October 24, 2002, in accordance with standard IEEE 802.11 procedures for task group submissions.

X. Grounds Challenging the ’720 Patent

A. Ground 1: Walton, Hamabe, and 802.11a Render Obvious Claims 19, 22-33, 36-43, 45, 46, 49-58, 60-75, 77-93, and 95.

1. Walton

76. Walton discloses “a multiple access MIMO system” that “adaptively process[es] data prior to transmission, based on channel state information.” EX1007, Abstract. Walton’s MIMO system uses the channel state information (CSI) to “achieve better utilization of the available resources (e.g., transmit power and bandwidth) and robust performance for the downlink and uplink.” *Id.*, [0010]. In several embodiments, discussed below, the CSI is the channel response matrix, **H**, itself, or a compressed approximation of it. *See* EX1007, [0091], [0312].

77. Walton discloses “a MIMO system utilizing OFDM” that can operate in various modes, including “multi-user MIMO mode.” EX1007, [0048], [0062]-[0067], [0129]-[0136], FIG. 3E. In a MIMO OFDM system, “each spatial subchannel of each frequency subchannel” is “a transmission channel,” a plurality of which make up the broader MIMO “communication channel” between a transmitter and one or more receivers. *Id.*, [0051]-[0052]. Using MIMO, “a transmitter unit may send multiple independent data streams on the same communication channel to [] multiple receiver units by exploiting the spatial dimensionality of the communication channel coupling the transmit and receive

antennas." *Id.*, [0055]. Figure 2A depicts "a block diagram of a [blue] base station 104 and two [green, red] terminals 106 within system 100." *Id.*, [0076].

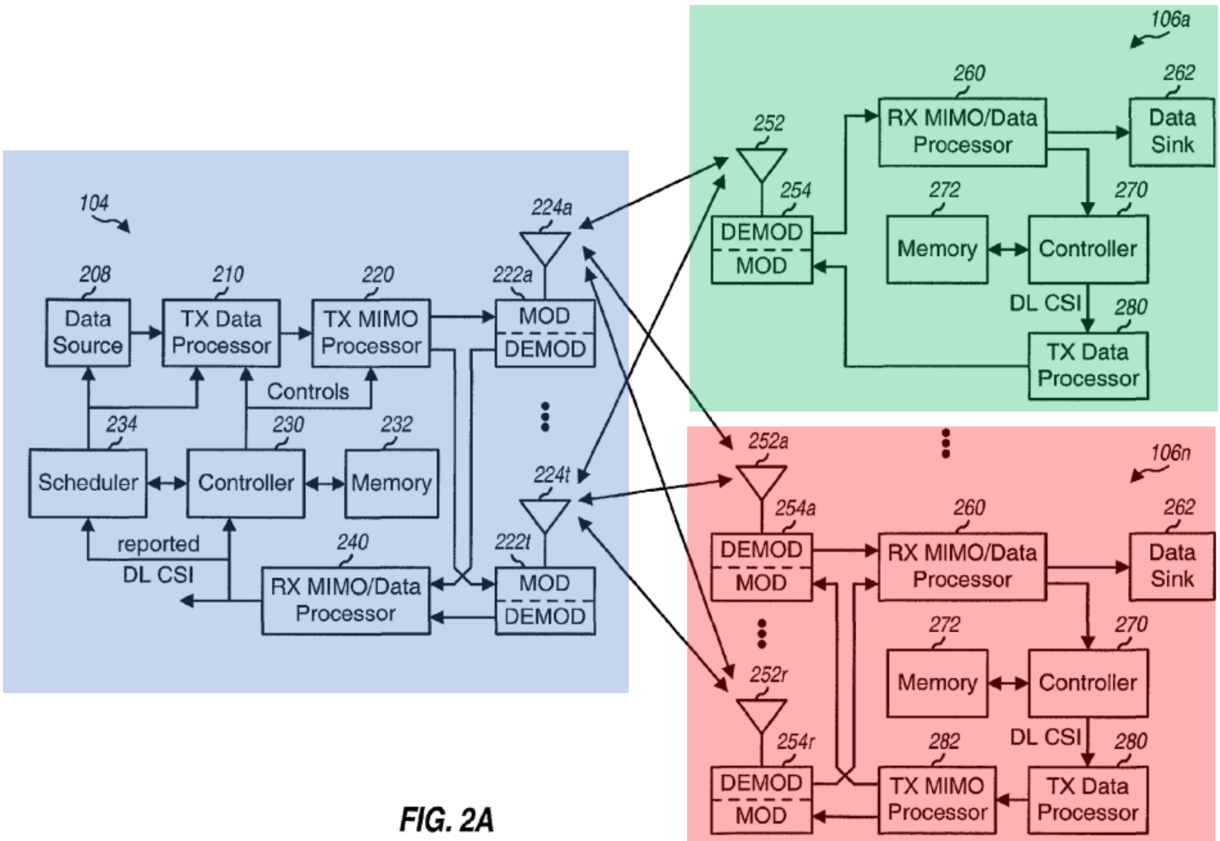


FIG. 2A

Id., FIG. 2A (annotated).

78. FIG. 3E depicts "a transmitter unit 300e, which utilizes OFDM and is capable of independently processing data for each frequency subchannel" using CSI. *Id.*, [0130].

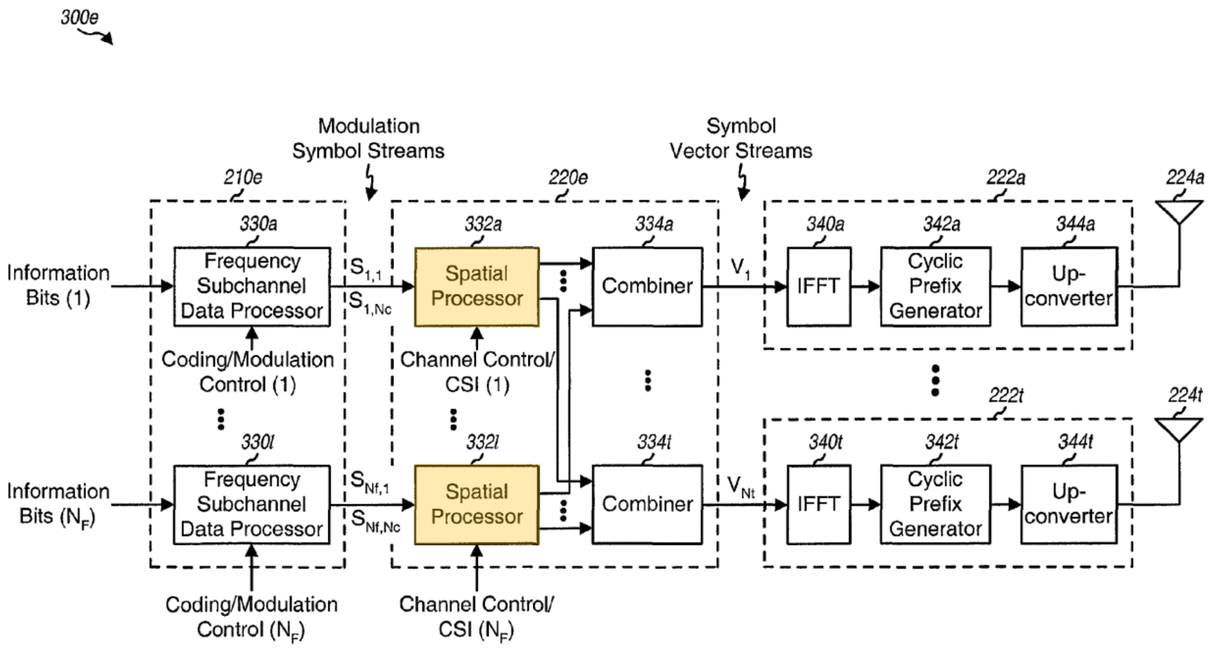


FIG. 3E

Id., FIG. 3E (annotated). "Each [orange] spatial processor 332 … may implement a MIMO processor followed by a demultiplexer (such as that shown in FIG. 3C) if full-CSI processing is performed." *Id.*, [0131].

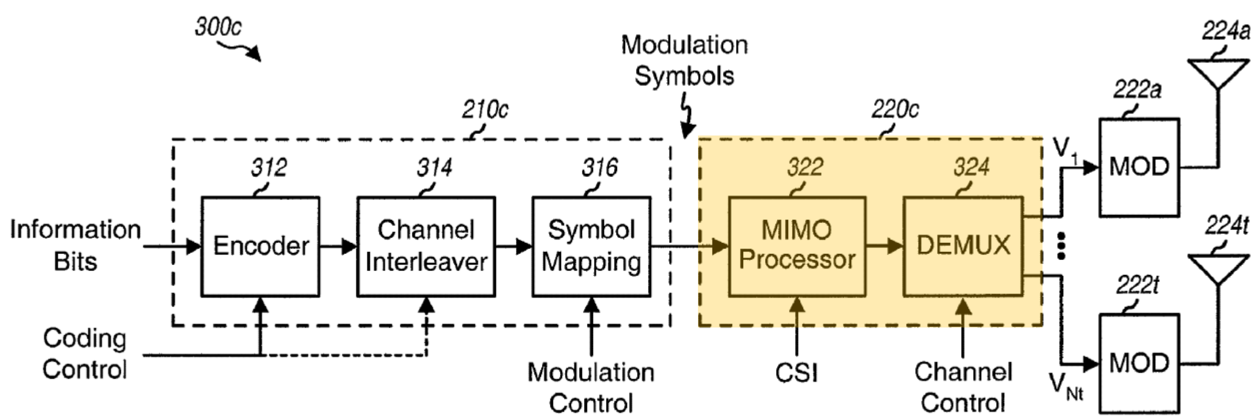


FIG. 3C

Id., FIG. 3C (annotated).

79. Walton also discloses several CSI embodiments that offer different balances between MIMO processing complexity, CSI feedback overhead, and the completeness of the channel characterization. *Id.*, [0303]-[0315]. It was known in the art that the MIMO channel may be more accurately characterized if the entire channel matrix is known. On the other hand, the channel matrix can be quite large, even for a relatively small number of transmit and receive antennas. Further, in an OFDM system, there may be a channel matrix per OFDM subcarrier. Therefore, a POSITA would have known that it may be advantageous to send the entire channel matrix under certain circumstances, for example when minimal quantization noise is required of delay of compression and decompression must be avoided. Likewise, a POSITA would know that it would be advantageous to send a more limited version of feedback under other circumstances, e.g. a version with less accuracy but also less data to transfer, when the amount of data to transfer becomes large or when the resolution of the CSI feedback is not the limiting factor in the system. To this end, Walton proposed several different variations for its CSI feedback that may be used under different operating conditions.

80. In the configuration of Walton mapped in this Petition, the CSI is "full CSI [that] comprises eigenmodes [of the channel]," as well as "other information that is indicative of, or equivalent to, SNR." EX1007, [0312]. Walton explains that this full CSI may be compressed using "compression and feedback channel error

recovery techniques to reduce the amount of data to be fed back." *Id.*, [0323]. Other applicable compression techniques were also known in the art. *See e.g.,* EX1031, 33:32-35:10. Compression as a topic was well-studied by 2002 and a POSITA would have been familiar with any number of applicable compression techniques to reduce the amount of data (e.g. number of bits) that must be used to represent the CSI feedback signal. Both lossy and lossless compression techniques were known. Additionally, it was known to represent matrices in different forms. Mathematically, Givens rotations were a known method for representing a unitary matrix—such as **V** from the singular value decomposition of a matrix—in a compact form as a product of planar rotations. EX1040, 2:52-3:57; *see also* EX1041, 3:22-45 (applying a Givens rotation to parameterize unitary matrices in the MIMO context).

2. IEEE 802.11a

81. As discussed in Section VII.B, IEEE 802.11a disclosed a Wireless LAN employing an OFDM physical layer operating in the 5 GHz band, along with PHY and MAC layer functionality for carrier sense multiple access with collision avoidance (CSMA/CA) using RTS/CTS frames. The basic RTS/CTS exchange first involves the transmission of a RTS message from a STA that desires to send data on the network's channel. EX1025, 88-89/528. The addressed STA responds with a CTS. *Id.*, 98/528. It was known in the art that control information providing specific instructions as to how to perform communication could be included in either the

RTS or CTS frames, either through modification or remapping of parameters. *See e.g.,* EX1032, [0048]; EX1033, [0029]-[0031], [0086], Fig. 7. In many cases, it was desirable to extend the MAC header information in a frame like RTS or CTS to capture new control signals because legacy devices were already familiar with these known formats. The RTS and CTS messages are also very short messages, thus they are ideal for communicating a small amount of information and for avoiding collisions with other transmissions.

82. 802.11a splits the 5 GHz band into 12 "channels," so that "overlapping and/or adjacent cells" may "operate simultaneously" "using different channels." EX1009, 34-35/90.

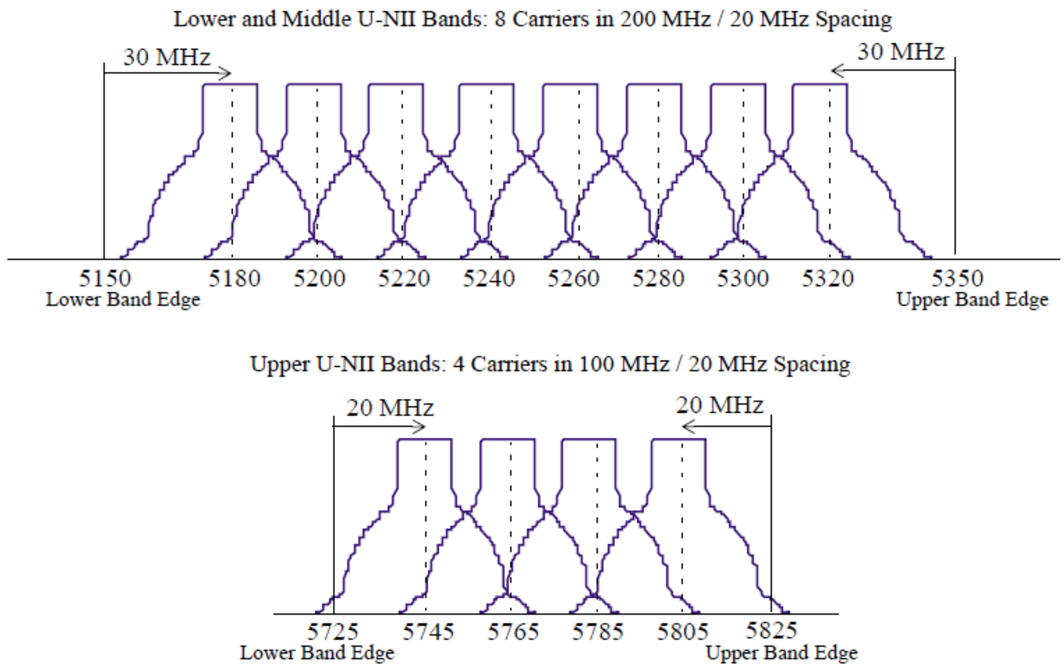


Figure 119—OFDM PHY frequency channel plan for the United States

Id., 35/90.

83. 802.11a discloses a "PPDU encoding process" to generate the OFDM symbols and "[u]p-convert the resulting 'complex baseband' waveform to an RF frequency." *Id.*, 15-16/90. 802.11a also specifies that the "transmitted signals" must comply with "spectral mask and modulation accuracy requirements" and "[t]ime domain windowing, as described here, is just one way to achieve those objectives." *Id.*, 18-19/90. The spectrum mask is shown below:

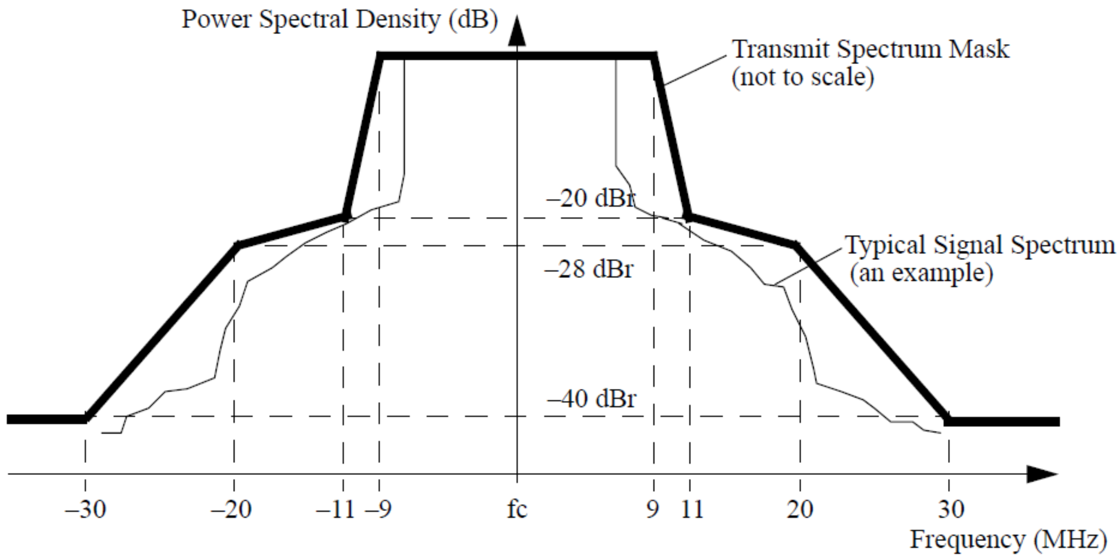


Figure 120—Transmit spectrum mask

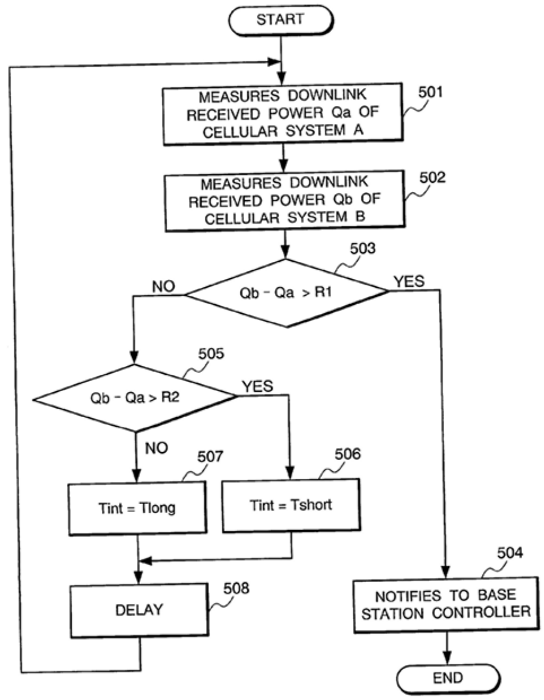
Id., 37/90. PO pointed to "PPDU encoding process" and spectrum mask requirements that existed in 802.11a and were carried forward to 802.11ac to assert that 802.11ac-compliant devices meet Limitation [53.2]. EX1010, 48-53/426 (asserting that claimed filtering "is accomplished via a mask PPDU and resulting data scrambling. Further, power (that was used or could be used) is dynamically removed.").

3. Hamabe

84. Hamabe discloses a method to "determine[] that the carrier frequency must be changed in order to avoid adjacent frequency interference," then "assign[ing] a carrier frequency that is not adjacent to the carrier frequencies" of the interfering system. EX1008, [0117]. The mobile station "***measures*** the downlink received power Qa of Cellular System A" with which it is communicating and "the

downlink received power Qb of Cellular System B" "in the same area." *Id.*, [0126], [0098]. If the mobile station "finds that the difference between the received power Qb and the received power Qa is greater than the predetermined threshold R1, the mobile station 21 ***determines*** that the carrier frequency must be changed." *Id.*, [0127]. The mobile station then "generates control information to notify [the base station] that the condition for changing the carrier frequency has been satisfied, and transmits the control information to the base station 11." *Id.*, [0127], [0119] ("the information to be sent by the mobile station 21 should contain the results of this determination"). When the base station receives this notification, it "begins the process of changing the carrier frequency," selecting frequencies "which are not adjacent to the carrier frequencies" of the other network. *Id.*, [0124]. Said simply, at step 503 of Figure 5, Hamabe identifies a strong interferer in the area at the station, then at step 504 the station notifies, or instructs, the base station to switch channels to avoid the interference.

FIG. 5



Id., FIG. 5, *see also id.*, [0125]-[0131].

4. Motivation to Combine

85. A POSITA would have been motivated to combine Walton's MIMO OFDM techniques with the OFDM PHY and MAC layer protocols of 802.11a based on Walton's explicit disclosures and the complementary nature of the disclosures.

86. ***First***, Walton does not purport to describe a complete system but rather discloses "***techniques*** that may be used to achieve better utilization of the available resources" that "may be advantageously employed in … an OFDM system." EX1007, [0010]. Because 802.11a is a wireless OFDM system, a POSITA would

be motivated based on Walton's explicit instruction to adopt the 802.11a system as the base for applying Walton's MIMO OFDM techniques.

87. ***Second***, Walton states that the use of the disclosed MIMO system "is an effective technique for enhancing the capacity of multiple-access systems (e.g., cellular, PCS, ***LAN***, and so on)." EX1007, [0055]. Thus, a POSITA would be motivated to apply Walton's MIMO techniques to 802.11a based on Walton's specific identification of wireless LANs such as 802.11a as systems that could obtain the benefit of enhanced capacity by applying Walton's techniques. EX1007, [0007], [0010] ("better utilization of the available resources" and "robust performance").[4]

88. ***Third***, Walton and 802.11a's use of the same architecture and modulation demonstrates a likelihood of success. Walton teaches that "base station 104" "may also be referred to as an access point," the specific terminology used for a base station in 802.11. EX1007, [0043]; EX1025, 19/528. And Walton discloses use of OFDM as in 802.11a. EX1007, [0047]; EX1009, 3-4/90.

89. Next, based on the explicit motivation published by 802.11 Task Group h to "enabl[e] regulatory acceptance of 802.11 5 GHz products" by adding "Dynamic Channel Selection and Transmit Power Control mechanisms" that are

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[4] Consistent with Walton's explicit motivation, in July 2004, shortly after 802.11 began soliciting 802.11 MIMO proposals as part of 802.11 Task Group n, Walton's inventors and their team at Qualcomm proposed the MIMO techniques disclosed in Walton for use in the first version of 802.11 to include MIMO. EX1026.

"able to detect radars and change channel accordingly" (EX1016, 5-6/7, EX1018, 3/3), a POSITA would be motivated to seek existing teachings of interference detection and channel selection. Hamabe is one such reference, disclosing a method to "determine[] that the carrier frequency must be changed in order to avoid adjacent frequency interference. EX1008, [0117]. Hamabe's disclosure of a cellular base station or a mobile station detecting interference from geographically overlapping wireless systems (an adjacent base station in Hamabe) and exchanging instructions to change frequencies is analogous to access points and non-access point stations in a wireless LAN detecting interference from geographically overlapping wireless systems (such as existing radar system) and changing frequencies as described by the 802.11h Task Group. Interference from transmissions in adjacent channels was a known problem in both cellular and Wi-Fi networks. In both cases, transmission errors may be reduced by avoiding channels adjacent to those being used by nearby networks. Accordingly, solutions to this problem were known to be beneficial in both cellular and Wi-Fi contexts. Thus, a POSITA would have been motivated to apply Hamabe's teachings to Walton/802.11a.

5. Modification of Walton in View of Hamabe and 802.11a

90. Combining Walton's MIMO OFDM techniques with the OFDM PHY and MAC layer protocols of 802.11a results in adopting 802.11a's OFDM modulation and channelization and CSMA/CA RTS/CTS protocols into Walton.

Walton's "[blue] base station 104" is thus implemented in the form of an 802.11 access point "and two [green, red] terminals" 106a and 106n are implemented in the form of 802.11 stations "within system 100" (the "radio communications network"). EX1007, [0076], FIG. 2A; EX1025, 24-26/528.

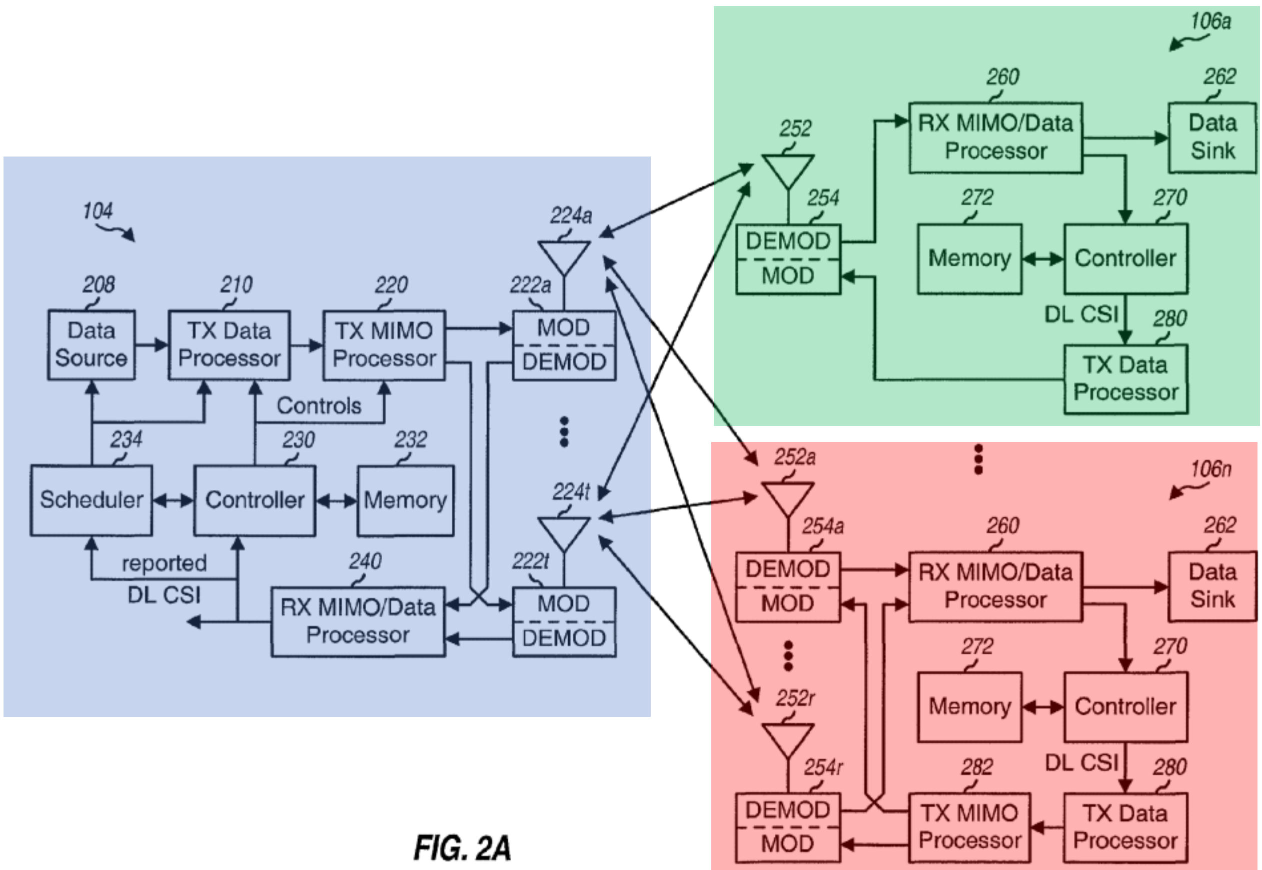


FIG. 2A

EX1007, FIG. 2A (annotated). In the combination, the base station/access point will be referred to as "access point 104," adopting the terminology of 802.11 but in reference to the physical layer implementation disclosed in Walton.

91. Walton's references to "frequency subchannel" in its MIMO system (EX1007, [0054], [0132], FIG. 3E) correspond to 802.11a's OFDM subcarriers

(EX1009, 11, 27-31/90). Combining the two, Walton's MIMO processing would be performed across the 52 subcarriers (or 48 data subcarriers) defined in 802.11a, which are used within each 20 MHz channel in the 5 GHz band. *See* EX1009, 27-31, 35/90.

92. More specifically, the processing would apply to the 312.5 kHz subcarriers (i.e., frequency subchannels) of 802.11a, of which there are 52 in total (48 data subcarriers and 4 pilot subcarriers). These 52 subcarriers (or 53, including the unused DC subcarrier) span a signal bandwidth of approximately 16.5625 MHz (53 × 312.5 kHz). IEEE 802.11a defines a spectral mask for these signals, ensuring that independent channels can be spaced 20 MHz apart. This spacing forms the basis of the IEEE 802.11a channelization scheme, which allows multiple channels within a designated spectrum band—such as the FCC's U-NII bands in the 5 GHz range or their equivalents in EU regulatory domains.

93. The combined system would therefore support operation on the 52 OFDM frequency subchannels within any of the 12 channels in the 5 GHz band defined in 802.11a. *See id.*, 35/90. This is accomplished by changing the system's center frequency, as was known in the art and already implemented in prior art 802.11a networks. *See id.*, 33-34/90. In addition, the system would be modified to comply with the other channelization specifications standardized in 802.11a's

OFDM system, including OFDM time windowing and spectral mask requirements. *See id.*, 15-19, 37/90.

94. Next, a POSITA would turn to Hamabe to include functionality in Walton/802.11a to comply with the 5 GHz regulatory requirements discussed in Sections VII.B, **Error! Reference source not found.** and recognized as prior art in the '720 Patent. Specifically, a POSITA would include in each terminal 106's functionality Hamabe's measuring and determining steps, but using the measurement target ("be able to detect radars" operating within the current channel) and criteria ("avoid[ing] co-channel operation") specified by the regulatory requirements. This can be done by, for example, modifying Hamabe's step 106 of Figure 6 to simply detect an unknown transmission over the power level specified in the applicable regulations. The unknown signal is presumed to be a radar signal.

95. If "co-channel operation" is determined, that terminal 106 performs Hamabe's steps of generating and transmitting "control information" (i.e., instruction) to the access point "to notify that the condition for changing the carrier frequency has been satisfied." EX1009, 3-4/90 EX1013, 3-4/7; EX1014, 1/2; EX1015, 4/28 EX1008, [0126]-[0127]. That is, each terminal 106 sends and access point 104 receives "control information" indicating that the current 802.11 channel includes interference from, for example, a radar, and instructing access point 104 to move to a different 802.11 channel. Because "various terminals 106 are dispersed

throughout the system" (EX1007, [0043]-[0044], FIG. 1), a POSITA would understand that each terminal would implement Hamabe's method in order to detect interfering devices in various geographic locations within the system.

96. Further, it would have been obvious to a POSITA to implement such an interference management mechanism because this is precisely what was required by regulatory agencies like the ERC. It was understood that the ERC regulations required evacuating channels in which government, or other licensed users were operating. In the art of wireless communication design, if a feature is required by a regulatory body, then developers (i.e., POSITAs) will react by implementing those features in their products. In addition, regulatory bodies generally do not issue regulations requiring features for which there are no known implementations. In this case, many possible implementations were known, Hamabe being one such example.

97. Further, to detect a radar, one only needed to detect an unknown transmission source above a power level prescribed by regulation, a capability built into 802.11 systems since the 802.11-1999 standard required an energy detect feature. EX1025, 239/528. . Energy detect capability was also required for 802.11a-1999 as part of the clear channel assessment (CCA) feature. EX1009, 40/90. Thus, the mechanisms by which a radar could be detected, were already built into the 802.11 standard. A POSITA would have readily been able to threshold the received

signal strength against the regulatory limit in combination with knowing that no 802.11 signal was detected as a means to detect and avoid radar signals.

98. 802.11a defines a modular framework for control messages that can implement Hamabe's "control information" messages and Walton's CSI feedback. EX1025, 49-58/528. Based on the modular nature of the MAC frame structure, it would have been obvious to a POSITA to modify a known MAC frame to include additional header fields for sending control information not defined in 802.11a. The 802.11 MAC frame has a structure that includes the frame type and subtype as well as the length (number of bytes), so frame types can be added/modified and modified without breaking compatibility with legacy devices. The obviousness of this approach is consistent with others contemporaneously reaching this solution. *See e.g.,* EX1033, Abstract, Figs. 7, 15, [0029]-[0031], [0086] (disclosing adding an additional MAC control field to "RTS-CTS," "DATA," and "ACK" messages to "with directives of link adjustment"); EX1032, [0048] (disclosing including a field specifying modulation format in an "RTS" frame and a field from the receiving station in a "CTS" frame indicating "whether accepts or refuses" the specified modulation). In addition to the examples above, task groups like 802.11e were already working on the addition of new fields to known frame formats, such as a quality-of-service (QoS) Control field, among others. EX1037, 27-29/90

99. Further, it would have been obvious to add Hamabe's "control information" into RTS and CTS MAC headers, specifically, because in the presence of interference, it is preferable to send very short messages that have a higher likelihood of being received without being interfered with. RTS and CTS are fundamentally designed to be short messages carrying a small amount of information, thus they would be obvious frame types to use for Hamabe's "control information," which is designed to be used when interference is present.

100. For these reasons, it would have been obvious to include a form of RTS/CTS frames that enabled the mobile station "to notify that the condition for changing the carrier frequency has been satisfied" within a MAC header field. EX1008, [0127]. Similarly, it would also have been obvious to send Walton's CSI in a MAC management frame, an 802.11 frame format that was known in the art as the ideal format for sending larger payloads of network management information. *See e.g.,* EX1037, 42-43/90 (defining a generic MAC management frame for sending information in the draft standard of 802.11e); *see also* EX1025, 65/528.

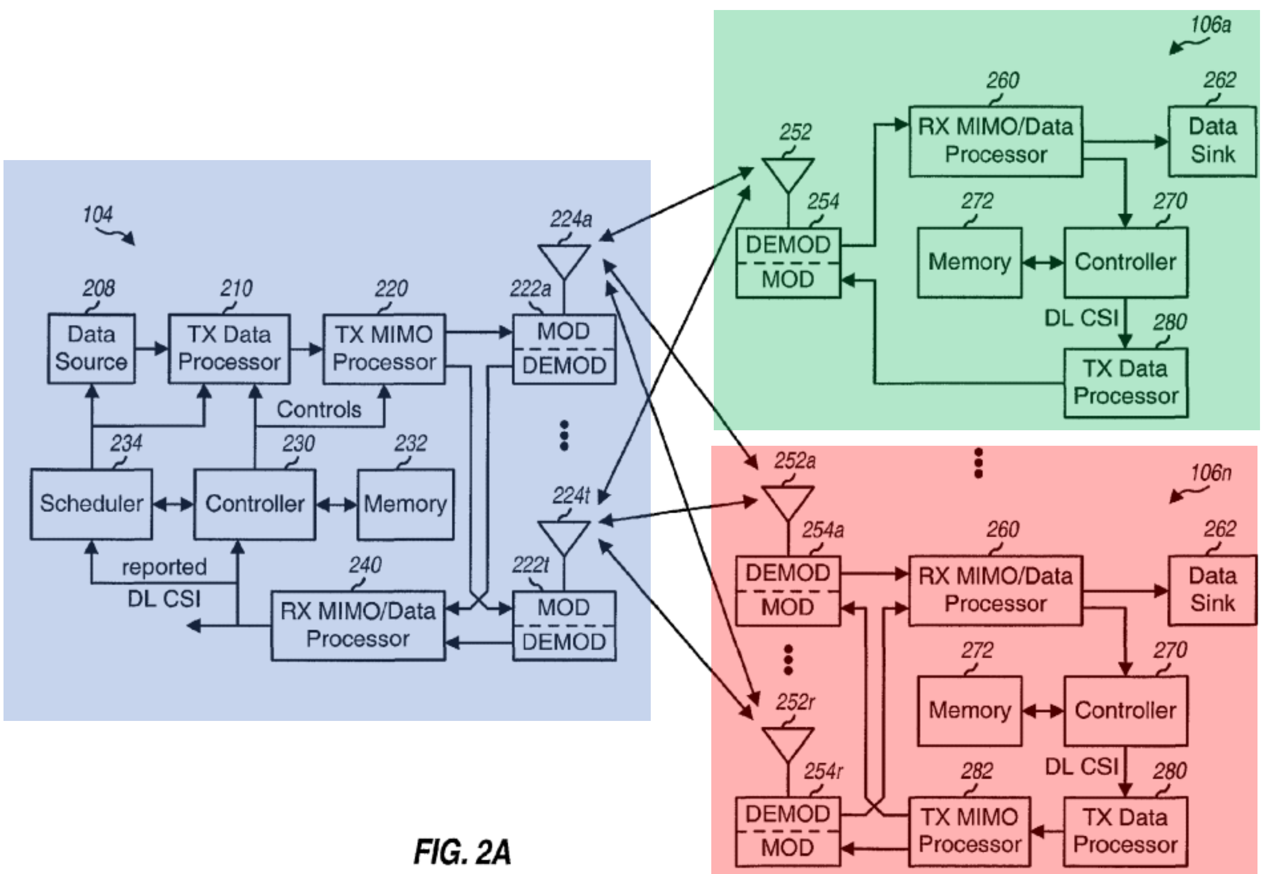
6. Element-by-Element Analysis

101. The analysis of each element below incorporates the above descriptions of each reference, the motivation to combine the references, and the resulting modification.

a. Claim 19

[19.pre] A method for managing interference in a radio communications network, comprising the steps of:

102. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [19.pre]. Walton/802.11a/Hamabe includes a [blue] access point 104 (the "first node") "and two [green, red] terminals" 106a and 106n in the form of 802.11 stations (the "second" and "third" "nodes") "within system 100" (the "radio communications network"). EX1007, [0076], FIG. 2A.



EX1007, FIG. 2A (annotated).

103. Walton describes MIMO techniques for "a wireless communication system." EX1007, [0010], FIG. 1. Walton's CSI and related preconditioning reduces co-channel interference (EX1007, [0090]-[0093]) and Hamabe's "carrier frequency interference avoiding method," implemented to "avoid co-channel operation" (EX1008, [0126]-[0127], EX1018, 3/3; EX1017, 1/17; EX1013, 6/7), avoids interfering signals. Thus, each aspect constitutes a method for managing interference in a radio communications network. *Id.*; EX1007, [0010], [0012]-[0013], [0090]-[0093], FIGs. 1, 2A, 4E; EX1008, [0002], [0020], [0125]-[0131].

[19.1] receiving at a first node in the radio communications network an instruction transmitted from a second node in the radio communications network to avoid using a plurality of frequencies to transmit to the second node;

104. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [19.1]. As discussed in Section **Error! Reference source not found.**, in Walton/802.11a/Hamabe if terminal 106a "determines that the carrier frequency must be changed," it "transmits the control information to" access point 104 that "contain[s] the results of this determination." EX1008, [0127], [0119], [0124]. Access point 104 in response "begins the process of changing the carrier frequency." *Id.* That is, access point 104 (the "first node") receives "control information" transmitted from terminal 106a (the "second node") indicating the current 802.11 channel "must be changed." *Id.*, [0127]. An indication that the current 802.11 channel "must be changed" instructs access point 104 to select a different 802.11

channel than the current channel, having a different center frequency. EX1009, 34-35/90. As Hamabe explains, upon receipt of this "control information," access point 104 "begins the process of changing" the 802.11 channel in use, confirming that the "control information is "an instruction" "to avoid using" the current channel "to transmit to the second node." EX1008, [1024].

105. PO's infringement allegations assert that an instruction to not use "at least one secondary channel" (a continuous 20, 40, or 80 MHz OFDM channel) constitutes an instruction "to avoid using a plurality of frequencies." EX1010, 30-31/426. Walton/802.11a/Hamabe's instruction that the current 802.11 channel (containing a plurality of frequencies) "must be changed" and, therefore, should be avoided, meets this element in the same way as PO's infringement mapping.[5]

[19.2] filtering a transmission signal to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided; and

106. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [19.2]. As explained in Limitation [19.1], in response to receiving "control information," access point 104 "begins the process of changing" the 802.11 channel in use to a different 802.11 channel. EX1008, [1024]. After selecting the different 802.11 channel, access point 104 would make subsequent transmissions, including

[5] To the extent a different 802.11 channel is selected that partially overlaps with the current channel, the non-overlapping frequencies constitute the plurality of frequencies to be avoided.

to terminal 106a, on that different 802.11 channel, observing 802.11a's standard channelization (EX1009, 11, 34-36/90) and "PPDU encoding process," "time windowing," and "spectral mask" requirements (*id.*, 15-19, 37/90).

107. In accordance with the standard, access point 104 will generate and "[u]p-convert the resulting 'complex baseband' waveform to an RF frequency according to the center frequency of the desired channel and transmit." EX1009, 15-16, 33/90. Where the "desired channel" is the different channel, the generated signal will not contain the "plurality of frequencies to be avoided" from the prior channel because each channel uses different frequencies. EX1009, 33-35/90. Further, 802.11a requires that the "transmitted spectral density of the transmitted signal shall fall within the spectral mask defined by the channel carrier frequency, f_c, of the desired channel, further confirming the signal does not include the plurality of frequencies to be avoided. EX1009, 33-37/90.

108. PO's infringement allegations assert that this standard process is sufficient to meet this limitation because filtering is allegedly "accomplished via a mask PPDU and resulting data scrambling." EX1010, 48/426. Walton/802.11a/Hamabe's use of 802.11a's standard channelization including the spectral "mask" meets this element in the same way as PO's infringement mapping.

109. Further, while 802.11a does not require a particular implementation of the spectral mask to comply with the standard, it would have been obvious to a

POSITA to implement a number of filtering processes to ensure transmit mask compliance. These include OFDM time domain windowing, intermediate frequency filtering during up-conversion, digital-to-analog converter filtering to reduce noise, and bandpass filtering following up-conversion. *See e.g.,* EX1009, 18-19/90 (OFDM time domain windowing), EX1029, 1:53-2:16, FIG. 2 (intermediate frequency filtering), EX1029, 3:20-40, FIG. 3 (digital-to-analog converter filtering), EX1030, 25:43-63, FIG. 26A (bandpass filtering).

[19.3] transmitting the filtered transmission signal to the second node;

110. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [19.3]. The conclusion of the process described in Limitation [19.2] is for access point 104 to "[u]p-convert the resulting 'complex baseband' waveform to an RF frequency according to the center frequency of the desired channel ***and transmit***" to the target station, including station 106a (the "second node") the "filtered transmission signal" generated in Limitation [19.2]. EX1009, 15-16, 33/90; *see also* EX1007, FIG. 2A, [0048] ("System 100 may be operated to transmit data via a number of 'transmission' channels").

[19.4] separately from the receipt of the instruction, receiving a compressed first feedback from the second node that is based on a received power and one or more frequencies of a first signal transmitted from the first node to the second node;

111. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [19.4]. Walton discloses at "***each*** terminal 106 for which a data transmission is

directed" from access point 104 "estimat[ing] the conditions of the downlink and provid[ing] channel state information (CSI) (e.g., post-processed SNRs or channel gain estimates) indicative of the estimated link conditions" and "transmit[ting] the downlink CSI back to [access point] 104 via a reverse channel." EX1007, [0080]-[0081], [0326]-[0327], FIG. 2A.

112. "At ***each*** active terminal," "[yellow] RX MIMO/data processor 260 [] estimates the conditions of the downlink and provides channel state information (CSI) … indicative of the estimated link conditions," "[red] TX data processor 280 [] receives and processes the [purple] downlink CSI, and provides processed data indicative of the downlink CSI (directly or via [red] TX MIMO processor 282) to one or more modulators 254" that "transmit the downlink CSI back" to access point 104." EX1007, [0080], FIG. 2A. At access point 104, "the transmitted feedback signal is received by antennas 224, demodulated by demodulators 222, and provided to [blue] RX MIMO/data processor 240." EX1007, [0081], FIG. 2A.

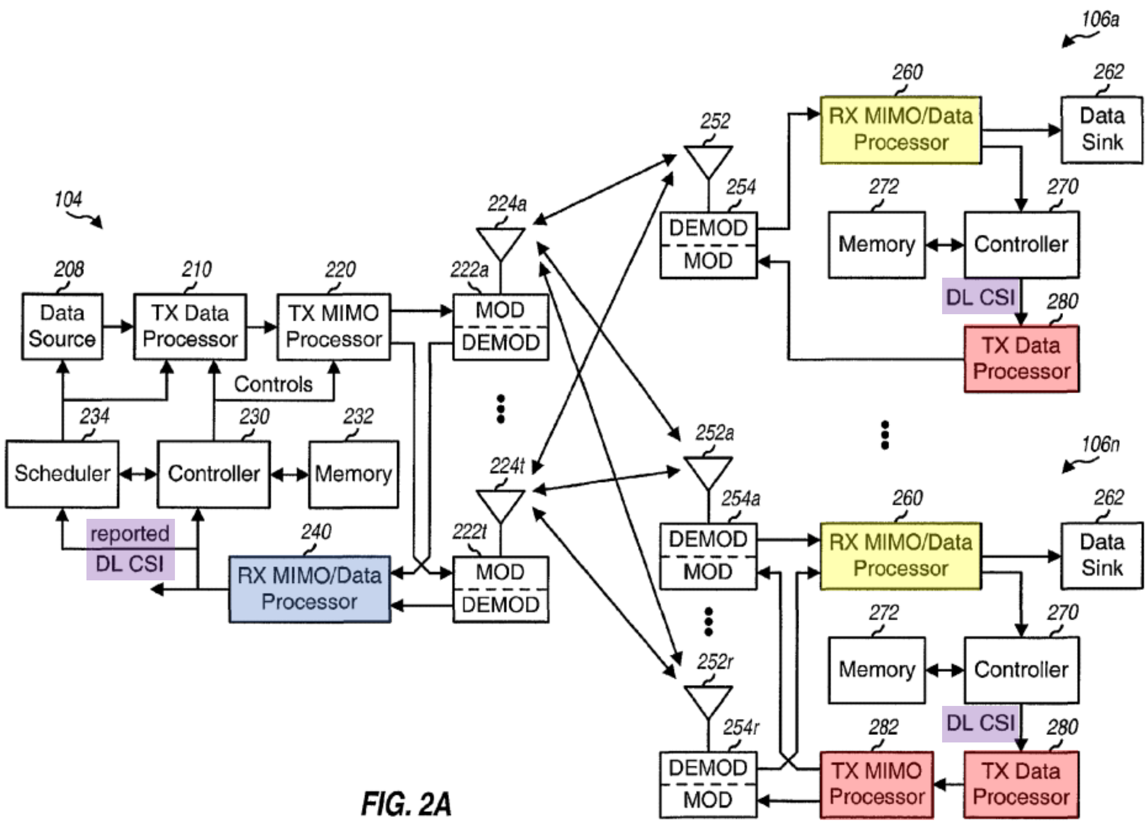


FIG. 2A

Id., FIG. 2A (annotated).

113. Thus, access point 104 receives first/second feedback from terminals 106a/106n (the "second"/"third" "nodes") of a first/second signal transmitted from access point 104 to terminals 106a/106n.

114. Walton's CSI feedback signal is "separate" from the "instruction" because the two are different signals used for different purposes.

115. Walton explains that this first/second feedback may be compressed. EX1007, [0323]. For example, "correlation in the frequency domain may be exploited to permit reduction in the amount of CSI to be fed back" by reporting a

shared CSI element for a range of frequencies, rather than for each frequency individually. *Id.* "Other compression and feedback channel error recovery techniques to reduce the amount of data to be fed back for CSI may also be used and are within the scope of the invention." *Id.* Walton contains substantially more disclosure than the '720 Patent includes regarding compression. *Compare to* EX1001, 22:17-19, FIG. 14.

116. The CSI is based on a received power of the first/second signal at least because it includes "information that is indicative of, or equivalent to, SNR" for each transmission channel, which is the ratio between the received signal's power and the noise power for that transmission channel. EX1007, [0312], [0093], [0326]. The CSI is also based on one or more frequencies of a first/second signal because the CSI is derived for each transmission channel (i.e., each spatial subchannel of each frequency subchannel) of the first/second signal. EX1007, [0325].

[19.5] separately from the receipt of the instruction, receiving a compressed second feedback from a third node that is based on a received power and one or more frequencies of a second signal transmitted from the first node to the third node;

117. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [19.5] for reasons discussed in Limitation [19.4]. As discussed above, terminal 106n shown in FIG. 2A of Walton is a third node that sends a compressed second feedback. *See* EX1007, [0080], FIG. 2A.

[19.6] decompressing the compressed first feedback resulting in a decompressed first feedback;

118. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [19.6]. At access point 104, "RX MIMO/data processor 240" "performs processing ***complementary*** to that performed by TX data processor 280 and TX MIMO processor 282" to "recover[] the reported CSI." EX1007, [0081], FIG. 2A. Where original CSI processing included compressing the CSI (*id.*, [0323]), the "complementary" processing includes decompressing the feedback. Further, a POSITA would understand that decompressing feedback is necessary to utilize the CSI to perform MIMO preconditioning as discussed with respect to Walton in Limitations [19.8]-[19.10] below. If the compression is lossless, for example, then the data can be recovered by reversing the process of compression (i.e., decompressing) the data to retrieve the data before it was compressed. It was known to decompress compressed data to recover the original, uncompressed data before using it for processing. *See* EX1039, Abstract, 1:63-2:3.

[19.7] decompressing the compressed second feedback resulting in a decompressed second feedback;

119. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [19.7] for reasons discussed in Limitation [19.6].

[19.8] generating one or more data structures based on the decompressed first feedback and the decompressed second feedback;

120. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [19.8]. Walton discloses multiple embodiments in which a MIMO Transmitter Unit of access point 104, which includes TX Data Processor 210 and TX MIMO Processor 220, generates one or more data structures based on the (decompressed) CSI received from terminals 106a and 106n in order to generate a multi-user MIMO waveform for transmission. EX1007, [0104]-[0128], FIGs. 3B-3C.

121. In the FIG. 3C embodiment, "[red] channel MIMO processor 322" performs "full-CSI processing" "to generate N_T preconditioned modulation symbols" (vector x) by multiplying the "modulation symbols" vector, b, by the "eigenvector matrix E" of the MIMO channel, as shown in equation 5. EX1007, [0117]-[0122].

$$\begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_{N_T} \end{bmatrix} = \begin{bmatrix} e_{11}, & e_{12}, & e_{1N_C} \\ e_{21}, & e_{22}, & e_{2N_C} \\ e_{N_T1}, & e_{N_T2}, & e_{N_TN_C} \end{bmatrix} \cdot \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_{N_C} \end{bmatrix} \qquad \text{Eq (5)}$$

Id. As shown in FIG. 3C, the [purple] CSI is an input to "[red] channel MIMO processor 322."

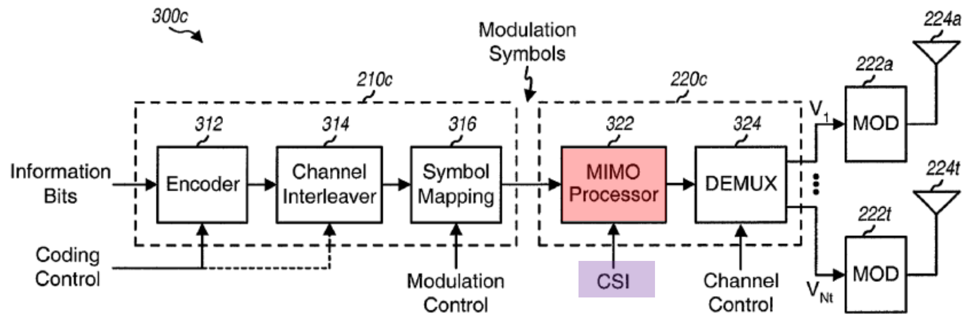


FIG. 3C

Id., FIG. 3C. Confirming channel transmitter unit MIMO processor 322 uses the received CSI, Walton explains: "The eigenvector matrix E ***may be computed*** by the transmitter unit or is provided to the transmitter unit (e.g., by the receiver unit)." *Id.* [0122]. A POSITA would understand that "computing" the eigenvector matrix E, which is "related to the transmission characteristics from the transmit antennas to the receive antennas," requires using the CSI received from terminals 106a and 106n (and decompressed) to determine the transmission characteristics from the transmit antennas of access point 104 to the receive antennas of terminals 106a and 106n. Accordingly, "eigenvector matrix E" and vector x of "N_T preconditioned modulation symbols," which is derived from eigenvector matrix E, are both one or more data structures based on the decompressed first feedback and the decompressed second feedback.

122. In the FIG. 3B embodiment, "transmitter unit 300b includes a TX data processor 210b" that "further includes a symbol weighting element 318 that weighs the modulation symbols for each selected transmission channel based on a respective

weight to provide weighted modulation symbols" such that "the modulation symbols for each selected transmission channel (*j*, *k*) may be weighted by a weight *W*(*j*, *k*) that is related to that channel's SNR" and calculated as shown in equation 3.

$$W(j,k) = \sqrt{\frac{\beta}{\gamma(j,k)}}. \qquad \text{Eq (3)}$$

EX1007, [0114], [0110]. In equation 3, γ(*j*, *k*) includes "the ***received*** SNR [] for transmission channel (*j*, *k*)," which is "the j-th spatial subchannel of the k-th frequency subchannel." *Id.*, [0106]-[0107]. The weight matrix W(j, k) is thus a data structure based on the CSI received from terminals 106a and 106n (where those terminals report SNR for different spatial subchannels) and decompressed.

> ***[19.9] wherein the filtered transmission signal is a filtered first transmission signal that is transmitted using a first frequency and an 802.11-based orthogonal frequency-division multiplexing (OFDM) protocol via at least one antenna of a plurality of antennas, using a first power that is based on at least one of the one or more data structures; and further comprising:***

123. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [19.9]. Access point 104 supports "[s]patial multiplexing, multi-user (multi-user MIMO mode)—the use of multiple transmit and receive antennas to accommodate communication with multiple terminals concurrently on the same channel" and "[m]ixed mode—the use of multiple transmit and receive antennas to accommodate

communication with a combination of SIMO and MIMO terminals concurrently on the same channel." EX1007, [0065]-[0066]. "Scheduler 234" in access point 104 "uses the reported downlink CSI to perform a number of functions such as (1) selecting the best set of terminals for data transmission and (2) assigning the available transmit antennas to the selected terminals." EX1007, [0082], [0071] ("multiple transmit antennas at the base station may be used to send data to different terminals using parallel transmission channels"). The scheduler can also allocate available "frequency subchannels." *Id.*, [0385] ("the scheduler can find combinations of 'mutually compatible' terminals for simultaneous data transmission on the allocated channels … by exploiting the 'spatial signatures' (and possibly the frequency signatures)"); *see also id.*, [0049]-[0054] ("The following channels and subchannels may be supported by the system: … transmission channel—a spatial subchannel, a frequency subchannel, or a spatial subchannel of a frequency subchannel over which an independent data stream may be transmitted"), [0076] ("the coded bits are transmitted over multiple frequency subchannels"), [0130]-[0131] ("the modulation symbols may be transmitted on multiple frequency subchannels and from multiple transmit antennas").

124. Accordingly, access point 104 may transmit to multiple terminals simultaneously on the same OFDM channel by employing multiple antennas and frequency subchannels. That is, access point 104 may simultaneously transmit a

filtered first transmission signal to terminal 106a and a second filtered transmission signal to terminal 106n with each signal transmitted via one or more antennas of access point 104's multiple antennas and using one or more frequency subchannels of the OFDM channel. EX1007, [0065]-[0066], [0071], [0082], [0385], [0049]-[0054], [0076], [0130]-[0131], FIGs. 2A, 3B-3E.

125. Each signal is "filtered" for the reasons discussed in Limitations [19.2]-[19.3].

126. Each signal is transmitted using 802.11a's "OFDM PHY" layer (EX1009, 15-16, 32/90), as modified by Walton. Section **Error! Reference source not found.**. This modified 802.11a protocol is significantly closer to the 802.11a and 802.11g protocols that were known and the '720 Patent references (EX1001, 19:42-45) than the unknown-in-2002 802.11ac protocol that PO accuses in the Litigation. EX1010, 1/426.

127. The filtered first/second transmission signals use a first/second frequency for at least two reasons. First, as discussed above, in scheduling simultaneous MIMO transmissions to multiple terminals, access point 104 may assign certain frequency subchannels, including a first frequency, to the first transmission signal and certain frequency subchannels, including a second frequency, to the second transmission signal. EX1007, [0385] ("Various scheduling schemes may be designed … by scheduling and assigning terminals to the allocated

channels such that simultaneous data transmissions on these channels are supported."), [0049]-[0054] (defining a "channel" of an OFDM system as "a frequency subchannel"), [0076], [0130]-[0131]. Second, even if the filtered first/second transmission signals are transmitted with the same set of frequency subchannels (called OFDM subcarriers in 802.11a), each will be transmitted using multiple frequency subchannels ("a frequency bin in an OFDM system," EX1007, [0054]), such that a first frequency subchannel in the set may be the "first frequency" and a second frequency subchannel in the set may be the "second frequency."

128. The filtered first/second transmission signals use a first/second power that is based on at least one of the one or more data structures. PO's infringement allegations assert that a transmission signal uses a first/second power that is based on at least one of the one or more data structures by applying "one or more respective steering matrices" in a MIMO system. EX1010, 66, 71/426. PO's mapping of this element is met by Walton's FIG. 3C embodiment in which a transmission signal is generated by applying the "eigenvector matrix, E." EX1007, [0117]-[0122]; Limitation [19.8]. A POSITA would understand that this "eigenvector matrix, E," is a steering matrix that preconditions the independent data streams to steer each through the MIMO channel.

129. Walton's FIG. 3B embodiment also meets this requirement because the power of the filtered first/second transmission signals are generated using the weights matrix, *W*(*j*, *k*). EX1007, [0104]-[0114]; Limitation [19.8].

130. Further, Walton's FIG. 3E embodiment employs both the weights matrix, *W*(*j*, *k*), and the eigenvector matrix, E, to process each data stream using the data processor 210b of FIG. 3B and "a MIMO processor followed by a demultiplexer" as "shown in FIG. 3C." EX1007, [0130]-[0131], FIGs. 3B, 3C, 3E.

[19.10] transmitting, using a second frequency and the 802.11-based OFDM protocol, a filtered second transmission signal, simultaneously with the filtered first transmission signal, to the third node, using a second power that is based on at least one of the one or more data structures.

131. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [19.10] for reasons discussed in Limitation [19.9].

b. Claim 22

[22.1] The method of claim 19, wherein the instruction includes a first instruction, and further comprising:

132. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [22.1]. The instruction from terminal 106a in Limitation [19.1] is a "first instruction."

[22.2] receiving at the first node in the radio communications network a second instruction transmitted from the third node to avoid using a different plurality of frequencies to transmit to the third node; and

133. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [22.2]. As described in Limitations [19.1]-[19.2], access point 104 (the "first node")

receives "control information" transmitted from terminal 106a (the "second node") indicating the current 802.11 channel "must be changed," which results in access point 104 changing from a first to a second 802.11 channel. EX1008, [0127]. As explained in Section **Error! Reference source not found.**, a POSITA would apply Hamabe's method to each of terminals 106. Accordingly, access point 104 (the "first node") also receives "control information" (a "second instruction") transmitted from terminal 106n (the "third node") indicating the current 802.11 channel "must be changed." EX1008, [0127]. Subsequent to access point 104 changing from a first to a second 802.11a frequency channel (i.e. a frequency channel in the 5 GHz which has regulatory requirements for interference avoidance) in response to the first instruction, terminal 106n may make a determination and send an instruction to access point 104 indicating that the second 802.11a channel "must be changed," constituting an instruction "to avoid using a ***different*** plurality of frequencies" (the frequencies of the second 802.11a channel) to transmit to the third node" for the reasons discussed for Limitation [19.1].

[22.3] filtering a second transmission signal to remove power from the second transmission signal at each frequency in the different plurality of frequencies to be avoided, resulting in the filtered second transmission signal.

134. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [22.3]. As discussed for Limitation [19.2], in response to an instruction to change from a second 802.11a frequency channel to a third 802.11a frequency channel,

access point 104 will perform standard processing to generate and transmit a signal on the third channel, that signal not including the "plurality of frequencies to be avoided" of the second 802.11a channel. Section **Error! Reference source not found.**; EX1008, [0127], [0119], [0124]; EX1009, 34-35/90.

c. Claim 23

[23.1] The method of claim 19, wherein the first power and the second power are the same.

135. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [23.1] for reasons discussed in Limitations [19.9] and [19.10]. Specifically, at least in the FIGs. 3B and 3E embodiments, Walton allocates the same transmit power to transmission channels with the same SNR at the receiver. EX1007, [0110]-[0111], Eq (4). A POSITA would have understood that terminals 106a and 106n may periodically experience the same SNR on their respective transmission channels, for example, because they are located a similar distance from access point 104 in a low-interference environment. Thus, it was obvious that the first power and second power may be the same.

136. Alternatively, this Limitation is rendered obvious when all channels operate at the maximum transmit power permitted by regulatory limits or by the device's own power capability. To prevent interference with nearby systems, regulatory bodies impose transmit power limits on the frequency bands used by 802.11a devices. It is standard practice for devices to transmit at its maximum

transmit power levels, as doing so typically maximizes range, improves throughput, and reduces transmission errors. Accordingly, when all channels are configured to use the maximum allowed transmit power, this Limitation would have been obvious.

d. Claim 24

[24.1] The method of claim 19, wherein the first power and the second power are different.

137. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [24.1] for reasons discussed in Limitations [19.9], [19.10], and [23.1]. Specifically, at least in the FIGs. 3B and 3E embodiments, Walton allocates different transmit power to transmission channels with different SNRs at the receiver. EX1007, [0110]-[0111], Eq (4). A POSITA would have understood that the measured SNRs across transmission channels (defined as a spatial subchannel of a frequency subchannel) may be different. Further, Walton contemplates the same, defining the SNR matrix, $\gamma(j, k)$, as a function of both frequency subchannel (k) and spatial subchannel (j). Thus, it was obvious that the first power and second power may be different.

e. **Claim 25**

[25.1] The method of claim 19, wherein an update of the compressed first feedback is repeatedly received at time periods of less than one second, and the first power is repeatedly updated based on an updated decompressed first feedback at time periods of less than one second; and an update of the compressed second feedback is repeatedly received at time periods of less than one second, and the second power is repeatedly updated based on an updated decompressed second feedback at time periods of less than one second.

138. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [25.1] for reasons discussed in Limitations [19.4], [19.5], [19.9], and [19.10]. Walton teaches that "differential updates to the full CSI characterization may be sent periodically, when the channel changes by some amount." EX1007, [0314]; *see also id.*, [0323]. The fed back CSI, including the differential updates, may be used to implement "adaptive processing" to "improve utilization of the MIMO channel." *Id.*, [0325]-[0328]. While Walton does not provide a timescale on which the channel might change and CSI updates are sent, a POSITA would have understood that this time period is much less than one second, even for a person walking while holding a mobile device. *See* EX1022, 36:5-15 (deriving a MIMO channel stability time of 7.5 milliseconds for a remote station moving at 1 meter per second and transmitting at a carrier frequency of 2 GHz); EX1023, 1/17 (finding that the mean "usual" walking speed is approximately 1.31 meters per second).

139. Generally, MIMO channel matrix estimates are only good for about 0.1 seconds when devices are moving at pedestrian speeds. In addition to the references

cited above, this can be shown with an example based on the wavelength of a transmission. It is known that, if objects move a significant portion of the transmission wavelength, the channel will be different. A reasonable amount that would materially change the channel matrix is 10% of the wavelength. The relevant transmission protocol in the Petition is 802.11a, which operates in the 5 GHz band. In the 5 GHz band, the wavelength is about $\lambda = c/f = 3x10^8$ m/s / $5x10^9$ Hz = 6 cm. That's about 2.5 inches. Assuming 10% changes the channel, the amount of movement allowed is 0.25 inches. A person walking moves that far in a fraction of a second. A POSITA would have known that, for WLANs, channel estimates would need to be updated at least based on pedestrian speeds, and that would result in calculation of updates that occur at time periods of less than one second. That type of calculation would have been routine for a POSITA working on wireless communication networks.

140. Based on the above, a POSITA would have understood that Walton's teaching to send CSI updates when the channel changes and update the system's CSI processing accordingly is repeatedly receiving an update of both the first and second compressed feedbacks at time periods of less than one second and updating the first and second powers at time periods of less than one second based on the respective feedback, via the processes described with respect to Limitations [19.9] and [19.10].

f. Claim 26

[26.1] The method of claim 19, wherein the filtered first transmission signal and the filtered second transmission signal are transmitted via the same transceiver.

141. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [26.1]. Each of Walton's FIG. 3B and 3C embodiments discussed above illustrate a "transmitter unit" in which a ***single*** series of components perform processing "for ***each*** selected transmission channel" and, thus, the filtered first/second transmission signals are transmitted via the same transceiver. EX1007, FIGs. 2A, 3B-3C, [0114], [0116]-[0117].

g. Claim 27

[27.1] The method of claim 19, wherein the filtered first transmission signal and the filtered second transmission signal are transmitted via different transceivers.

142. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [27.1]. In Walton's FIG. 3E embodiment discussed in Limitation [19.9] "the stream of information bits for ***each*** frequency subchannel used for data transmission is provided to a ***respective*** frequency subchannel data processor 330" and "the up to N_C modulation symbol streams from each data processor 330 are provided to a ***respective*** spatial processor 332" and each transmit antenna has "a ***respective*** modulator 222." EX1007, [0130]-[0132]. Walton also teaches to "***assign*** the available transmit antennas to the selected terminals" for transmission. *Id.*, [0466], [0476]-[0494] (describing the antenna assignment process). Using Walton's

method, "scheduling schemes may be designed to maximize the downlink performance by evaluating which ***specific*** combination of terminals and antenna assignments provide the best system performance." *Id.*, [0466]. Ultimately, the system transmits using "the specific set of terminals scheduled for data transmission in the upcoming transmission interval and ***their assigned transmit antennas***." *Id.*, [0482]. Thus, each terminal may have a respective spatial processor, frequency subchannel, and transmit antenna for any particular transmission interval.

143. As shown in FIG. 3E, this results in multiple different transceivers, one for each frequency subchannel/antenna combination.

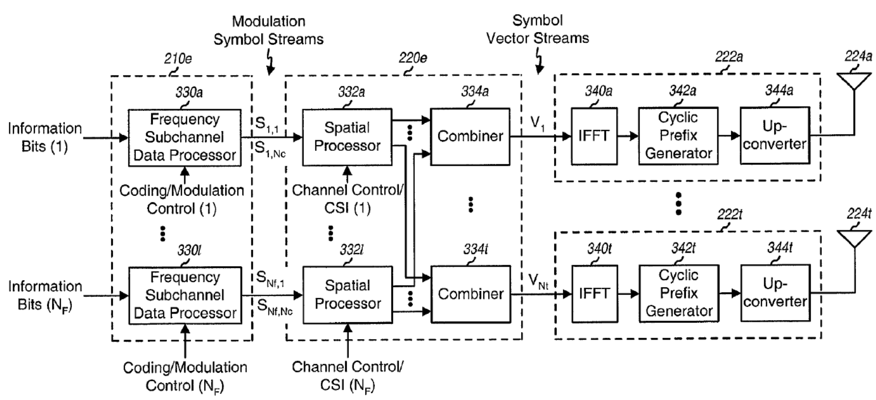


FIG. 3E

Id., FIG. 3E. Accordingly, at least where the filtered first/second transmission signals are divided by frequency subchannel and transmit antenna, they are transmitted via different transceivers.

144. In addition, it would also have been obvious to a POSITA to design access point 104 in the combination such that it includes different transceivers for

different sectors (i.e., directions from the access point 104). While Walton does not provide hardware implementation details for its MIMO transceiver(s), it was known in the art that directional antennas may be used to transmit independent data streams to terminals located in different sectors around the access point. *See* EX1022, 11:1-26, FIG. 8. For example, three antennas may be arranged to each cover a 120 degree sector. *Id.* Then, the access point transmits to each terminal using the antenna for the sector in which the ideal paths to the terminal lie. *Id.* Using this transceiver configuration, there will be circumstances under which the ideal path to transmit to the first terminal ("second node") lies in one antenna's sector, while the path for the second terminal ("third node") lies in a different antenna's sector. In this case, the access point 104 would use different transceivers to transmit to each terminal, or node.

145. Alternatively, it would also have been obvious to a POSITA to design access point 104 such that it contained two separate transceivers operating in different channels in the 5 GHz band. It was known in the art that dual-band 802.11 access points with multiple transceivers can increase system capacity (i.e., bandwidth) by allowing simultaneous communication in different 802.11 channels. *See e.g.,* EX1038. Considering that the 802.11a 5 GHz band was already divided into upper and lower sets of channels, a POSITA would have considered it obvious to implement Walton/802.11a/Hamabe as a multiple transceiver system with one

transceiver operating on an 802.11 channel in the lower set of 5 GHz channels and one transceiver operating on an 802.11 channel in the upper set. *See* EX1009, 34-35/90. This would effectively double the available bandwidth of access point 104, improving data rates and downlink communication speed, all desirable features of wireless networks.

h. Claim 28

[28.1] The method of claim 19, wherein the instruction is received utilizing a dedicated channel.

146. In my opinion, Walton/802.11a/Hamabe renders this Limitation obvious for reasons discussed in Section X.A.5. PO's infringement allegations assert that a "MIMO Control field" MAC frame field constitutes receiving the instruction "utilizing a dedicated channel." EX1010, 103-104/426. As discussed in Section X.A.5, it would be obvious to include the instruction in a MAC frame field, such as one included in a RTS or CTS message. Therefore, if a dedicated channel can be formed via a field in a MAC frame header, Walton/802.11a/Hamabe meets this element in the same way as PO's infringement mapping.

i. Claim 29

[29.1] The method of claim 19, wherein the instruction is received via an antenna configured for omnidirectional communication.

147. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [29.1]. A POSITA would have understood that the antennas disclosed in Walton, Hamabe, and 802.11a may be antennas configured for omnidirectional

communication because antennas with omnidirectional antenna patterns were well known in the art of antenna design and it was known to use them in beamforming applications. *See e.g.,* EX1022, 8:19-20 ("Antennas 16, 18 are diversity antennas that cover overlaid sectors or are omnidirectional."), FIG. 4; EX1023, 3:31-36. An omnidirectional radiation pattern is important in many applications because "the signal received from the [access point] can arrive at any principal angle relative to the orientation of the terminal." EX1023, 3:36-39. This is similarly true of the signals received at the access point from the terminals. Therefore, a POSITA would have understood that the antennas disclosed in Walton that receive the instruction from the first terminal are configured for omnidirectional communication. *See* EX1007, FIG. 2A.

j. Claim 30

[30.1] The method of claim 19, wherein the compressed first feedback and the compressed second feedback are received utilizing a dedicated channel.

148. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [30.1] for reasons similar to those discussed in Section X.A.5 and Limitation [28.1]. PO's infringement allegations assert that a "MIMO Control field" within a MAC management frame (e.g. CSI frame) constitutes receiving the compressed first and second feedbacks "utilizing a dedicated channel." EX1010, 105-106/426. As discussed in Section X.A.5, it would be obvious to include the CSI feedback in a MAC frame such as a management frame. IEEE 802.11a describes three general

types of MAC layer frames: data, control, and management. The management frames are used to support IEEE 802.11 services. EX1025, 51-52, 61-62/528. It would have been obvious to a POSITA to use the management frame category to introduce a new frame to send CSI information. This is evidenced by 802.11e draft 1.0 from March 2001 adding a generic action frame format to carry various types of information related to management. *See* EX1037, 42-43/90. If sending CSI information using a management frame meets this limitation, as PO asserts, then , Walton/802.11a/Hamabe meets this element in the same way as PO's infringement mapping.

k. Claim 31

[31.1] The method of claim 19, wherein the compressed first feedback and the compressed second feedback are received via an antenna configured for omnidirectional communication.

149. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [31.1] for reasons discussed in Limitations [29.1]. Specifically, the compressed first feedback and compressed second feedback are received at the same antennas as the interference avoidance determinations (instructions). *See* EX1007, FIG. 2A; [0327] ("At base station 104, the transmitted feedback signal is received by antennas 224").

l. Claim 32

[32.1] The method of claim 19, wherein the decompressed first feedback and the decompressed second feedback are used to increase spatial separation among transmissions.

150. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [32.1]. Walton's full CSI is used to precondition each data stream so that the data streams are separable at the receiver. EX1007, [0157] ("the spatial and space-time receiver processing techniques attempt to separate out the transmitted signals at the receiver unit"), [0268] ("greater signal separation may be possible if the transmitted signals are less correlated"). Achieving spatially separable data streams is a fundamental goal of MIMO. *See* EX1023, 41:18, 43:10-12. Without the ability to distinguish each spatial channel at the receiver, it is not possible to successfully transmit multiple data streams from the transmit antennas to the receive antennas. It was known in the art that this separation may be accomplished using one of the linear algebra techniques described in Section VII.A, each of which compensate for the effect of the MIMO channel to separate each of the spatial channels (i.e., channels between each transmit and receive antenna) at the receiver.

151. Similarly, in Walton, it is the MIMO preconditioning that creates spatial channels that can be distinguished at the receiver. EX1007, [0163] ("The ability to effectively null undesired signals or optimize the SNRs depends upon the correlation in the channel coefficient matrix H that describes the channel response

between the transmit and receive antennas.”). Thus, the CSI received by the access point from the terminals are a decompressed first feedback and a decompressed second feedback that are used to increase spatial separation among transmissions. *See also* EX1007 [0157], [0268].

152. Walton’s transmission of independent data streams using eigenvectors of the channel matrix, as described at [0017] and Equation (5), exemplifies the kind of signal preconditioning (or spatial precoding) that a POSITA would understand to increase spatial separation among transmitted data streams. Each data stream is transmitted in a subspace defined by a distinct eigenvector of the MIMO channel matrix. Because the eigenvectors are linearly independent, the subspaces they span are mutually orthogonal (or nearly so, depending on channel conditions), thereby minimizing interference among streams. This orthogonality allows each stream to be decoded independently at the receiver, increasing the effective separation between them and enhancing spatial distinguishability.

m. Claim 33

[33.1] The method of claim 19, wherein the decompressed first feedback and the decompressed second feedback are used to increase spatial separation among transmissions at the same frequency.

153. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [33.1] for reasons discussed in Limitation [32.1]. In Walton’s MIMO OFDM mode, there is “one data substream for each spatial subchannel selected for use for the

[OFDM] frequency subchannel." EX1007, [0130]. As explained in Limitation [32.1] and Section VII.A, preconditioning increases spatial separation among these data substreams, or transmission channels, which are transmissions at the same frequency. *See also* EX1007, [0157], [0268].

n. Claim 36

[36.1] The method of claim 19, wherein the compressed first feedback is based on a received power at a plurality of frequencies via which the first signal is received.

154. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [36.1] for reasons discussed in Limitation [19.4]. Specifically, the CSI includes "information that is indicative of, or equivalent to, SNR" for each transmission channel (i.e., each spatial subchannel of each frequency subchannel), which is the ratio between the received signal's power and the noise power for that transmission channel. EX1007, [0312], [0093], [0325]-[0326]. It was known to use SNR to characterize the interference on a channel, whether a spatial channel, frequency channel, or otherwise. SNR is a measure of the ratio between the received power of the signal that was intended to be transmitted and the received power of noise and interference signals. Accordingly, Walton's SNR is based on the received power of the training (also called pilot) signal from the transmitter at each of the frequencies (e.g., OFDM subcarriers) in the MIMO channel. Such SNR information is feedback that is based on the received power of training signals, as taught in Walton, and may

be advantageously used at the transmitter when performing MIMO transmissions. Walton makes clear that the SNR corresponds to frequency via the index *k* which corresponds to subcarriers, the same index that is used for subcarriers in IEEE 802.11a-1999.

155. Thus, the CSI is based on a received power at a plurality of frequencies via which the first signal is received.

o. Claim 37

[37.1] The method of claim 19, wherein the instruction is received prior to the receipt of the compressed first feedback.

156. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [37.1]. Both the Walton CSI feedback and Hamabe interference avoidance algorithms are ongoing processes, with both CSI and interference avoidance determinations being transmitted to the access point periodically, as needed. *See* EX1007, [0323] ("full or partial CSI is reported periodically"); EX1008, [0130]-[0131]. Therefore, a POSITA would have understood that an interference avoidance determination may be received prior to the receipt of a subsequently transmitted instance CSI feedback.

p. Claim 38

[38.1] The method of claim 19, wherein the filtered second transmission signal is transmitted simultaneously with the filtered first transmission signal via the same plurality of antennas.

157. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [38.1]. As discussed for Limitations [19.9], Walton discloses scheduling of different users based on "a spatial subchannel, a ***frequency subchannel***, or a spatial subchannel of a frequency subchannel." EX1007, [0049]-[0054]. Where the filtered first/second transmission signals are separated based on frequency, but scheduled on the same antennas, they are sent "via the same plurality of antennas." *See also* EX1007, [0065]-[0066], FIGs. 2A, 3E.

q. Claim 39

[39.1] The method of claim 19, wherein the first frequency is selected as a function of the compressed first feedback, and the second frequency is selected as a function of the compressed second feedback.

158. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [39.1]. In Walton's selective channel inversion method, "only transmission channels for which the received SNR is greater than or equal to the SNR threshold … are selected for use." EX1007, [0112], Eq (4).

$$P_{ix}(j,k) = \begin{cases} \dfrac{\beta P_{tx}}{\gamma(j,k)}, \text{ for } \gamma(j,k) \geq \gamma_{th}. \\ 0, \text{ otherwise} \end{cases} \qquad \text{Eq (4)}$$

Id., Eq (4). Walton discloses that SNR is provided as part of the CSI fed back from each terminal. *Id.*, [0312]. Therefore, when transmission channels are "selected for use" for each terminal based on the SNR fed back as part of the CSI from each terminal, the first frequency is selected as a function of the compressed first feedback, and the second frequency is selected as a function of the compressed second feedback.

r. Claim 40

[40.1] The method of claim 19, wherein the instruction includes a 802.11 clear to send (CTS) instruction.

159. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [40.1]. As discussed in Section **Error! Reference source not found.**, it would have been obvious to include a form of CTS/RTS frames that enabled the mobile station "to notify that the condition for changing the carrier frequency has been satisfied." EX1008, [0127]; EX1025, 49-58/528.

s. Claim 41

[41.1] The method of claim 19, wherein the instruction includes a 802.11 request to send (RTS) instruction.

160. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [41.1] for reasons discussed in Limitation [40.1] and Section X.A.5.

t. Claim 42

[42.1] The method of claim 19, wherein the filtered second transmission signal is transmitted simultaneously with the filtered first transmission signal via at least one different antenna of the plurality of antennas.

161. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [42.1]. As discussed for Limitations [19.9], Walton discloses scheduling of different users based on "a ***spatial subchannel***, a frequency subchannel, or a ***spatial*** subchannel of a frequency subchannel." EX1007, [0049]-[0054]. Where the filtered first/second transmission signals are separated based on spatial subchannels by sending on separate antennas, they are sent via at least one different antenna." *See also* EX1007, [0065]-[0066], FIGs. 2A, 3E.

u. Claim 43

[43.1] The method of claim 19, wherein the filtered second transmission signal is transmitted simultaneously with the filtered first transmission signal using the at least one antenna of the plurality of antennas.

162. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [43.1]. As discussed for Limitations [19.9], Walton discloses scheduling of different users based on "a spatial subchannel, a ***frequency subchannel***, or a spatial

subchannel of a frequency subchannel." EX1007, [0049]-[0054]. Where the filtered first/second transmission signals are separated based on frequency, but scheduled on the same antennas, they are sent "using the at least one antenna." *See also* EX1007, [0065]-[0066], FIGs. 2A, 3E.

v. Claim 45

[45.1] The method of claim 19, wherein the removal of power from the transmission signal at each frequency in the plurality of frequencies to be avoided is accomplished by adjusting a processing of the transmission signal so that certain power that was previously used in connection with the transmission signal at each frequency in the plurality of frequencies to be avoided before the instruction is received, is no longer used in connection with the transmission signal at each frequency in the plurality of frequencies to be avoided in accordance with the instruction.

163. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [45.1] for reasons discussed in Limitation [19.2]. Specifically, when Walton/802.11a/Hamabe's access point 104 switches into a new channel, the access point adjusts its processing to comply with the 802.11a spectral mask such that no power is used in the original 802.11a channel, where transmission power was previously used. *See* EX1009, 37/90. This is consistent with PO's infringement allegations, which assert that this Limitation is met by changing the frequency band to be used by the network such that the "plurality of frequencies to be avoided" are not used. EX1010, 141/426. Walton/802.11a/Hamabe's switching between 802.11a's channels meets this element in the same way as PO's infringement mapping.

w. Claim 46

> ***[46.1] The method of claim 19, wherein the removal of power from the transmission signal at each frequency in the plurality of frequencies to be avoided is accomplished by adjusting a processing of the transmission signal so that certain power that was previously used in connection with the transmission signal at each frequency in the plurality of frequencies to be avoided before the instruction is received, is no longer used in connection with the transmission signal at each frequency in the plurality of frequencies to be avoided in accordance with the instruction, which specifies at least one frequency to use so as to avoid using the plurality of frequencies to be avoided in order to transmit to the second node.***

164. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [45.1] for reasons discussed in Limitations [19.1], [19.2] and [45.1]. Hamabe's interference avoidance notification indicates that the access point must move the network's carrier frequency out of the current channel and into a channel not adjacent to the current channel. As there are a limited number of channels in the 802.11a 5 GHz band, a POSITA would have understood this as an instruction to use any of the only 9 other 802.11 OFDM channels in the 5 GHz band. *See* EX1009, 35/90. Alternatively, given the limited options and unique ability of each terminal to measure its local spectrum, it would have been obvious for a POSITA to explicitly include one or more of these 9 channels in the interference avoidance notification to streamline the channel switching process for the access point.

x. Claim 49

[49.1] The method of claim 19, wherein frequency channels are reused in order to increase spatial reuse across multiple basic service sets.

165. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [49.1]. Walton discloses an "[a]daptive reuse scheme" under which "system resources may be divided into sets of 'orthogonal' channels, which may then be assigned to the cells, one channel set per cell in a reuse cluster." EX1007, [0344]-[0345]. Each "channel" may be a "frequency band[] for an FDM-based scheme." *Id.*, [0341]. An intelligent reuse scheme "reduces or eliminates mutual interference caused by terminals within a reuse cluster" because "[t]he channels in the set allocated to any one cell in a reuse cluster are orthogonal to the channels in the other sets allocated to the other cells in the cluster." *Id.* For example, in a "3-cell reuse pattern," the available channels are grouped into three sets, and "each cell in a 3-cell cluster may be allocated one of the channel sets." *Id.*, [0342]. Then, "the reuse cluster is repeated throughout the network." *Id.*, [0333]. Walton uses the term "cell," but a POSITA would understand Walton's cells to be analogous to the basic service set (BSS) used in 802.11. *See* EX1007, [0043] ("The base station and/or its coverage area are also often referred to as a 'cell'"). Based on this disclosure, a POSITA would have understood that the adaptive channel reuse scheme disclosed in Walton reuses frequency channels in order to increase spatial reuse across multiple basic service sets.

y. Claim 50

[50.1] The method of claim 19, wherein RTS/CTS signaling is extended such that frequency channels are reused in order to increase spatial reuse across multiple basic service sets.

166. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [50.1] for reasons discussed in Section IX.A.5 and Limitation [49.1]. As explained in Section X.A.5, it was known to include control information in MAC frames such as RTS and CTS frames. It would be obvious to implement Walton's adaptive reuse scheme such that the control information required to instantiate and update the adaptive reuse scheme is sent in an additional field in a RTS or CTS message so that the RTS/CTS signaling is extended.

167. Further, the '720 Patent contains no teachings related to "extended" RTS/CTS signaling, or an explanation as to what this means or how to accomplish it. To the extent that this claim is supported by the specification, it must be that it includes the modification of RTS and CTS messages to extend their capabilities via the addition of control information in ways that would have been obvious to a POSITA in view of the prior art.

z. Claim 51

[51.1] The method of claim 19, wherein RTS/CTS signaling is extended such that frequency channels are reused in order to increase spatial reuse across multiple basic service sets, to accommodate legacy access points.

168. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [50.1] for reasons discussed in Limitations [40.1] and [49.1]. In addition, a POSITA

would have understood that a purpose of frequency reuse schemes is to reduce the number of devices in a particular geographic area that are operating on the same frequency, which lowers the level of background noise on that frequency, thereby accommodating legacy access points operating on that frequency. *See* EX1007, [0333] ("This strategy reduces or eliminates mutual interference caused by terminals within a reuse cluster.").

aa. Claim 52

[52.pre] A method for managing interference in a radio communications network, comprising the steps of:

169. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [52.pre] for reasons discussed in Limitation [19.pre].

[52.1] receiving at a first node in the radio communications network an instruction transmitted from a second node in the radio communications network to avoid using a plurality of frequencies to transmit to the second node;

170. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [52.1] for reasons discussed in Limitation [19.1].

[52.2] filtering a transmission signal to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided;

171. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [52.2] for reasons discussed in Limitation [19.2].

[52.3] transmitting the filtered transmission signal to the second node;

172. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [52.3] for reasons discussed in Limitation [19.3].

[52.4] wherein the instruction includes a first instruction and the filtered transmission signal includes a filtered first transmission signal that is transmitted to the second node using a first power via an 802.11-based orthogonal frequency-division multiplexing (OFDM) protocol, and further comprising:

173. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [52.4] for reasons discussed in Limitations [19.1] and [19.9].

[52.5] receiving at the first node in the radio communications network a second instruction transmitted from a third node in the radio communications network to avoid using a different plurality of frequencies to transmit to the third node;

174. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [52.5] for reasons discussed in Limitation [22.2].

[52.6] filtering a second transmission signal to remove power from the second transmission signal at each frequency in the different plurality of frequencies to be avoided; and

175. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [52.6] for reasons discussed in Limitation [22.3].

[52.7] transmitting, using a second power via the 802.11-based OFDM protocol and simultaneously with the filtered first transmission signal, the filtered second transmission signal to the third node.

176. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [52.7] for reasons discussed in Limitations [19.10] and [22.3].

bb. Claim 53

[53.pre] A method for managing interference in a radio communications network, comprising the steps of:

177. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [53.pre] for reasons discussed in Limitation [19.pre].

[53.1] receiving at a first node in the radio communications network an instruction transmitted from a second node in the radio communications network to avoid using a plurality of frequencies to transmit to the second node;

178. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [53.1] for reasons discussed in Limitation [19.1].

[53.2] filtering a transmission signal to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided;

179. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [53.2] for reasons discussed in Limitation [19.2].

[53.3] transmitting the filtered transmission signal to the second node;

180. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [53.3] for reasons discussed in Limitation [19.3].

[53.4] receiving a compressed first feedback from the second node that characterizes receipt of a first signal sent from the first node to the second node;

181. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [53.4] for reasons discussed in Limitation [19.4]. Further, Walton's CSI is not only based on a received pilot signal, a training signal in Walton, as described in

Limitation [19.4], but also characterizes the receipt of that pilot signal because full CSI is the "channel coefficient matrix that gives the channel response for the N_T transmit antennas and N_R receive antennas at a specific time," that specific time being when the pilot signal is received and used to derive the CSI. *See* EX1007, [0174], [0077] ("full CSI (e.g., a channel response matrix H)"), FIG. 4E.

182. Relatedly, IEEE 802.11a-1999 uses the term training field to refer to signals transmitted for the purpose of enabling channel estimation at the receiver. For example, the Long Training Field (LTF) is specifically used by the receiver to generate a channel estimate. In contrast, the term pilot in 802.11a refers to designated subcarriers embedded within the data portion of the PPDU to assist in tracking frequency and timing offsets—distinct from estimating the full channel response.

183. Walton, however, uses the term pilot to refer to training sequences used to characterize the full channel response. This usage aligns with what 802.11a refers to as a training field (particularly the LTF), rather than 802.11a's narrower use of pilot. A POSITA would readily understand this distinction, recognizing that in many contexts, the term pilot is used more broadly to refer to training signals for full channel estimation, as it is in Walton.

[53.5] receiving a compressed second feedback from a third node that characterizes receipt of a second signal sent from the first node to the third node;

184. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [53.5] for reasons discussed in Limitations [19.5] and [53.4].

[53.6] decompressing the compressed first feedback resulting in a decompressed first feedback; and

185. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [53.6] for reasons discussed in Limitation [19.6].

[53.7] decompressing the compressed second feedback resulting in a decompressed second feedback;

186. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [53.7] for reasons discussed in Limitation [19.7].

[53.8] wherein the filtered transmission signal is a filtered first transmission signal that is transmitted to the second node using an 802.11-based orthogonal frequency-division multiplexing (OFDM) protocol via at least one antenna of a plurality of antennas, using a first power that is based on the decompressed first feedback; and further comprising:

187. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [53.8] for reasons discussed in Limitation [19.8] and [19.9]. Specifically, because the data structures described in Limitation [19.8] are themselves based on the decompressed first feedback, the first power that is based on the data structures—as described in Limitation [19.9]—is also based on the decompressed first feedback.

[53.9] transmitting, using the 802.11-based OFDM protocol, a filtered second transmission signal, simultaneously with the filtered first transmission signal, to the third node using a second power that is based on the decompressed second feedback.

188. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [53.9] for reasons discussed in Limitation [19.10]. Specifically, because the data structures described in Limitation [19.8] are themselves based on the decompressed second feedback, the second power that is based on the data structures—as described in Limitation [19.10]—is also based on the decompressed second feedback.

cc. Claim 54

[54.1] The method of claim 53, wherein the instruction includes a first instruction, and further comprising:

189. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [54.1] for reasons discussed in Limitation [19.1].

[54.2] receiving at the first node in the radio communications network a second instruction transmitted from the third node to avoid using a different plurality of frequencies to transmit to the third node; and

190. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [54.2] for reasons discussed in Limitation [22.2].

[54.3] filtering a second transmission signal to remove power from the second transmission signal at each frequency in the different plurality of frequencies to be avoided, resulting in the filtered second transmission signal.

191. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [54.3] for reasons discussed in Limitation [22.3].

dd. Claim 55

[55.1] The method of claim 53, wherein the first power and the second power are the same.

192. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [55.1] for reasons discussed in Limitation [23.1].

ee. Claim 56

[56.1] The method of claim 53, wherein the first power and the second power are different.

193. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [56.1] for reasons discussed in Limitation [24.1].

ff. Claim 57

[57.1] The method of claim 53, and further comprising: generating a first data structure based on the decompressed first feedback, where the first power is based on the first data structure; and

194. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [57.1] for reasons discussed in Limitations [19.8] and [19.9]. Specifically, the matrix, "$W(j, k)$" used to weight "the modulation symbols for each selected transmission channel (j, k)" is a first data structure that the first power is based on. EX1007, [0110], Eq (3). Additionally, a POSITA would have understood that the matrix, $W(j, k)$ must be unique for each receiving node in the network because it is based on the received SNRs, as shown in Eq (3), and the SNR for a transmission channel will be different at each receiving node, which may be located at different

locations relative to the transmitter and experience different local noise profiles. *See* EX1007, Eq (3), [0106]-[0110].

[57.2] generating a second data structure based on the decompressed second feedback, where the second power is based on the second data structure.

195. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [57.2] for reasons discussed in Limitations [19.8], [19.10], and [57.1]. As explained in Limitation [57.1], a POSITA would have understood that the matrix of modulation symbol weights, $W(j, k)$ must be unique to each receiving node because it is based on the unique set of SNRs for each receiving node. *See* EX1007, Eq (3), [0106]-[0110]. Therefore, a POSITA would have understood Walton to disclose both a first matrix of weights for transmission to the first terminal, as discussed in Limitation [57.1], and a second matrix of weights for transmission to the second terminal in the network.

gg.Claim 58

[58.1] The method of claim 57, wherein the first data structure and the second data structure are different.

196. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [58.1] for reasons discussed in Limitations [57.1] and [57.2].

hh. Claim 60

[60.1] The method of claim 57, wherein the first data structure is unique to the second node, and the second data structure is unique to the third node.

197. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [60.1] for reasons discussed in Limitations [57.1] and [57.2].

ii. Claim 61

[61.1] The method of claim 57, wherein the first data structure is a first profile, and the second data structure is a second profile.

198. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [61.1] for reasons discussed in Limitations [57.1] and [57.2]. Specifically, a POSITA would have understood the respective weights matrices for transmission to each node as respective first and second profiles because each matrix is defined across each "j-th spatial subchannel of the k-th frequency subchannel." *See* EX1007, [0107]. Thus, the weights matrices represent the first and second weighting profile to be used to transmit modulation symbols to the second and third nodes, respectively.

jj. Claim 62

[62.1] The method of claim 57, wherein the first data structure is a first optimal waveform profile.

199. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [62.1] for reasons discussed in Limitations [57.1] and [61.1]. Walton teaches that the weight matrix, $W(j, k)$ enables the transmitter "[t]o simplify the data processing

at both the transmitter and receiver units" by using "a common coding and modulation scheme." EX1007, [0105]. To the extent that the phrase "optimal waveform profile" has a definite meaning, a POSITA would have understood that tailoring the transmission waveform to simplify the data processing required at the transmitter and receiver is one form of optimality. Thus, the weight matrix disclosed in Walton is a first data structure that is a first optimal waveform profile. *See* EX1007, [0105]-[0110].

kk. Claim 63

> ***[63.1] The method of claim 53, and further comprising: generating a single data structure based on the decompressed first feedback and the decompressed second feedback, where both the first power and the second power are based on the single data structure.***

200. Walton/802.11a/Hamabe renders obvious Limitation [63.1] for reasons discussed in Limitations [19.8] and [19.10]. Specifically, the eigenvector matrix, E, is generated based on CSI from both the first and second terminals when the access point has scheduled a simultaneous MU-MIMO transmission to both terminals because it has a row for each receive antenna. *See* EX1007, [0117], [0065]-[0066], FIG. 2A. Under PO's interpretation of the claim language and its relation to MIMO preconditioning, the first power and the second power are based on this single data structure. *See* Limitation [19.9]; EX1010 65-76/426.

201. Further, there is no apparent disclosure of a data structure based on the decompressed first and second feedbacks in the specification of the '720 Patent that

would inform the meaning of this Limitation. Based on PO's interpretation of the claim language in its infringement contentions, it appears that this Limitation is satisfied by MIMO preconditioning matrices that were known in the art, such as the one disclosed in Walton.

ll. Claim 64

[64.1] The method of claim 53, wherein the filtered second transmission signal is transmitted simultaneously with the filtered first transmission signal via the same plurality of antennas.

202. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [64.1] for reasons discussed in Limitation [38.1].

mm. Claim 65

[65.1] The method of claim 53, wherein the filtered second transmission signal is transmitted simultaneously with the filtered first transmission signal via at least one different antenna of the plurality of antennas.

203. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [65.1] for reasons discussed in Limitation [42.1].

nn. Claim 66

[66.1] The method of claim 53, wherein the filtered second transmission signal is transmitted simultaneously with the filtered first transmission signal via the at least one antenna of the plurality of antennas.

204. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [66.1] for reasons discussed in Limitation [43.1].

oo. Claim 67

[67.1] The method of claim 53, wherein an update of the compressed first feedback is repeatedly received, and the first power is repeatedly updated based on an updated decompressed first feedback; and an update of the compressed second feedback is repeatedly received, and the second power is repeatedly updated based on an updated decompressed second feedback.

205. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [67.1] for reasons discussed in Limitation [25.1].

pp. Claim 68

[68.1] The method of claim 53, wherein an update of the compressed first feedback is repeatedly received in real-time, and the first power is repeatedly updated in real-time based on an updated decompressed first feedback; and an update of the compressed second feedback is repeatedly received in real-time, and the second power is repeatedly updated in real-time based on an updated decompressed second feedback.

206. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [68.1] for reasons discussed in Limitation [25.1]. To the extent that the phrase "in real-time" has a definite meaning, a POSITA would have understood it to be rendered obvious by Walton/802.11a/Hamabe's periodic CSI updates for the same reasons described in Limitation [25.1].

qq. Claim 69

[69.1] The method of claim 53, wherein an update of the compressed first feedback is repeatedly received at time periods of less than one second, and the first power is repeatedly updated based on an updated decompressed first feedback at time periods of less than one second; and an update of the compressed second feedback is repeatedly received at time periods of less than one second, and the second power is repeatedly updated based on an updated decompressed second feedback at time periods of less than one second.

207. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [69.1] for reasons discussed in Limitation [25.1].

rr. Claim 70

[70.1] The method of claim 53, wherein the filtered first transmission signal and the filtered second transmission signal are sent via the same transceiver.

208. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [70.1] for reasons discussed in Limitation [26.1].

ss. Claim 71

[71.1] The method of claim 53, wherein the filtered first transmission signal and the filtered second transmission signal are sent via different transceivers.

209. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [71.1] for reasons discussed in Limitation [27.1].

tt. Claim 72

[72.1] The method of claim 53, wherein the compressed first feedback and the compressed second feedback are received utilizing a dedicated channel.

210. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [72.1] for reasons discussed in Limitation [30.1].

uu. Claim 73

[73.1] The method of claim 53, wherein the compressed first feedback and the compressed second feedback are received via an antenna configured for omnidirectional communication.

211. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [73.1] for reasons discussed in Limitation [31.1].

vv.Claim 74

[74.1] The method of claim 53, wherein the decompressed first feedback and the decompressed second feedback are used to increase spatial separation among transmissions.

212. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [74.1] for reasons discussed in Limitation [32.1].

ww. Claim 75

[75.1] The method of claim 53, wherein the decompressed first feedback and the decompressed second feedback are used to increase spatial separation among transmissions at the same frequency.

213. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [75.1] for reasons discussed in Limitation [33.1].

xx. Claim 77

[77.1] The method of claim 53, wherein the compressed first feedback is based on a received power and one or more frequencies via which the first signal is communicated.

214. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [77.1] for reasons discussed in Limitation [19.4].

yy. Claim 78

[78.1] The method of claim 53, wherein the compressed first feedback is based on a received power at a plurality of frequencies via which the first signal is communicated.

215. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [78.1] for reasons discussed in Limitation [36.1].

zz. Claim 79

[79.1] The method of claim 53, wherein the compressed first feedback is based on a series of power values as a function of frequency.

216. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [79.1] for reasons discussed in Limitation [19.4]. Specifically, the CSI is based on a series of power values as a function of frequency at least because it includes "information that is indicative of, or equivalent to, SNR" for ***each*** transmission channel, which is the ratio between the received pilot signal's power and the noise power for that transmission channel. *See* EX1007, [0312], [0093], [0326].

aaa. Claim 80

[80.1] The method of claim 53, wherein the compressed first feedback includes a data structure that is based on a series of power values as a function of frequency.

217. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [80.1] for reasons discussed in Limitations [19.4] and [79.1]. Further, Walton discloses that full CSI may "comprise[] eigenmodes plus any other information that is indicative of, or equivalent to, SNR." EX1007, [0312]. Thus, the CSI fed back to the access point that contains the eigenmodes and SNRs for each transmission channel is a data structure that is based on a series of power values as a function of frequency.

bbb. Claim 81

[81.1] The method of claim 53, wherein the instruction is received prior to the receipt of the compressed first feedback.

218. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [81.1] for reasons discussed in Limitation [37.1].

ccc. Claim 82

[82.1] The method of claim 53, wherein the instruction is received separately with respect to the receipt of the compressed first feedback.

219. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [82.1] for reasons discussed in Limitation [19.4].

ddd. Claim 83

[83.1] The method of claim 53, wherein at least three transmission signals are capable of being simultaneously transmitted to at least three different devices, using the same multiple antennas.

220. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [83.1] for reasons discussed in Limitations [19.9] and [19.10]. Further, Walton teaches that a base station/access point may communicate with at least three terminals (and up to N) using N_R receive antennas and multi-user MIMO mode. EX1007, [0044], [0046], [0066], FIGs. 1, 2A. Accordingly, Walton/802.11a/Hamabe renders obvious simultaneous transmission of a third transmission signal to a third device for the same reasons described in Limitations [19.9] and [19.10] with respect to a first and second device.

eee. Claim 84

[84.1] The method of claim 53, wherein at least three transmission signals are capable of being simultaneously transmitted to at least three different devices, using at least one different antenna.

221. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [84.1] for reasons discussed in Limitations [42.1] and [83.1].

fff. Claim 85

[85.1] The method of claim 53, wherein the instruction includes a request to send (RTS) instruction.

222. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [85.1] for reasons discussed in Limitation [41.1].

ggg. Claim 86

[86.1] The method of claim 53, wherein the instruction includes a 802.11 clear to send (CTS) instruction.

223. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [86.1] for reasons discussed in Limitation [40.1].

hhh. Claim 87

[87.1] The method of claim 53, wherein the filtered first transmission signal is transmitted using a frequency band that is selected based on the instruction and the filtered second transmission signal is transmitted using the frequency band that is selected based on another instruction received from the third node, where the filtered first transmission signal is transmitted using a first frequency in the frequency band and the filtered second transmission signal is transmitted using a second frequency in the frequency band.

224. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [87.1] for reasons discussed in Limitations [19.1], [19.9], and [19.10]. Specifically, the network's current 802.11 channel is determined using interference avoidance determinations from the first and second terminals, which a POSITA would have understood should both be considered in determining a new channel, in the event that notifications have been received from both mobile stations since the last channel selection by the access point. Once the network's new channel is determined and the devices switch into the new channel, the filtered first transmission signal from the first station and the filtered second transmission signal from the second station are transmitted using a first and second frequency, respectively, for reasons discussed in [19.9] and [19.10].

iii. Claim 88

[88.1] The method of claim 53, wherein the filtered first transmission signal is transmitted using a first frequency and the filtered second transmission signal is transmitted using a second frequency.

225. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [88.1] for reasons discussed in Limitations [19.9] and [19.10].

jjj. Claim 89

[89.1] The method of claim 53, wherein the filtered first transmission signal and the filtered second transmission signal are transmitted using the same one or more frequencies.

226. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [89.1] for reasons discussed in Limitation [19.9] and [19.10]. Specifically, Walton discloses that a MIMO OFDM transmission channel refers to "***each*** spatial subchannel of each frequency subchannel." EX1007, [0048]. Each spatial subchannel is one of the "N_C independent channels" "formed by the N_T transmit and N_R receive antennas," where N_C is the smaller of N_T and N_R. EX1007, [0046]. As explained above with respect to MIMO, generally, this means that each frequency subchannel can be used to simultaneously transmit a separate data stream to each of the receiving nodes in a different spatial subchannel. *See* EX1007, [0055], [0065]. Based on this disclosure, a POSITA would have understood Walton to disclose using the same set of frequency subchannels, but different spatial channels, to transmit two separate data streams to two separate receiving nodes. This would occur if, for example, two terminals were scheduled for downlink transmission on all available

OFDM frequencies, but in different spatial subchannels. Therefore, Walton/802.11a/Hamabe discloses simultaneous transmission wherein the filtered first transmission signal and the filtered second transmission signal are transmitted using the same one or more frequencies.

kkk. Claim 90

[90.1] The method of claim 53, wherein the filtered first transmission signal and the filtered second transmission signal are transmitted using the same frequency band.

227. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [90.1] for reasons discussed in Limitation [89.1]. Specifically, transmission using the same one or more frequencies is, by definition, transmission using the same frequency band.

lll. Claim 91

[91.1] The method of claim 53, wherein the filtered first transmission signal is transmitted using a first frequency that is based on the instruction and the filtered second transmission signal is transmitted using a second frequency that is based on another instruction received from the third node.

228. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [91.1] for reasons discussed in Limitations [19.9], [19.10], and [22.2]. Because the available transmission channels are defined by the current frequency channel (i.e., they are the spatial channels of each OFDM subcarrier in the frequency channel), the frequencies used by the access point to transmit to each station in the network are necessarily based on the network's current frequency channel, which is based on

the interference avoidance notifications, which may be received both from the first and second terminals. Therefore, the signals transmitted by the access point to other stations in the network after switching channels pursuant to these notifications are filtered transmission signals that are transmitted using frequencies that are based on the claimed instruction and the claimed another instruction received from the third node.

mmm. Claim 92

> ***[92.1] The method of claim 53, wherein the filtered first transmission signal is transmitted using a frequency that is based on the instruction and the filtered second transmission signal is transmitted using the frequency that is based on another instruction received from the third node.***

229. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [92.1] for reasons discussed in Limitations [87.1] and [89.1]. Specifically, the OFDM subcarrier frequencies (or, in Walton, "frequency subchannels") to be used for each transmission signal are selected from within the current 802.11 channel and are, therefore, based on the interference avoidance notifications (instructions) used to determine the current channel. *See* EX1009, 11/90, 31/90. Further, as described in Limitation [89.1], Walton teaches that the filtered first and second transmission signals may be transmitted using the same frequency, but in different spatial subchannels, rendering obvious the remainder of Limitation [92.1]. *See* EX1007, [0055], [0065].

nnn. Claim 93

[93.1] The method of claim 53, wherein the filtered first transmission signal is transmitted using a frequency band that is selected based on the instruction and the filtered second transmission signal is transmitted using the frequency band that is selected based on another instruction received from the third node.

230. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [93.1] for reasons discussed in Limitation [87.1].

ooo. Claim 95

[95.pre] A method for managing interference in a radio communications network, comprising the steps of:

231. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [95.pre] for the reasons for Limitation [19.pre]. The mapping of claim 95 employs the same architecture as the mapping of claims 19, 52, and 53, but the first/second/third nodes are mapped differently as follows: a [blue] access point 104 is the "***second*** node," "and two [green, red] terminals" 106a and 106n in the form of 802.11 stations are the "***first***" and "third" "nodes." EX1007, [0076], FIG. 2A.

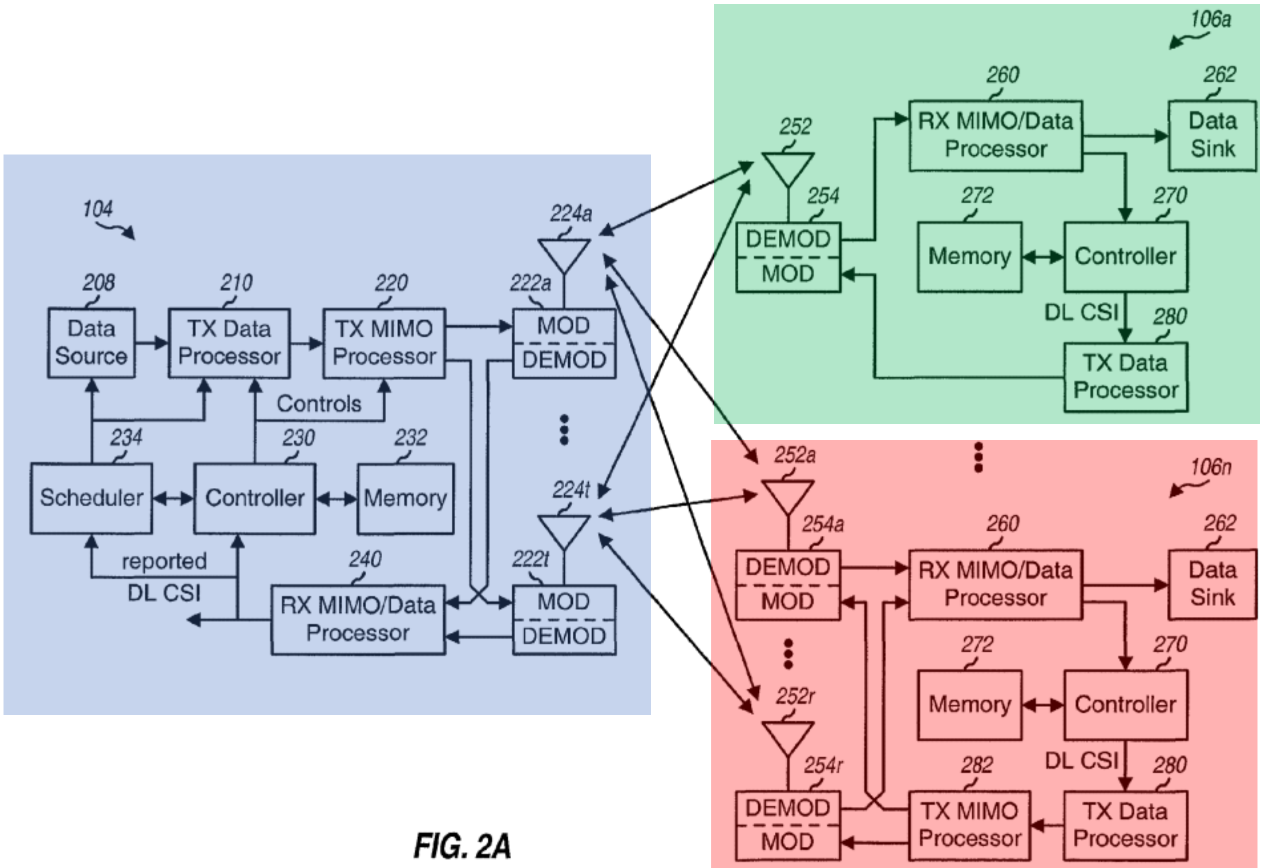


FIG. 2A

EX1007, FIG. 2A (annotated).

[95.1] receiving at a first node in the radio communications network an instruction transmitted from a second node in the radio communications network to avoid using a plurality of frequencies to transmit to the second node;

232. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [95.1]. In one embodiment of Hamabe, each mobile terminal, including terminal 106a ("first node"), "notifies" the access point ("second node") of interference "measurements." EX1008, [0143]. If access point 104 "determines that the carrier frequency must be changed," it selects a new channel and "notifies the selection to the" terminal, "which will change the carrier frequency to the selected carrier

frequency." *Id.*, [0144]. Thus, terminal 106a receives an instruction from access point 104 to use the second channel and, therefore, avoid a plurality of frequencies not used by that second channel, to transmit to access point 104.

[95.2] filtering a transmission signal to remove power from the transmission signal at each frequency in the plurality of frequencies to be avoided;

233. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [95.2]. As discussed for Limitation [19.2], a station, including terminal 106a, will perform standard 802.11a standard channelization (EX1009, 11, 34-36/90) and "PPDU encoding process," "time [domain] windowing," and "spectral mask" requirements (*id.*, 15-19, 37/90) for the newly-selected 802.11a channel. As explained for Limitation [95.2], this meets the "filtering" step under PO's infringement theory.

[95.3] transmitting the filtered transmission signal to the second node;

234. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [95.3] for reasons discussed in Limitations [19.3] and [95.2].

[95.4] separately from the receipt of the instruction, receiving a particular signal at the first node that is transmitted from the second node;

235. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [95.4]. "At ***each*** terminal 106 for which a data transmission is directed," the terminal "receive[s] the transmitted signals" and, which "active," "[yellow] RX MIMO/data processor 260 [] estimates the conditions of the downlink and provides channel state information (CSI) … indicative of the estimated link conditions." EX1007, [0079]-

[0080]; [0316] ("The CSI may be derived based on the signals transmitted by the [access point] transmitter unit and received at the [terminal] receiver unit."). That includes deriving the CSI "based on a pilot included in the transmitted signals" or "based on the data included in the transmitted signals." *Id.*, [316]. Thus, terminal 106a receives particular signals transmitted from access point 104, all such signals other than the message including the instruction being separate from the instruction.

[95.5] generating a feedback based on a received power and one or more frequencies via which the particular signal is received;

236. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [95.5] for reasons discussed in Limitations [19.4] and [95.4].

[95.6] compressing the feedback;

237. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [95.6] for reasons discussed in Limitation [19.4].

[95.7] transmitting the compressed feedback from the first node to the second node, for use by the second node in determining a transmit power with which the second node transmits to the first node via at least one antenna of a plurality of antennas, while simultaneously transmitting to one or more other nodes;

238. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [95.7] for reasons discussed in Limitations [19.4], [19.9], and [19.10].

[95.8] wherein the filtered transmission signal is transmitted to the second node using an 802.11-based orthogonal frequency-division multiplexing (OFDM) protocol;

239. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [95.8] for reasons discussed in Limitation [19.9].

[95.9] wherein an update of the compressed feedback is repeatedly generated, compressed, and transmitted at time periods of less than one second; so that the transmit power is repeatedly updated based thereupon at time periods of less than one second.

240. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [95.9] for reasons discussed in Limitation [25.1].

ppp. Claim 96

[96.1] The method of claim 95, wherein the instruction includes a first instruction and the filtered transmission signal includes a filtered first transmission signal, and further comprising:

241. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [96.1] for reasons discussed in Limitations [95.1] and [95.3].

[96.2] receiving at the first node in the radio communications network a second instruction transmitted from a third node in the radio communications network to avoid using a different plurality of frequencies to transmit to the third node;

242. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [96.2]. 802.11-1999, incorporated by reference into 802.11a, discloses that "mobile stations may move from one BSS to another (within the same ESS)." EX1025, 28/528. Because each BSS is managed by a single access point, a mobile station moving from one BSS to another will cease being associated with the first access

point ("second node," as described in Claim 95 above) managing the first BSS, and reassociate with a second access point (a "third node") that serves as the access point for the second BSS. *See* EX1025, 27-29/528 (depicting multiple BSS, each managed by a different access point). Walton similarly teaches that there may be multiple cells in the larger network, each serving a particular geographic area and managed by a different base station/access point. *See* EX1007, FIG. 1. Walton also explicitly contemplates that a mobile device (e.g., 106g in FIG. 1) may communicate with more than one base station/access point during operation. *See id.* Further, it was known in the art that it is beneficial to handoff mobile devices between base stations/access points as they move to achieve improved signal strength by associating the mobile device with whichever access point it is closest to or receiving the strongest signal from at any point in time.

243. Based on the above disclosure in 802.11a and Walton, a POSITA would have understood that a mobile station ("first node") that moves from a first BSS managed by the first access point 104 ("second node") to a second BSS managed by a second access point 104 ("third node") may then receive an instruction transmitted from the second access point 104 to avoid using a different plurality of frequencies to transmit to the second access point 104 via Hamabe's interference detection method described in Limitation [95.1]. A POSITA would have understood that the plurality of frequencies is likely to be different because each BSS is serving a

different area and may be receiving interference in different frequency channels from different sources as a result.

[96.3] filtering a second transmission signal to remove power from the second transmission signal at each frequency in the different plurality of frequencies to be avoided; and

244. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [96.3] for reasons discussed in Limitation [95.2]. Specifically, when the mobile station ("first node") receives Hamabe's channel selection message and moves 802.11 channels, as described in Limitations [95.1] and [95.2], but the channel selection message comes from the second access point 104 ("third node") described above, the mobile station is filtering a second transmission signal to remove power from the second transmission signal at each frequency in the different plurality of frequencies to be avoided.

[96.4] transmitting the filtered second transmission signal to the third node.

245. In my opinion, Walton/802.11a/Hamabe renders obvious Limitation [96.4] for reasons discussed in Limitation [95.3].

B. Ground 2: Walton, Hamabe, 802.11a, and Gubbi Render Obvious Claims 47 and 48.

1. Gubbi

246. Gubbi discloses "[q]uality of service extensions for multimedia applications communicating across a computer network" to address "existing issues that apply to 802.11 WLANs." EX1020, 5:59-63. These issues include

"unacceptable latencies" for multimedia streaming data caused both by (1) 802.11's contention scheme in 1999 (i.e., the "Point Coordinator Function (PCF)"), which cannot guarantee a streaming device access to the channel with certainty within the window required to maintain a stream that appears uninterrupted to the user; and (2) the requirement that all communications pass through the access point (AP), rather than allowing for peer-to-peer data transfers. *Id.*, 4:62-5:15.

247. Gubbi addresses these issues in 802.11-1999 by "enhanc[ing] the 802.11-MAC to provide QoS [Quality of Service]," while "maintain[ing] complete compatibility with the current definition of 802.11-MAC." *Id.*, 6:15-23. Specifically, the 802.11 MAC layer extensions disclosed in Gubbi allow for "dynamically negotiating for the priority, bandwidth and the retransmission parameters for each [multimedia] stream separately" so that "latency control is achieved." *Id.*, 6:7-11.

248. In addition to the MAC enhancements to coordinate channel access priority, Gubbi also discloses the use of a "Proxy Point Coordinator (PPC)" to "provid[e] data repeater services" between two devices in the same network." *Id.*, 10:40-45. A PPC is useful when the PPC "recognizes that a request from an MMS [multimedia device] is going unanswered by the operating PC [point coordinator (typically, the AP)]." *Id.*, 15:30-33; *see also id.*, 22:44-55. In such a case, "the PPC forms a tunnel between the operating PC and the requesting MMS by repeating the

frames transmitted from either network component to the other." *Id.*, 15:39-42; *see also id.*, 22:6-11. Further, "[e]xtending the above mechanism, two devices might be connected via more than one PPC." *Id.*, 22:12-13. Gubbi also discloses a set of 802.11 MAC commands that may be used "to request the service of a PPC upon recognizing that a link between [a multimedia device] and another device, including the PC, is too poor for proper communication." *Id.*, 39:53-56; *see id.*, 39:48-41:64.

2. *Motivation to Combine*

249. A POSITA would have been motivated to further combine Walton/802.11a/Hamabe with Gubbi because Gubbi explicitly teaches that its methods are "a supplement to the scheme proposed in the 802.11 standard for wireless networks" that address "existing issues that apply to 802.11 WLANs" that limit their ability to support streaming media. EX1020, 5:56-63. This is consistent with the 802.11 task groups that were working to improve various aspects of the 802.11 standard. For example, the 802.11e Task Group was working to enhance 802.11 QoS features, starting in 1999 and continuing until 2005. Rather than overhaul the entire standard, it was common for developers to propose supplements, amendments, modifications, or the like that would be combined with the larger standard to create an improved system. A POSITA looking at Gubbi in 2002 would have known that it was intended to be a modification of the existing 802.11 standard, like 802.11-1999.

250. Consistent with this design approach (i.e., supplements and amendments with backward compatibility), Gubbi's additions to the 802.11 MAC layer also "maintain[] complete compatibility with the current definition of 802.11-MAC." EX1020, 6:21-23. Because the Walton/802.11a/Hamabe combination is based on the 802.11 standard and adopts its MAC layer functionality, *see* EX1009, 12/90 ("[t]his subclause describes the PHY services provided to the IEEE 802.11 wireless LAN MAC"), a POSITA would have understood Gubbi's explicit teachings that its MAC layer enhancements may improve 802.11 devices without requiring substantial modification to the existing MAC layer as an obvious motivation to combine it with Walton/802.11a/Hamabe. *See* EX1020, 5:56-63, 6:21-23.

3. Modification of Walton/802.11a/Hamabe in view of Gubbi

251. The Walton/802.11a/Hamabe combination is modified by Gubbi to add Gubbi's 802.11 MAC layer enhancements, which includes the ability of a station to act as a PPC between two devices in the network, and the associated 802.11 MAC commands to facilitate this network topology. *See* EX1020, 10:40-45, 39:48-41:64. Such a modification could be performed without substantial changes to the underlying hardware required to implement the system because the changes are implemented at the MAC layer.

4. Element-by-Element Analysis

qqq. Claim 47

[47.1] The method of claim 19, wherein network forwarding decisions are guided using instantaneous information from a media access control (MAC) layer.

252. In my opinion, Walton/Hamabe/802.11/Gubbi renders this Limitation obvious. Specifically, Gubbi discloses a network topology for 802.11 WLAN in which a "Proxy Point Coordinator (PPC)" is used to "form[] a tunnel between the operating PC and the requesting MMS by repeating the frames transmitted from either network component to the other." EX1020, 15:39-42; *see also id.*, 22:6-11. Further, "[e]xtending the above mechanism, two devices might be connected via more than one PPC." *Id.*, 22:12-13. Gubbi also discloses a set of MAC layer commands to manage requests for a PPC, the instantiation of a PPC relationship, and broadcasts to the network of new PPC relationships. *Id.*, 39:48-41:64. Gubbi further teaches that "the PPC is allowed to modify the From-DS and To-DS bits in the MAC header and insert its own address in the from -DS address field." *Id.*, 22:6-11. Therefore, through both the MAC layer commands to create a PPC relationship between two nodes and, alternatively, by allowing the PPC to modify the MAC header of packets to be forwarded from the PC to the MMS, or vice versa, Gubbi discloses a network wherein network forwarding decisions are guided using instantaneous information from a media access control (MAC) layer.

rrr. Claim 48

[48.1] The method of claim 47, wherein the network forwarding decisions are guided to eliminate a dominant end-to-end latency effect of channel access delay at at least one hop.

253. In my opinion, Walton/Hamabe/802.11/Gubbi renders this Limitation obvious for reasons discussed in Limitation [47.1]. Specifically, Gubbi discloses that a PPC may be used to address an MMS whose requests are "going unanswered by the operating PC." EX1020, 15:31-34. As a POSITA would have been aware and Gubbi discloses, "a hidden node problem" may cause a PC to be unable to see and respond to messages from a particular node. *Id.*, 15:33-34. If a node's requests are going unanswered, there will be an associated increase in latency of the multimedia stream being received or transmitted by the MMS because the node must continue to retry sending the same data until it receives an acknowledgement from the PC that the data has been successfully received. If the node is forced to wait a long period of time between acknowledgements, the period between successful data transmissions or receptions will increase (i.e., higher latency). Gubbi's disclosure of a PPC stepping in to forward messages between a MMS and the PC to meet the latency requirements of the MMS (which is streaming) is a network in which network forwarding decisions are guided (using a PPC) to eliminate a dominant end-to-end latency effect of channel access delay (the inability of the MMS to contact

the PC, resulting in higher latency) across at least one hop (between the MMS and the PC).

XI. CONCLUSION

254. All statements made herein of my own knowledge are true, all statements made herein on information and belief are believed to be true, and these statements were made with the knowledge that willful false statement and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001.

Respectfully submitted,

Dated: June 16, 2025

Matthew B. Shoemake, Ph.D.