

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AMERICAN AIRLINES, INC., AND SOUTHWEST AIRLINES CO.,
Petitioners

v.

INTELLECTUAL VENTURES I LLC

Patent Owner

U.S. Patent No. 10,103,845
Issue Date: October 16, 2018

Title: DUAL MODE COMMUNICATION SYSTEMS AND METHODS

DECLARATION OF DR. CHUCK EASTTOM Ph.D., D.Sc.

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I. INTRODUCTION

1. My name is William C. Easttom II (Chuck Easttom), I have over 30 years of experience in the computer science industry including extensive experience with networking including high speed networking. I have authored 45 computer science books, including textbooks used at over 60 universities around the world. I also have authored over 80 research papers and am an inventor with 27 computer science patents.

2. I hold a Doctor of Science (D.Sc.) degree in Cyber Security from Capitol Technology University (Dissertation Topic: “A Comparative Study of Lattice Based Algorithms for Post Quantum Computing”). I also hold a Doctor of Philosophy (Ph.D.) in Technology focused on nanotechnology (Dissertation Topic: “The Effects of Complexity on Carbon Nanotube Failures”) from Capitol Technology University. I also have a Doctor of Philosophy (Ph.D.) in Computer Science from the University of Portsmouth (Dissertation Topic: topic “A Systematic Framework for Network Forensics Using Graph Theory”). I also hold four master’s degrees (one in Applied Computer Science, one in Education, one in Strategic and Defense Studies, and one in Systems Engineering).

3. I am currently an Adjunct Lecturer for Georgetown teaching graduate courses in requirements engineering and cryptography. I am also an adjunct at Vanderbilt University teaching graduate computer science courses, specifically quantum

computing, secure software engineering, and digital forensics. I also developed a graduate course in digital forensics for the University of Dallas and taught that course from 2019 to 2022.

4. I am a Senior member and Distinguished Speaker for the Association of Computing Machinery (ACM) and a Senior Member and Distinguished Visitor of the Institute for Electrical and Electronics Engineering (IEEE). The IEEE is the world's largest and most preeminent engineering organization. Among other activities, the IEEE creates industry standards for a wide range of engineering disciplines, including software development standards. I am also a Distinguished Visitor of the IEEE. I have been involved in IEEE standards creation for several years.

5. My publications directly related to network communication are listed here:

- Easttom, C. (2006). Network Defense and Countermeasures. New York City, New York: Pearson Press.
- Easttom, C. (2012). Network Defense and Countermeasures, 2nd Edition. New York City, New York: Pearson Press.
- Easttom, C. & Roberts, R. (2018). Networking Fundamentals, 3rd Edition. Goodheart-Wilcox Publishing.
- Easttom, C. (2018). Network Defense and Countermeasures, 3rd Edition. New York City, New York: Pearson Press.

- Easttom, C. (2022). Networking Fundamentals, 4th Edition. Goodheart-Wilcox Publishing.
- Easttom, C. (2023). Network Defense and Countermeasures, 4th Edition. New York City, New York: Pearson Press.
- Easttom, C. (2020). On the Application of Algebraic Graph Theory to Modeling Network Intrusions. 2020 IEEE 10th Annual Computing and Communication Conference.
- Easttom, C. Adda, M. (2020). An Enhanced View of Incidence Functions for Applying Graph Theory to Modeling Network Intrusions. WSEAS Transactions on Information Science and Applications. DOI: 10.37394/23209.2020.17.12
- Easttom, C. Adda, M. (2020) The Creation of Network Intrusion Fingerprints by Graph Homomorphism. WSEAS Transactions on Information Science and Applications. 17(2020). DOI: 10.37394/23209.2020.17.15
- Easttom, C., Adda, M. (2021). Application of the Spectra of Graphs in Network Forensics. IEEE 11th Annual Computing and Communication Conference.

6. My industry certifications directly related to network communication are listed here:

- CompTIA Network + Certified COMP10163630
- JN0-103 Juniper Networks Certified Associate, Junos JNCIA-Junos
- Cisco 100-490 Supporting Cisco Routing and Switching Network Devices
- CompTIA Network Infrastructure Professional – CNIP
COMP10163630
- CompTIA Linux Network Professional – CLNP COMP10163630
- CompTIA Network Vulnerability Assessment Professional-CNVP
COMP001021522764
- CompTIA Security Network Professional – CNSP

7. My patents directly related to networking are listed here:

- U.S. Patent No. 8,825,845 B1 Managing a network element operating on a network.
- US Patent No. 9,755,887 Managing a network element operating on a network
- US Patent No. 10,122,573 Managing a network element operating on a network
- U.S. Patent No. 10,708,118 Managing a network element operating on a network.

- U.S. Patent No. 11,165,629 Managing a network element operating on a network
- US Patent 12,155,523 B1 Managing a Network Element Operating on A Network

8. My full CV is attached as Exhibit 1003.

9. I have been asked to review the U.S. Patent 10,103,845 and prior art cited in this declaration, and to form my own independent scientific opinions.

10. I am being compensated at my usual rate of \$550 per hour. My compensation is not dependent in any way upon my conclusions.

II. LEGAL STANDARDS

11. The following subsections represent my understanding of the relevant legal standards.

A. Validity

12. I understand that each claim of a patent is presumed to be valid. Dependent claims shall also be presumed valid even if they depend upon an invalid claim.

13. 35 U.S. Code § 282 states, “[a] patent shall be presumed valid. Each claim of a patent (whether in independent, dependent, or multiple dependent form) shall be presumed valid independently of the validity of other claims; dependent or multiple dependent claims shall be presumed valid even though dependent upon an invalid

claim. The burden of establishing invalidity of a patent or any claim thereof shall rest on the party asserting such invalidity.”

B. Obviousness

14. I understand that a patent claim is invalid if the differences between the subject matter and the prior art are such that the subject matter as a whole would have been obvious to a person of skill in the art, or POSITA, at the time of the alleged invention. I further understand that an obviousness analysis involves a review of the scope and content of the asserted prior art; the differences between the prior art and the claims at issue; the level of ordinary skill in the pertinent art; and objective indicia of non-obviousness (i.e., secondary considerations), such as long-felt but unsolved needs, failure of others, industry praise, commercial success, and skepticism of others in the field.

15. In determining obviousness based on a combination of prior art references, I also understand that evidence of a reason to combine the teachings is required to make the combination. Any evidence that one or more of the references would have taught away from the claimed invention at the time of the invention must also be considered.

16. I have been informed that the following rationales, among others, may support a conclusion of obviousness:

- i. the combination of familiar elements according to known methods to yield predictable results;
- ii. the simple substitution of one known element for another to obtain predictable results;
- iii. the use of known techniques to improve similar methods or apparatuses in the same way;
- iv. the application of a known technique to a known method or apparatus ready for improvement to yield predictable results;
- v. the choice of a particular solution from a finite number of identified, predictable solutions with a reasonable expectation of success;
- vi. the use of known work in one field of endeavor in either the same field or a different one based on design incentives or other market forces, if the variations are predictable to one of ordinary skill in the art; and
- vii. the following of some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

17. I also understand that secondary considerations such as long-felt but unsolved needs, failure of others, praise, skepticism, and commercial success are relevant to determining obviousness.

18. I understand that there must be evidence showing an articulated reasoning with rational underpinnings to support a motivation to combine teachings and to support the legal conclusion of obviousness. However, I understand that proposed modifications which would render the prior art unsatisfactory for its intended purposes or change the principal operation of the reference do not render a claim obvious.

19. Moreover, if prior art indicates that the invention would not have worked for its intended purpose, or otherwise teaches away from the invention, then a claim would not be obvious. A reference teaches away when a POSITA, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken in the claim.

C. Motivation to Combine

20. It is my understanding that a motivation to combine must meet certain requirements. It is not sufficient for an expert to simply state there is a motivation to combine. Instead, there must be a clearly articulated reason to combine. In order to satisfy these requirements, the articulated motivation to combine should include the following:

- i. the prior art included each element claimed, although not necessarily in a single prior art reference, with the only difference between the

claimed invention and the prior art being the lack of actual combination of the elements in a single prior art reference;

- ii. one of ordinary skill in the art could have combined the elements as claimed by known methods, and that in combination, each element merely performs the same function as it does separately; and
- iii. one of ordinary skill in the art would have recognized that the results of the combination were predictable.

D. Claim Construction

21. I understand that the words of a claim are generally given their ordinary and customary meaning to a POSITA as of the effective filing date of the application for the patent at issue. I understand that claim construction is a task for the Court to undertake and, as such, I offer no constructions of any claim terms. Throughout my analysis I view terms using their plain and ordinary meaning to one of ordinary skill in the art.

III. TECHNOLOGY BACKGROUND

22. The '845 patent and the prior art utilize specific technologies that are described in the following subsection.

A. Orthogonal Frequency Division Multiplex (OFDM)

23. Orthogonal Frequency Division Multiplexing (OFDM) is a multi-carrier modulation technique widely used in modern wireless communication systems such

as Wi-Fi (IEEE 802.11 a/g/n/ac), LTE, 5G NR, DVB, and DSL. Its primary advantage lies in efficiently transmitting data over channels subject to multipath fading and narrowband interference, both of which commonly degrade signal performance^{1,2,3}.

24. The fundamental concept of OFDM is to divide a high-rate data stream into multiple lower-rate parallel data streams, each modulated onto its own carrier frequency^{4,5}. These carriers are carefully chosen so that they are orthogonal to each other, meaning their cross-correlation is zero over the symbol interval. This ensures that even though the subcarriers overlap in frequency, they can still be separated at the receiver without interference. In OFDM, subcarriers are spaced by $\Delta f = 1/T$, where T is the symbol duration.

B. Multiple-Input Multiple-Output (MIMO)

25. MIMO (Multiple-Input Multiple-Output) is a wireless communication technology that uses multiple antennas at both the transmitter and receiver to improve data throughput, reliability, and spectral efficiency^{6,7}. By exploiting spatial diversity and multipath propagation, MIMO systems enhance performance beyond

¹

https://people.ece.cornell.edu/land/courses/eceprojectsland/STUDENTPROJ/2009to2010/mal283/Micha_Li_twin_MEng_Project_Report2.pdf

² https://faculty.uml.edu/jweitzen/16.543/Class%20Notes/Great_ofdm2_tutorial.pdf

³ https://repository.lsu.edu/cgi/viewcontent.cgi?article=2618&context=gradschool_theses

⁴ <https://ui.adsabs.harvard.edu/abs/2013arXiv1309.7334C/abstract>

⁵ <https://ee.stanford.edu/~jmk/pubs/ofdm.vs.pam.trans.com.pdf>

⁶ <https://techtransfer.universityofcalifornia.edu/NCD/29058.html>

⁷ <https://engineering.purdue.edu/~djllove/papers/paper1.pdf>

what single-antenna (SISO) systems can achieve. MIMO is integral to modern standards like Wi-Fi (802.11n/ac/ax), LTE, and 5G NR.

IV. ANALYSIS

26. This section contains my analysis of the ‘845 patent and the prior art.

A. Level Of Ordinary Skill in the Art

27. In determining the level of one of ordinary skill in the art I considered the ‘845 patent itself, the state of the art at the time of the invention (which I assume for the purposes of this declaration is no earlier than April 14, 2004), and the prior art referenced in the ‘845 patent itself.

28. I arrived at the conclusion that a POSITA as of April 14, 2004, would be a person with at least a bachelor’s degree in computer science, electrical engineering, or related field, with at least three to four years of experience in wireless communication technology

29. Additional education could substitute for professional experience and vice versa.

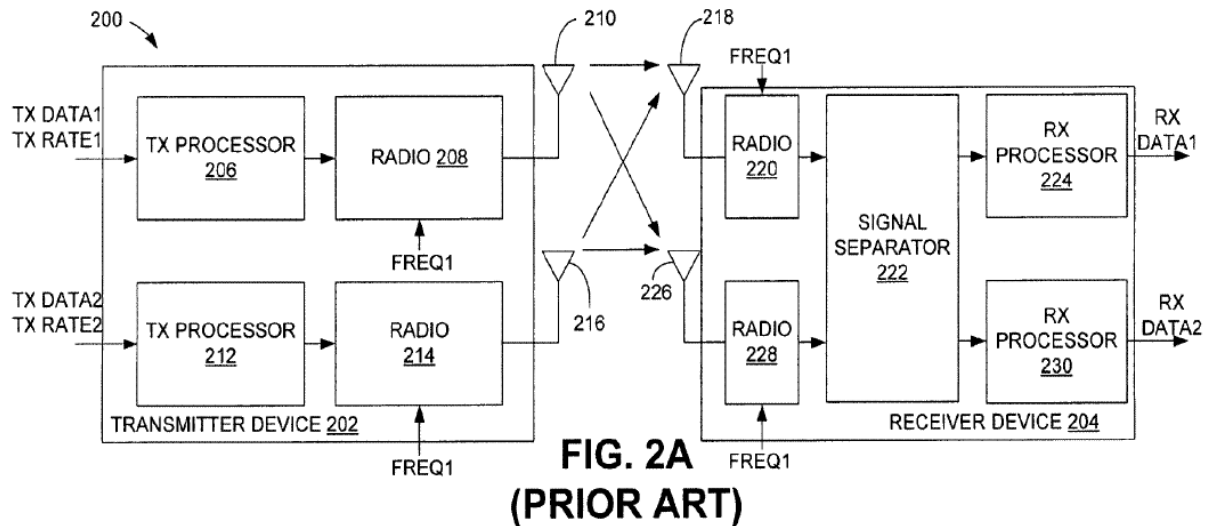
30. I was at least a person of ordinary skill in the art at the time of the invention of the ‘845 patent.

B. The ‘845 patent

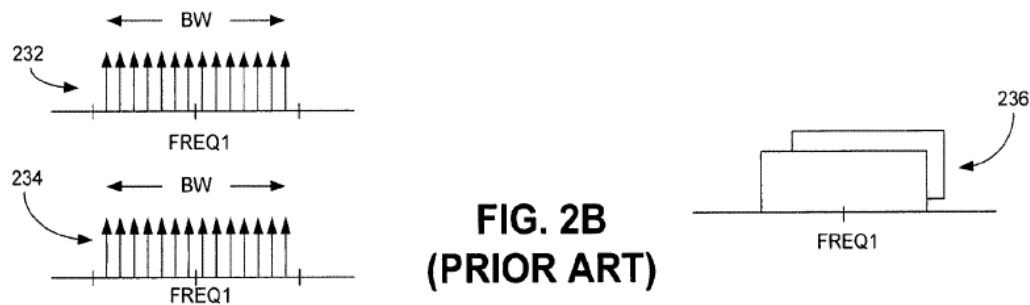
31. U.S. Patent 10,103,845 was granted on October 16, 2018 and was filed September 27, 2012. The listed inventors are Mark Webster and Michael J. Seals.

32. The '845 Patent describes a dual-mode communications system configured to perform spatial multiplexing and expanded bandwidth data transmission. This is described in the abstract of the '845: "Embodiments of dual mode communication systems and methods are disclosed. On system embodiment, among others, comprises logic configured to perform spatial multiplexing and expanded bandwidth signaling to data."

33. Shown below is a figure from the '845 Patent depicting a "block diagram that illustrates a multiple-input multiple-output (MIMO) OFDM communication system 200 (herein, MIMO system 200). The MIMO system 200 employs multiple transmit antennas and multiple receive antennas for data transmission." (Ex.1001 2:32-36). The '845 Patent describes spatial multiplexing as "a technique where a transmission channel is divided into multiple "spatial channels" through which independent streams can be transmitted and received via multiple transmit and receive antennas, respectively." (Ex.1001 2:26-30).



34. The MIMO system depicted above, which the '845 Patent acknowledges to be prior art, comprises hardware necessary to transmit and receive data wirelessly. The system depicted above operates at a single common frequency for each transmitter and receiver. (Ex.1001 2:42-49). Figure 2B below depicts “a schematic diagram that illustrates spectrum of the signals processed in the MIMO system 200.” (Ex.1001 2:63-64).



35. This is again prior art, as acknowledged by the '845 patent.

36. An embodiment of the system described in the '845 Patent is shown below in Figure 3A:

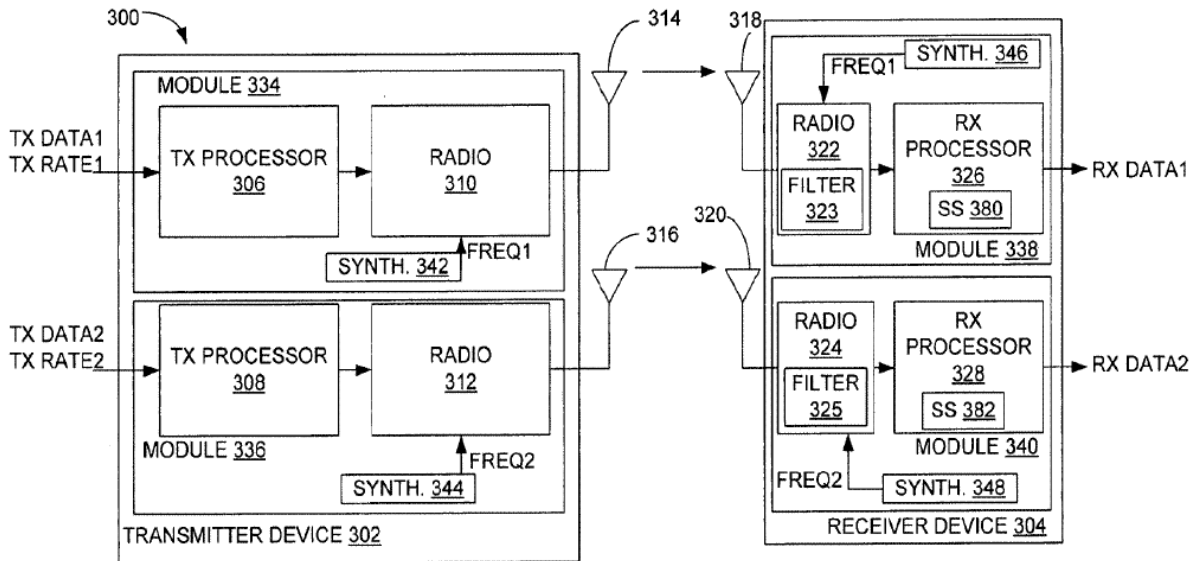
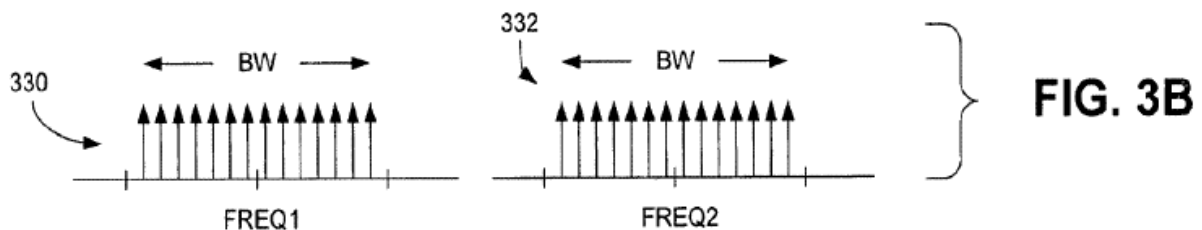


FIG. 3A

37. The '845 describes this figure as follows: "FIG. 3A is a block diagram that illustrates an embodiment of BES system 300. The BES system 300 may also be referred to as a dual mode communication system. In one embodiment, the BES system 300 comprises a multiple input multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) communication system that implements bandwidth expansion and/or spatial multiplexing." (Ex.1001 4:50-57). Bandwidth expansion is enabled if "the synthesizers of the respective transmit/receive chains are tuned to different, non-overlapping frequencies rather than the same frequency." (Ex.1001 4:32-34).



38. Figure 3B above is described as “a schematic diagram that illustrates exemplary spectrums for OFDM symbols of the BES system 300 shown in FIG. 3A.” (6:13-15). Figures 3C and 3D are described as follows: “FIGS. 3C-3D are schematic diagrams that illustrate exemplary adjacent and non-adjacent spectrums, respectively, of the BES system 300 shown in FIG. 3A.” (6:21-23)

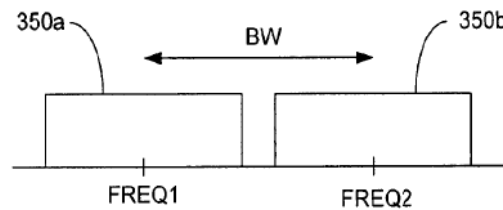


FIG. 3C

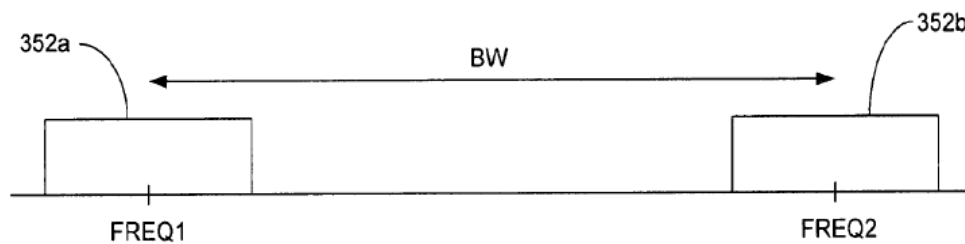


FIG. 3D

39. The '845 Patent states that one benefit of the non-adjacent channels is "Such an expanded bandwidth technique may provide several benefits, such as finding a free or available channel (since there is no requirement that the channels be adjacent)." (Ex.1001 6:31-33)

40. The '845 Patent also describes that its bandwidth expansion and spatial multiplexing modes can be configured either manually or automatically based on

operational conditions, such as “signal-to-noise ratio, multipath environment, [or] interference.” (Ex.1001 6:57-59).

41. The '845 Patent also discloses some embodiments that utilize “gap filling,” or sending transmissions in the gap between spectrums 350*a* and 350*b* stating “Note that in some embodiments, gap filling may be provided between two spectrums with extra subcarriers, which may increase the composite data rate. For example, 25 referring to FIG. 3C, subcarriers may fill in the gap between spectrums 350*a* and 350*b*.” (Ex.1001 7:23-27)

C. Prior Art References

1. Walton (U.S. Patent App. No. 2002/0154705)

42. Walton was filed on March 22, 2000 and published on October 24, 2002. (Ex.1005 Cover). I understand based on these dates that Walton qualifies as prior art to the '845 Patent.

43. Walton describes “Transmitter and receiver units for use in a communications System and configurable to provide antenna, frequency, or temporal diversity, or a combination thereof, for transmitted Signals.” (Ex.1005 Abstract). Figure 1, below, is a diagram of a MIMO communications system disclosed by Walton. (Ex.1005 0024).

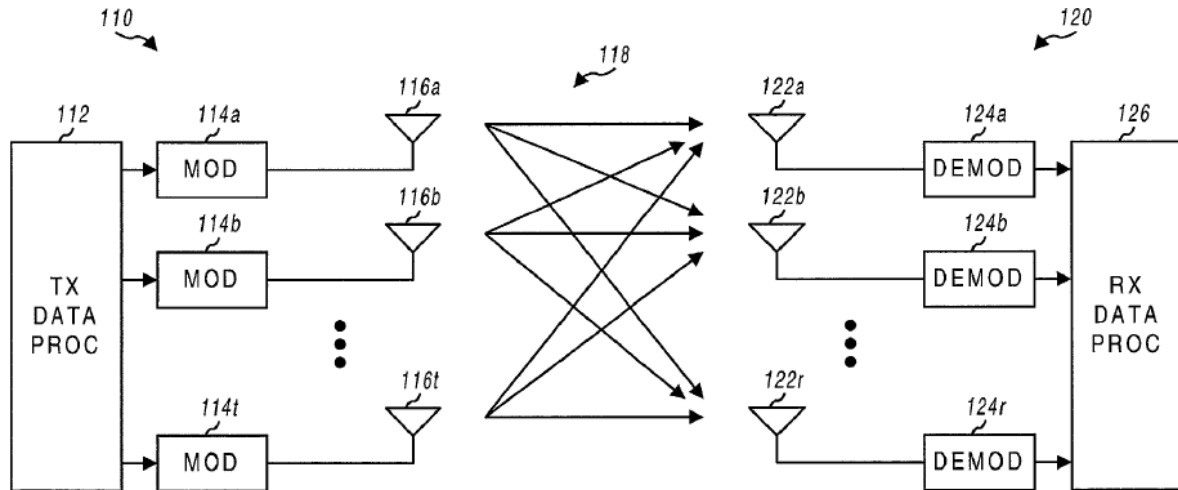


FIG. 1

44. Antenna diversity “refers to the transmission and/or reception of data over more than one antenna.” (Ex.1005 0043). “[A]ntenna diversity is achieved by employing a number of (N_T) transmit antennas at the transmitter unit or a number of (N_R) receive antennas at the receiver unit, or multiple antennas at both the transmitter and receiver units.” (Ex.1005 0045). Walton notes that antenna diversity can be considered to have a number of subcategories, including transmit diversity (multiple transmit antennas), receive diversity (multiple receive antennas), and spatial diversity (multiple transmit and receive antennas). (Ex.1005 0045). Similarly, Walton’s “MIMO communications mode employs antenna diversity at both ends of the communication link and is generally used to improve both the reliability and increase the capacity of the communications link.” (Ex.1005 0056).

45. Frequency diversity “refers to the transmission of data over more than one sub-band.” (Ex.1005 0043). It can be achieved by employing a multi-carrier

modulation scheme, such as OFDM, wherein the “overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data.” (Ex.1005 0048). “The overall transmission channel occupies the total operating bandwidth of W , and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth.” (Ex.1005 0048). Walton explains that “[e]ach of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme.” (Ex.1005 0048).

46. Figure 2 from Walton, below, depicts “a specific example of a transmission from a transmit antenna at a transmitter unit.” (Ex.1005 0025). The horizontal axis represents time, and the vertical axis is frequency, as divided into sub-channels. (Ex.1005 0080).

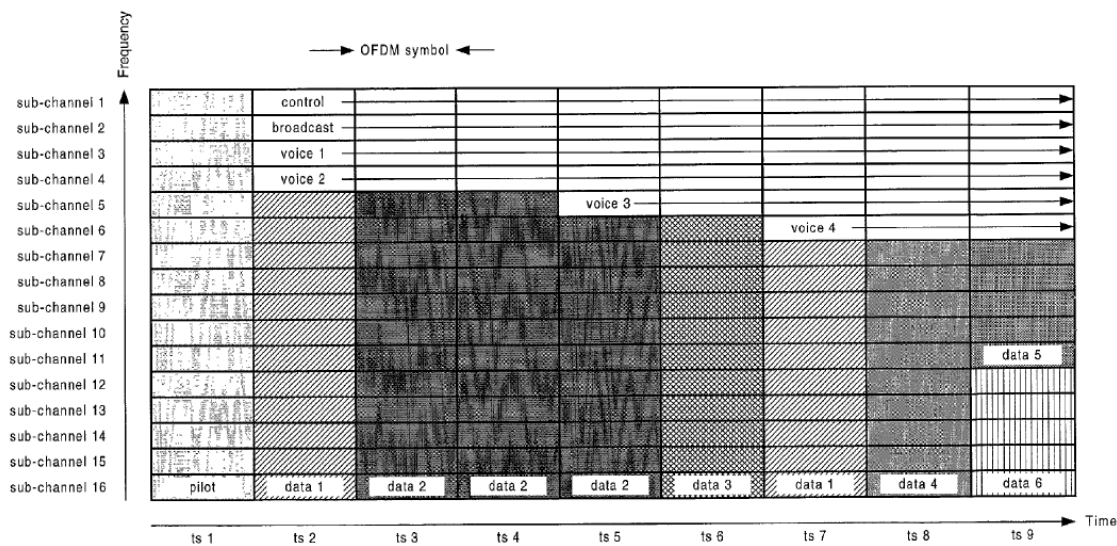


FIG. 2

47. Walton's antenna, frequency, or temporal diversity modes "can be independently achieved and dynamically selected." (Ex.1005 0042). For example, "antenna diversity is dynamically provided based on the characteristics of the communications link to provide the required performance," including the carrier-to-noise-interference ratio. (Ex.1005 0046). Walton further notes that "The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity." (Ex.1005 0049).

2. Ishikawa (U.S. Patent No. 7,130,592)

Ishikawa was filed in the U.S. on June 25, 2003. (Ishikawa Cover). I understand Ishikawa thus qualifies as prior art to the '845 Patent.

48. Ishikawa describes a radio transmission apparatus that can “control each transmission frequency of a plurality of antennas and the number of information transmitted from the plurality of antennas according to circumstances of a propagation path.” (Ishikawa 1:64-67). An embodiment of the invention is depicted in Figure 1 below, with two antennas shown “as an example.” (Ishikawa 3:16-18).

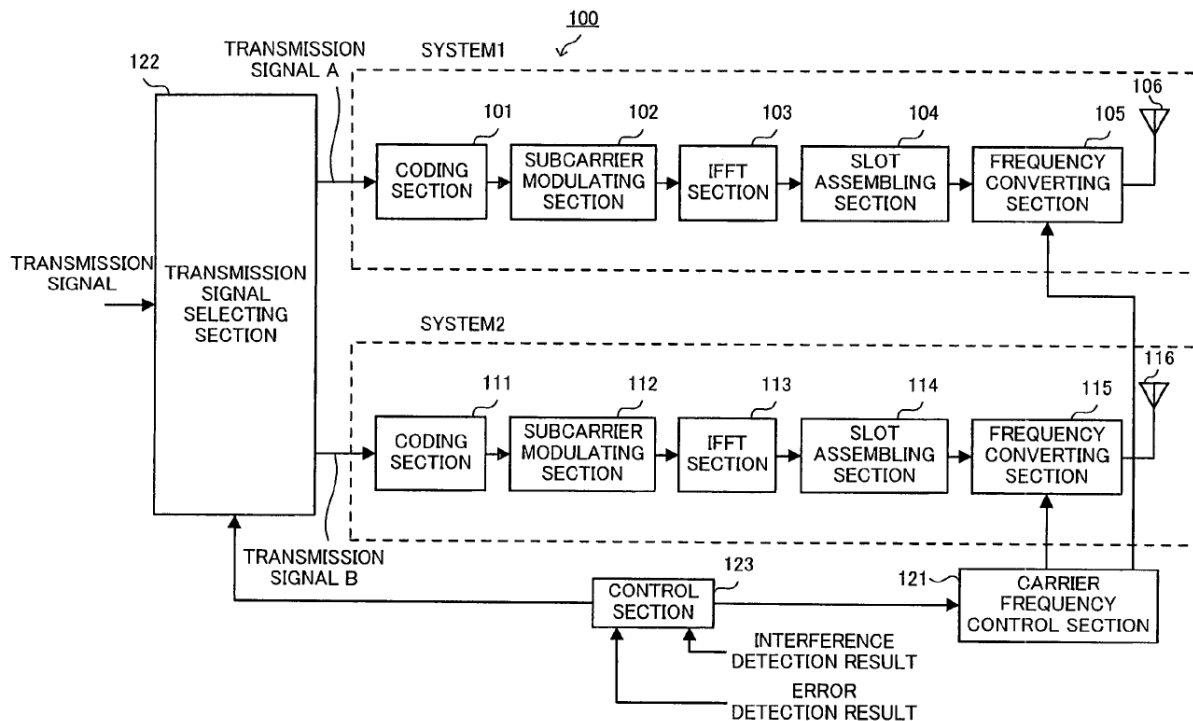


FIG.1

49. Ishikawa describes the ability to “adaptively select space multiplex where different information is transmitted from the plurality of antennas with the same frequency [and] frequency multiplex where different information is transmitted from the plurality of antennas with different frequencies.” (Ishikawa 2:2-11).

50. Two example transmissions created by Ishikawa’s system are shown below. Figure 3 depicts a spatial multiplexing transmission where two antennas transmit at

the same frequency, and Figure 4 reflects frequency multiplexing where two antennas transmit information on different frequencies. (Ishikawa 5:40-43, 6:3-6).

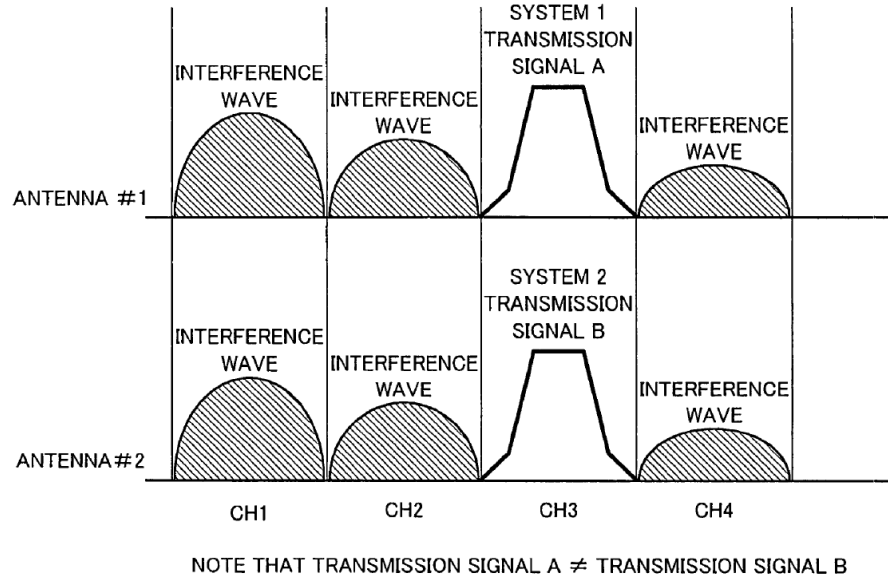


FIG.3

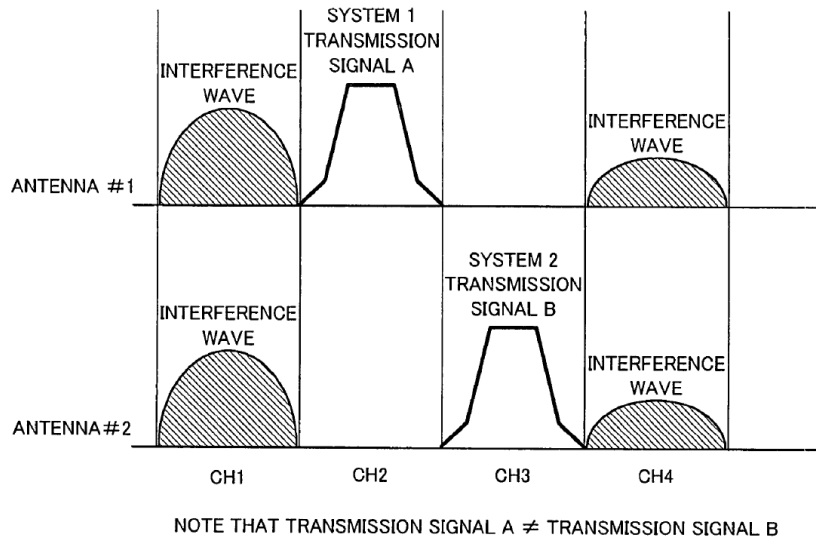


FIG.4

3. Maltsev (U.S. Patent No. 7,885,178)

51. Maltsev was filed on December 29, 2003 and issued February 8, 2011.

(Ex.1007 Cover). I understand Maltsev thus qualifies as prior art to the '845 Patent.

52. Maltsev is directed to multichannel receivers for wideband OFDM communications. (Ex.1007 Cover). Maltsev describes a receiver that “may receive an OFDM symbol on a wideband communication channel” that may comprise one or more subchannels that are themselves “separated in frequency” and which may comprise OFDM subcarriers. (Ex.1007 2:15-22).

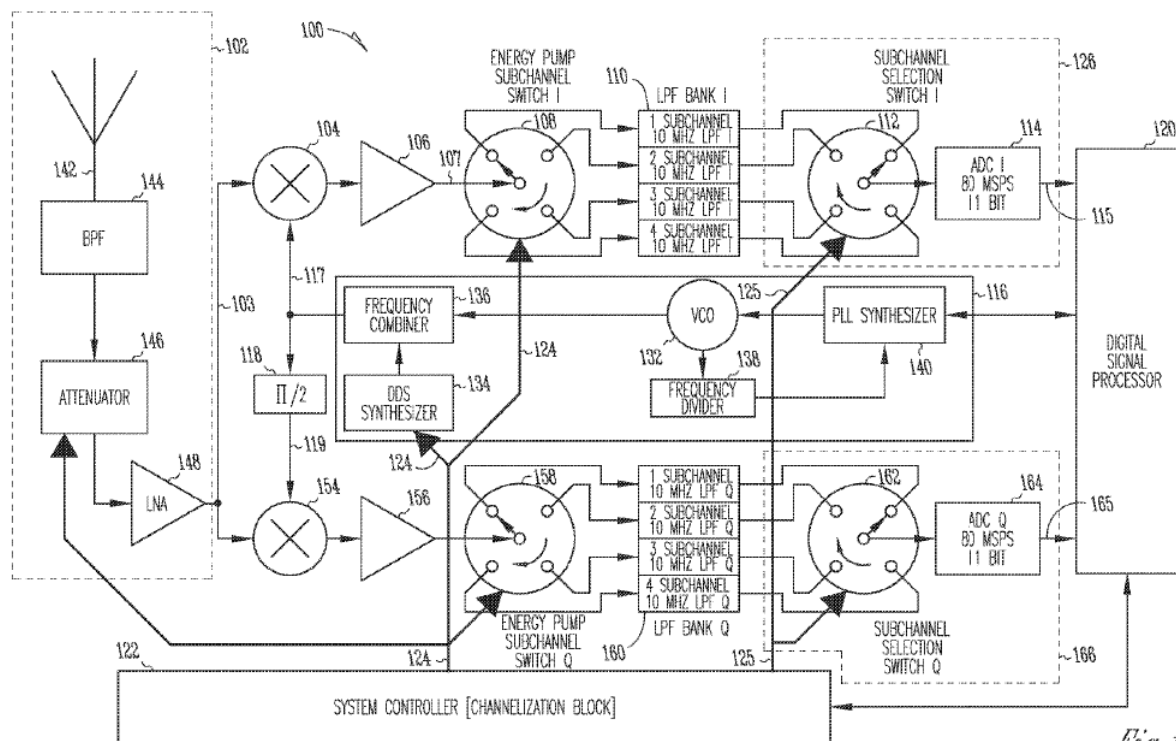


Fig. 1

53. Figure 1, above, depicts an embodiment in accordance with Maltsev’s invention. Maltsev notes that the antenna assembly depicted in Figure 5 below “may

be suitable for use as RF and front-end circuitry 102” as seen in Figure 1. (Ex.1007 8:32-35).

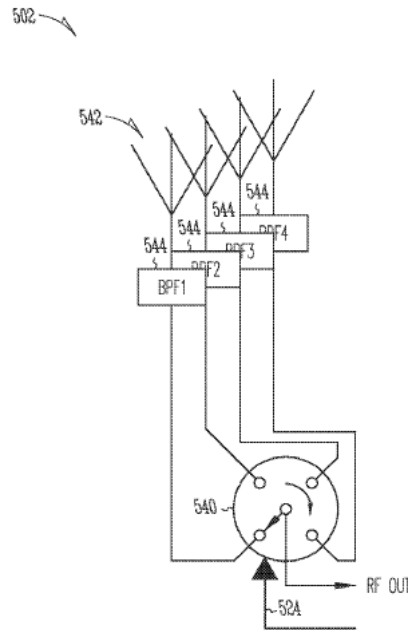


Fig. 5

54. Maltsev discloses embodiments wherein it acts as a “genuine multichannel receiver,” receiving OFDM symbols over more than one subchannel. (Ex.1007 3:43-45). In embodiments reflected by Figure 5, a receiver “may utilize more than one of spatially diverse antennas 542 to “divide” a single subchannel into one or more spatial channels.” (Ex.1007 8:37-39). Further, “each antenna 542 may receive signals from one spatial channel.” (Ex.1007 8:39-40). Spatial channels may carry the same data as other spatial channels or different data, allowing for increased data throughput without an increase in frequency bandwidth. (Ex.1007 8:40-47).

4. Gardner (U.S. Patent No. 7,916,803)

55. Gardner was filed on April 5, 2004, issued on March 29, 2011, and claims priority to U.S. Provisional App. No. 60/461,999, which was filed on April 10, 2003. (Ex.1008 Cover). I understand Gardner thus qualifies as prior art to the '845 Patent.

56. Gardner is directed towards modified preambles for 802.11 devices, and it discloses multi-antenna MIMO devices “where multiple data streams are multiplexed spatially” and “multichannel techniques, where an extended transmitter transmits using more than one 802.11a channel at a time.” (Ex.1008 Abstract).

57. Gardner’s Figure 5 “illustrates the case where out-of-band pilots are attenuated for 20 MHz channels used to transmit a MIMO signal.” (Ex.1008 6:29-31).

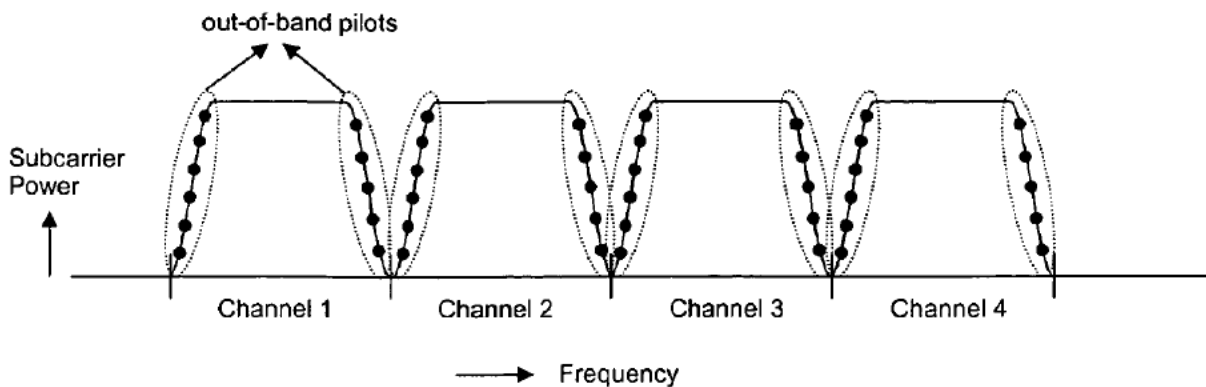


FIG. 5

58. Gardner further notes that “some or all of these out-of-band subcarriers may also be used in the data symbols to increase the data rate.” (Ex.1008 6:34-35). Gardner explains that it is possible that one device transmits on channels 1 and 4

simultaneously, while channels 2 and 3 are occupied by other devices. (Ex.1008 6:38-40).

59. Gardner also contains Figures 6 and 7, which respectively depict the situations in which a single device transmits using two adjacent 20 MHz channels and four adjacent 20 MHz channels.

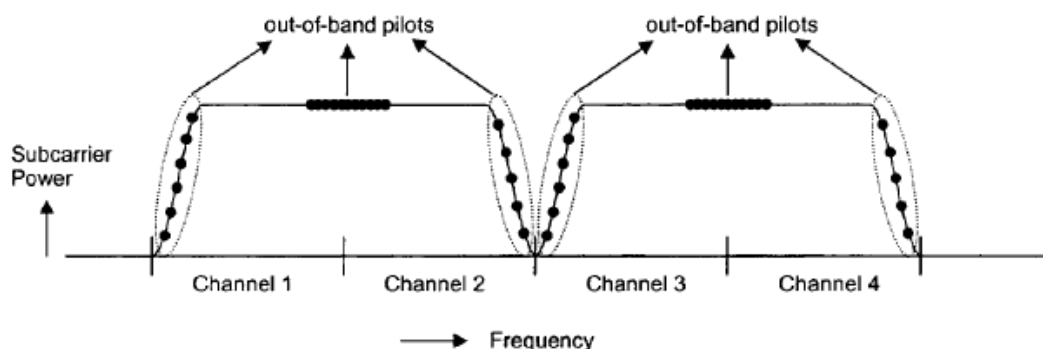


FIG. 6

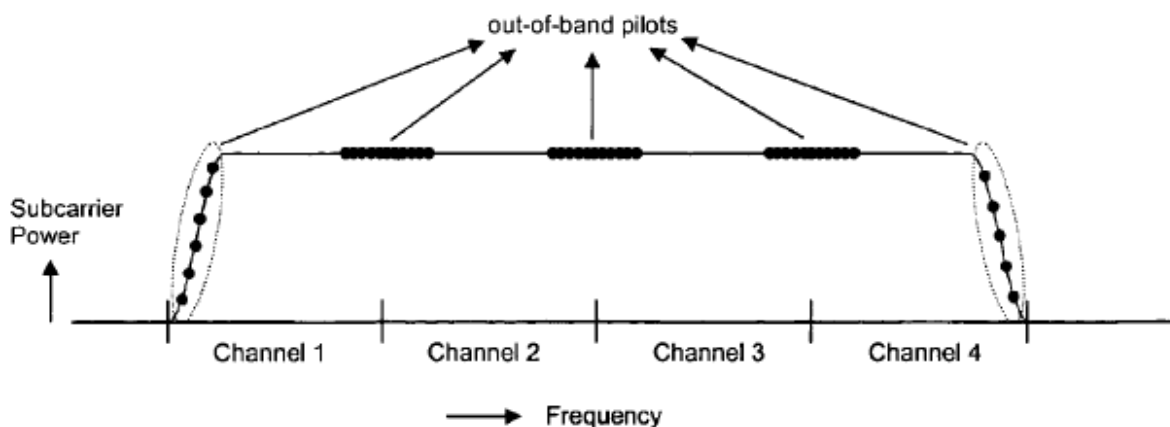


FIG. 7

60. As depicted, the previously attenuated out-of-band subcarriers/pilots are no longer attenuated, allowing information to be carried on them. (Ex.1008 6:57-61).

D. Motivations to Combine

1. Walton & Maltsev

61. A POSITA would have been motivated to combine Walton and Maltsev for at least the following reasons:

62. First, Walton and Maltsev both concern wireless transmitters employing OFDM modulation, MIMO techniques, and the ability to transmit in diverse frequencies. For example, Walton describes devices that process and transmit data streams that are modulated using OFDM, and “transmitted in a manner to provide antenna, frequency, or temporal diversity,” including in a MIMO mode. (Ex.1005 0016-0017). And Maltsev is directed to a “quasi-parallel receiver” that may “simultaneously receive signals within several subchannels that comprise a wideband channel.” (Ex.1007 Abstract). Maltsev describes “multiple-input, multiple-output (MIMO) embodiments” where each antenna of a device corresponds to a spatial channel. (Ex.1007 8:63-65). The references’ similarity would have led a POSITA to combine the two without undue burden or extensive experimentation.

63. Second, the MIMO and frequency diversity aspects of Walton and Maltsev were well-known technologies at the time of the ’845 Patent’s invention, and it would have been obvious to combine the two, especially because of the contemporary development of the 802.11n wireless standard, which sought to increase data throughput rates using spatial and frequency multiplexing techniques.

Sean Coffey, *Suggested Criteria for High Throughput Extensions to IEEE 802.11 Systems*, IEEE 802.11-02/252r0 (Mar. 2002), available at <https://mentor.ieee.org/802.11/documents> (Presentation to 802.11 task group regarding channel bonding); Frederik Petré, Bart Van Poucke, André Bourdoux & Liesbet Van der Perre, *MIMO-OFDM for High-Speed WLANs*, IEEE 802.11-04/0136-00-000n (Jan. 2004), available at <https://mentor.ieee.org/802.11/documents> (Presentation to 802.11 task group regarding MIMO).

64. Third, based on contemporary references, it would have been a simple combination of known elements to achieve a predictable result for a POSITA at the time of the '845 Patent's invention to combine the MIMO system of Walton with the expanded bandwidth system of Maltsev. For example, U.S. Patent No. 7,324,429 discloses a system capable of both frequency division duplex (FDD) and MIMO transmitting. U.S. Patent No. 7,324,429 at 2:53-55. This is noteworthy because the '845 Patent applicant claimed during prosecution that they overcame the prior art because the '845 Examiner's prior art reference did "not elaborate about combining spatial multiplexing with FDD (or bandwidth expansion)." Ex.1002 at 54. Similarly, Gardner also discusses at length the combination of MIMO spatial multiplexing and the bandwidth expansion frequency multiplexing. Ex.1008 at Cover.

2. Ishikawa & Gardner

65. A POSITA would have been motivated to combine Ishikawa and Gardner for at least the following reasons:

66. First, as before, Ishikawa and Gardner both concern wireless transmitters employing OFDM modulation, MIMO techniques, and the ability to transmit in diverse frequencies. For example, Ishikawa discloses an OFDM radio that can adaptively select between spatial and frequency multiplexing modes. Ishikawa at 1:18-20, 2:2-6. And Gardner discloses an 802.11-compliant device that can use either spatial multiplexing or simultaneous multi-channel transmitting. Ex.1008 at 2:39-46. Combining the two references would have been predictable and routine due to their similarity.

67. Second, as with Walton and Maltsev, a POSITA would have been motivated to combine Ishikawa and Gardner given both references' relation to the contemporary development of the 802.11 standard and its incorporation of spatial and frequency multiplexing techniques. Sean Coffey, *Suggested Criteria for High Throughput Extensions to IEEE 802.11 Systems*, IEEE 802.11-02/252r0 (Mar. 2002), available at <https://mentor.ieee.org/802.11/documents> (Presentation to 802.11 task group regarding channel bonding); Frederik Petré, Bart Van Poucke, André Bourdoux & Liesbet Van der Perre, *MIMO-OFDM for High-Speed WLANs*, IEEE 802.11-04/0136-00-000n (Jan. 2004), available at

<https://mentor.ieee.org/802.11/documents> (Presentation to 802.11 task group regarding MIMO).

68. Third, the “gap filling” and non-adjacent channel transmitting disclosed in Gardner were well-known techniques at the time of the ’845 Patent’s invention. International Patent App. No. WO2003003646A2 at 3:20-4:10; Texas Instruments Inc., *WLAN Channel Bonding: Causing Greater Problems Than It Solves*, White Paper SPLY003 (Sept. 2003) at 4. As I previously noted with respect to Walton and Maltsev, the same was true of spatial multiplexing and frequency multiplexing. Thus, it would have been a simple combination of known elements to obtain a predictable result to combine the gap-filling, non-adjacent transmitting, and spatial and frequency multiplexing techniques of Gardner with the spatial and frequency multiplexing system of Ishikawa.

E. Claim analysis

69. I lay out my analysis for each claim below.

70. Where appropriate, I refer back to earlier analysis. For example, claims 1, 7, 11, and 18 are substantially similar in scope except that claims 1 and 7 are transmitter/receiver method claims and 11 and 18 are transmitter/receiver system claims. Generally, any disclosure of a transmitter or a receiver would render the converse obvious to a POSITA. The same is true of transmitters/receivers and transceivers.

1. Claim 1pre: A method of operation of a transceiver in a plurality of modes including at least a first mode and a second mode, the method comprising:

71. Walton discloses: "Transmitter and receiver units for use in a communications system and configurable to provide antenna, frequency, or temporal diversity, or a combination thereof, for transmitted signals." (Walton, Abstract).

72. Walton further discloses a plurality of modes: "*Various communications modes* (e.g., diversity and MIMO) may be supported and are described in greater detail below." (Walton 17, emphasis added). The plurality of modes is disclosed in multiple places in Walton including: "The communications system of the invention can be *designed and operated in a number of different communications modes*, with each communications mode employing antenna, frequency, or temporal diversity, or a combination thereof. The communications modes include, for example, a diversity communications mode and a MIMO communications mode. Various combinations of the diversity and MIMO communications modes can also be Supported by the communications System. Also, other communications modes can be implemented and are within the scope of the present invention." (Walton, 53, emphasis added).

73. Figure 1 of Walton, shown below is described as follows "FIG. 1 is a diagram of a multiple-input multiple output (MIMO) communications system 100 capable of implementing Some embodiments of the invention. Communications system 100 can be operative to provide a combination of antenna, frequency, and temporal

diversity to increase spectral efficiency, improve performance, and enhance flexibility” (Walton 37).

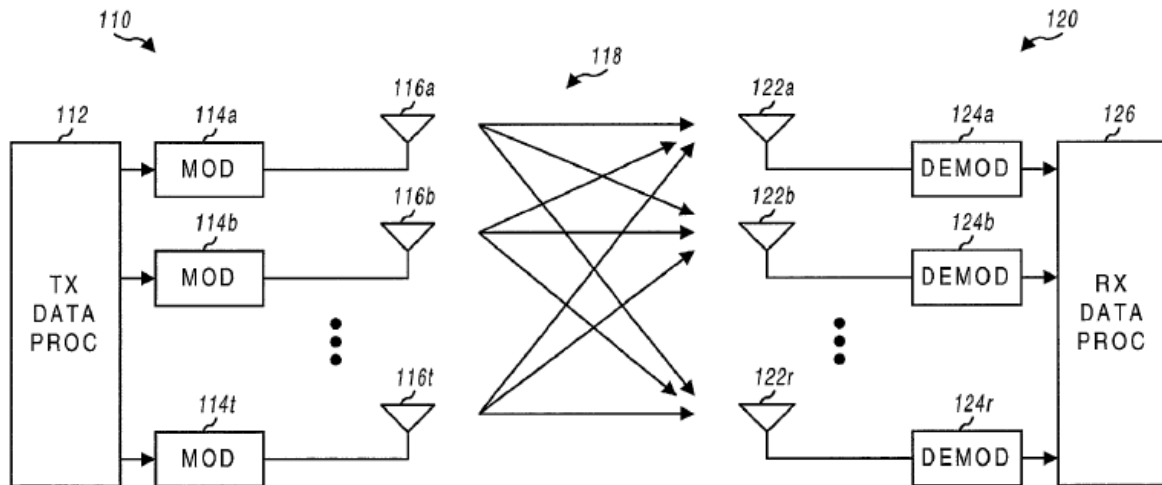


FIG. 1

74. Walton describes a temporal diversity mode (Walton, 12; 13; 17; 21; 22; 31; 32; 36; etc.)

75. A POSITA would recognize Ishikawa similarly describes a transceiver capable of operating in multiple modes.

76. For example, Ishikawa discloses that the essence of its invention is “to control each transmission frequency of a plurality of antennas and the number of information transmitted from the plurality of antennas according to circumstances of a propagation path ... namely, to adaptively select space multiplex where different

information is transmitted from the plurality of antennas with the same frequency [and] frequency multiplex where different information is transmitted from the plurality of antennas with different frequencies.” Ex.1006 1:64-2:6.

77. For at least these reasons, a POSITA would understand that Walton and Ishikawa disclose all the elements of this claim limitation.

2. Claim 1a: in the first mode based on spatial multiplexing:

78. As was discussed in reference to 1pre, Walton discloses a first and second mode. Walton also discloses spatial multiplexing. "For example, transmit diversity refers to the use of more than one transmit antenna in a manner to improve the reliability of the communications link, receive diversity refers to the use of more than one receive antenna in a manner to improve the reliability of the communications link, and *spatial diversity refers to the use of multiple transmit and receive antennas to improve the reliability and/or increase the capacity of the communications link.*" (Walton,43, emphasis added)

79. Walton also discloses spatial multiplexing in the following excerpt "The MIMO communications mode, which may also be referred to herein as the spatial communications mode, employs one or more processing modes to be described below." (Walton, 56). Spatial multiplexing is also disclosed in Walton 111, 112, 115, and 119.

80. Furthermore, Walton discloses MIMO (Walton 53, 56, 57, 58, 60, 74, 75, 77).

A POSITA would readily understand that MIMO is spatial multiplexing^{8,9,10}.

81. Ishikawa also discloses this claim limitation: "The essence of the present invention is to control each transmission frequency of a plurality of antennas and the number of information transmitted from the plurality of antennas according to circumstances of a propagation path when the same or different information is transmitted using a plurality of antennas, namely, to *adaptively select space multiplex where different information is transmitted from the plurality of antennas with the same frequency*, frequency multiplex where different information is transmitted from the plurality of antennas with different frequencies, *space diversity where the same information is transmitted from the plurality of antennas with the same frequency*, and frequency diversity where the same information is transmitted from plurality of antennas with the different frequencies according to the circumstances of the propagation path." (Ex.1006 1:64-2:11, emphasis added).

82. Figure 3 from Ishikawa demonstrates space multiplexing:

⁸ https://web.stanford.edu/~dntse/Chapters_PDF/Fundamentals_Wireless_Communication_chapter7.pdf

⁹ https://web.ecs.baylor.edu/faculty/dong/paper/polar_conf.pdf

¹⁰ <https://wireless-systems.ece.gatech.edu/6604/2019-lectures/week14.pdf>

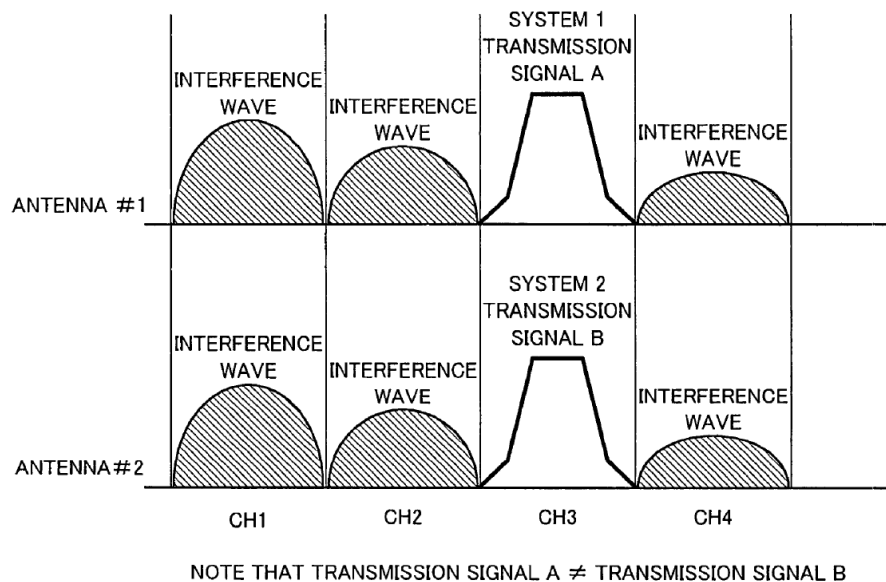


FIG.3

83. For at least these reasons, a POSITA would understand that Walton and Ishikawa individually render all the elements of this claim limitation obvious.

3. Claim 1b: generating separate first mode transmit symbols by first transmitters of the transceiver and second transmitters of the transceiver; and

84. Walton discloses different modes transmitting symbols. This begins in the abstract: "the system data processor receives and partitions an input data stream into a number of channel data streams and further processes the channel data streams to generate one or more modulation symbol vector streams." (Walton, Abstract)

85. The transmitting of symbols are further disclosed in the following excerpt from Walton: "The System data processor receives and partitions an input data Stream into a number of (K) channel data streams and further processes the channel data streams to generate one or more (NT) modulation Symbol Vector Streams. Each

modulation Symbol vector Stream includes a Sequence of modulation Symbol vectors representative of data in one or more channel data Streams." (Walton 13)

86. Transmitting symbols is also disclosed in Walton 14,15, 17, 19, 20, 22, 32, 33, 64, 66, 68, 74, 80, etc.

87. Ishikawa similarly discloses generating first mode transmit symbols by first and second transmitters. For example, Ishikawa discloses a transmission signal that is "convolutionally coded by the coding section 101." Ex.1006 at 3:62-63. This signal is then "modulated for each subcarrier by the subcarrier modulating section 102, and thereafter the resultant is outputted to the IFFT section 103." Ex.1006 at 3:64-66.

88. For at least these reasons, a POSITA would understand that Walton and Ishikawa individually disclose all the elements of this claim limitation.

4. Claim 1c: transmitting the separate first mode transmit symbols from the first transmitters and the second transmitters over a first set of antennas and a second set of antennas across a spectrum of frequencies that is same for each of the first transmitters and the second transmitters; and

89. As was noted in reference to claim 1b, Walton discloses transmitting symbols. As was discussed in reference to the pre-amble, Walton discloses a first and second mode. Both antenna sets and frequency modulation are disclosed in Walton, one example is: "The present invention is directed to a novel and improved

communications System capable of providing increased spectral efficiency, improved performance, and enhanced flexibility by employing a combination of antenna, frequency, and temporal diversity." (Watson, 13)

90. The antenna transmitting and receiving symbols using a spectrum of frequencies is also disclosed in Walton. As one example is the following: "The modulation symbol vectors are generated and transmitted in a manner to provide antenna, frequency, or temporal diversity, or a combination thereof." (Walton, 17)

91. Walton describes the first and second transmitters as follows: "Each transmitter unit may include a single transmit antenna or a number of transmit antennas, Such as that shown in FIG. 1. Similarly, each receiver unit may include a single receive antenna or a number of receive antennas, again such as that shown in FIG. 1." (Watson, 36). Figure 1 of Watson is shown here:

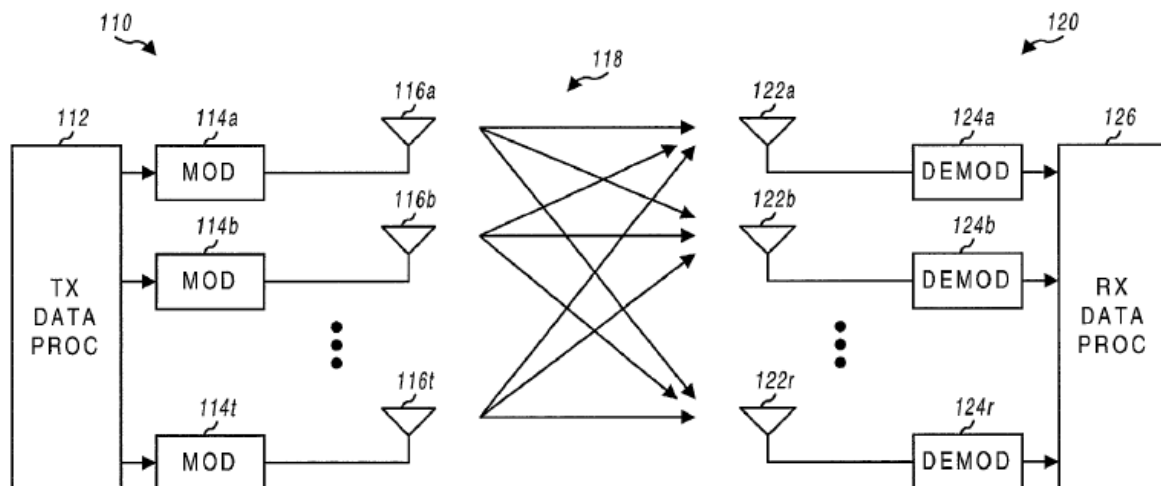


FIG. 1

92. These claim limitations are also disclosed elsewhere in Watson. One example is the following excerpt: “In the diversity communications mode, data is transmitted on one or more Sub-channels, from one or more antennas, and at one or more time periods.” (Watson, 55). A POSITA would understand this excerpt is disclosing a set of antennas, and data being transmitted across a spectrum of frequencies that could be the same for each antenna.

93. Furthermore, a POSITA would recognize that spread spectrum frequencies was already known in the art (Watson, 4)

94. A POSITA would recognize Ishikawa similarly describes transmitting first mode transmit symbols from first and second transmitters over first and second sets of antennas. For example, a POSITA would find it obvious that, after a system generated the spatial multiplexing symbols as described above, that same system would then be capable of transmitting the symbols over a set of antennas.

95. Moreover, Ishikawa discloses transmitting the converted transmission signal described above via multiple antennas. Ex.1006 at 4:9-12.

96. For at least these reasons, a POSITA would understand that Walton and Ishikawa independently disclose all the elements of this claim limitation.

5. Claim 1d: in the second mode based on the spatial multiplexing and bandwidth expansion:

97. As was discussed previously, Walton discloses multiple modes. Furthermore, Walton discloses “In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation Scheme. One Such Scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel Sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the Sub-channels occupies a Sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the Sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation Scheme, as described below.” (Walton, 48). A POSITA would find the above limitations obvious based on Walton’s parallel subchannels.

98. Furthermore, Walton discloses MIMO (Walton 53, 56, 57, 58, 60, 74, 75, 77).

A POSITA would readily understand that MIMO is spatial multiplexing^{11,12,13}.

¹¹ https://web.stanford.edu/~dntse/Chapters_PDF/Fundamentals_Wireless_Communication_chapter7.pdf

¹² https://web.ecs.baylor.edu/faculty/dong/paper/polar_conf.pdf

¹³ <https://wireless-systems.ece.gatech.edu/6604/2019-lectures/week14.pdf>

99. Further, Maltsev discloses the above limitations. For example, Walton discloses the reception of an OFDM symbol on a wideband communication channel comprising multiple standard-width channels. Maltsev 2:14-16, 4:17-23. Maltsev also discloses spatial multiplexing where “each of a plurality of spatially diverse antennas may receive signals from one spatial channel.” Maltsev 12:47-50. Each subchannel of Walton’s wideband communication channel may be further divided into spatial channels. Maltsev 8:36-39. Given the motivations to combine described previously, a POSITA would find the above limitations obvious based on the combination of Walton and Maltsev.

100. A POSITA would find this claim limitation obvious based on Ishikawa: "The essence of the present invention is to control each transmission frequency of a plurality of antennas and the number of information transmitted from the plurality of antennas according to circumstances of a propagation path when the same or different information is transmitted using a plurality of antennas, namely, to *adaptively select* space multiplex where different information is transmitted from the plurality of antennas with the same frequency, frequency multiplex where different information is transmitted from the plurality of antennas with different frequencies, space diversity where the same information is transmitted from the plurality of antennas with the same frequency, and frequency diversity where the same information is transmitted from plurality of antennas with the different frequencies

according to the circumstances of the propagation path." (Ex.1006 1:64-2:11, emphasis added).

101. Figures 4 and 6, from Ishikawa demonstrate frequency multiplexing:

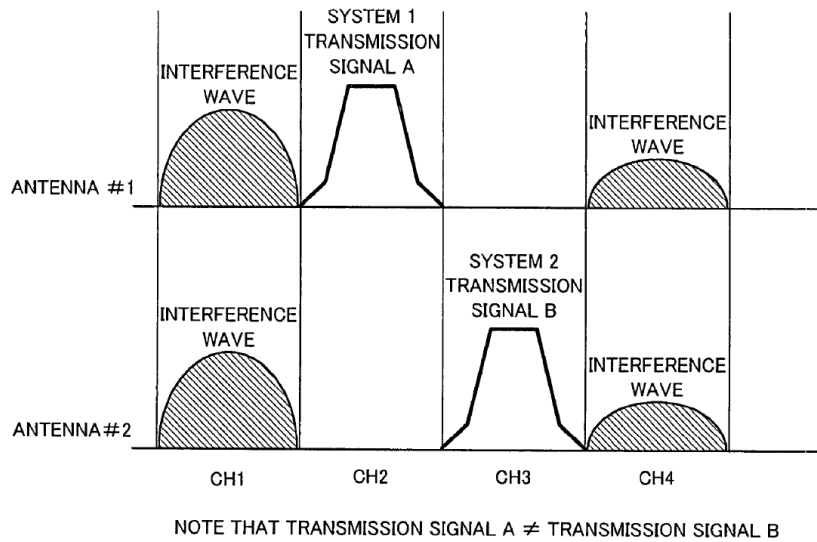


FIG.4

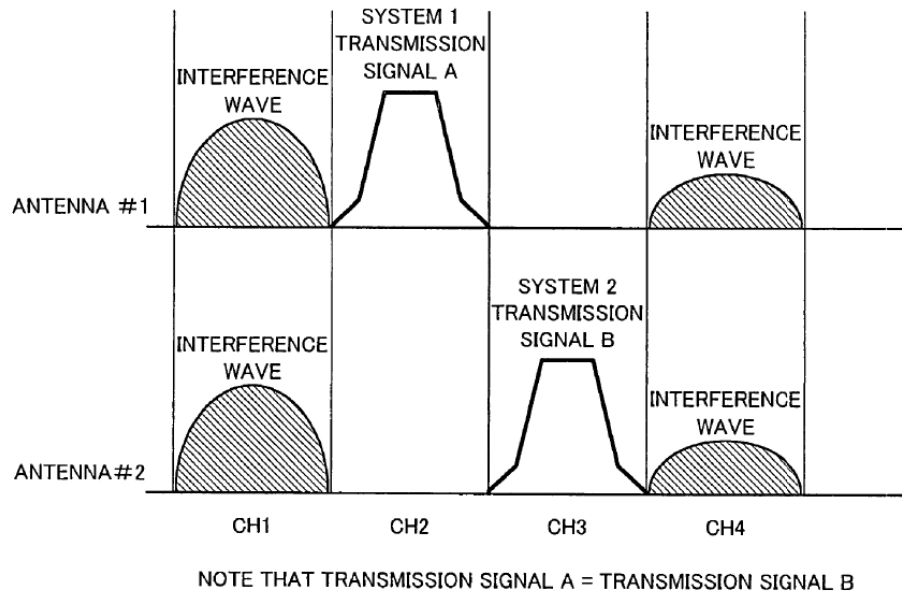


FIG.6

102. Further: Ishikawa teaches transmitting in the frequency multiplex mode “when the circumstances of the propagation path are good” and in the frequency diversity mode “when the error detection result is extremely poor.” Ex.1006 6:22-38. Similarly, “when the error detection result is good,” different information is transmitted from “antennas 106 and 116 with the same frequency and the space multiplex is thereby performed.” Ex.1006 5:38-43. When the error detection result is “extremely poor,” the same information is transmitted from both antennas at the same frequency and “space diversity is thereby performed.” Ex.1006 at 6:38-67.

103. Ishikawa’s disclosure of frequency and spatial multiplexing and diversity modes, and its ability to select between them based on propagation path circumstances, would have rendered the second mode described in the above claim limitation obvious to a POSITA.

104. Gardner similarly discloses the above claim limitations. For example, Gardner discloses 802.11 devices that “might use one or more of multiple antenna techniques (MIMO), where multiple data streams are multiplexed spatially and multi-channel techniques, where an extended transmitter transmits using more than one 802.11a channel at a time.” Ex.1008 2:41-46.

105. Given the motivations to combine the two references described above, a POSITA would have found the above claim limitation obvious based on a combination of Ishikawa and Gardner.

106. For at least these reasons, a POSITA would understand that Walton alone, Walton in view of Maltsev, Ishikawa alone, and/or Ishikawa in view of Gardner disclose all the elements of this claim limitation.

6. Claim 1e: generating separate second mode transmit symbols by the first transmitters and the second transmitters;

107. As was previously described in this declaration, Walton and Ishikawa both disclose first and second modes as well as symbols generated by transmitters.

108. Furthermore, Walton discloses "As described above, each sub-channel at each time slot is associated with *a modulation symbol that is selected from some alphabet such as M-PSK or M-QAM*. In certain embodiments, the modulation symbol in each of the L sub-channels can be selected Such that the most efficient use is made of that Sub-channel. *For example, Sub-channel 1 can be generated using QPSK, Sub-channel 2 can be generate using BPSK, Sub-channel 3 can be generated using 16-QAM, and so on*. Thus, for each time slot, up to L modulation symbols for the L sub-channels are generated and combined to generate the modulation symbol vector for that time slot."(Walton, 134, emphasis added)

109. For at least these reasons, a POSITA would understand that Walton and Ishikawa disclose all the elements of this claim limitation.

7. Claim 1f: transmitting the separate second mode transmit symbols from the first transmitters over the first set of antennas across a first spectrum of frequencies; and

110. As was discussed previously, Walton discloses first and second modes as well as first and second sets of antennas. This claim limitation is also disclosed in the following excerpt: "As shown in FIG. 1, each receive antenna 122 may receive signals from one or more transmit antennas 116 depending on a number of factors such as, for example, the operating mode used at system 110, the directivity of the transmit and receive antennas, the characteristics of the communications links, and others. Each demodulator 124 demodulates the respective received signal using a demodulation scheme that is complementary to the modulation scheme used at the transmitter."(Walton, 33)

111. Furthermore, Ishikawa discloses two signals A and B that are separately encoded by systems 1 and 2, transmitted over antennas 106 and 116, received by antennas 201 and 211, and separately decoded. Ex.1006 2:2-8, 2:33-36, 4:9-12, 4:28-40.

112. Ishikawa notes that "the transmitter 100 can use four radio communication systems. ... The second case is a frequency multiplex case, namely, a case in which different information (transmission signal A≠transmission signal B) is transmitted from two antennas 106 and 116 with the different frequencies." Ex.1006 5:14-23.

113.

114. For at least these reasons, a POSITA would understand that Walton and Ishikawa individually disclose all the elements of this claim limitation.

8. Claim 1g: transmitting the separate second mode transmit symbols from the second transmitters over the second set of antennas across a second spectrum of frequencies, wherein the first spectrum of frequencies does not overlap with the second spectrum of frequencies.

115. As was discussed previously, Walton discloses first and second modes as well as first and second sets of antennas. This claim limitation is also disclosed in the following excerpt: "As shown in FIG. 1, each receive antenna 122 may receive signals from one or more transmit antennas 116 depending on a number of factors such as, for example, the operating mode used at system 110, the directivity of the transmit and receive antennas, the characteristics of the communications links, and others. Each demodulator 124 demodulates the respective received signal using a demodulation scheme that is complementary to the modulation scheme used at the transmitter."(Walton, 33)

116. Furthermore, in addition to my earlier discussion of Maltsev's disclosure of a simultaneous spatial multiplexing and bandwidth expansion mode, Maltsev further discloses that its receiver "may be part of a ... device that may receive and/or transmit information wirelessly." Maltsev 6:3-8.

117. Furthermore, in addition to the transmission capabilities discussed in the previous section, Ishikawa discloses a frequency multiplexing mode, "a case in

which different information (transmission signal $A \neq$ transmission signal B) is transmitted from two antennas 106 and 116 with the different frequencies.” Ex.1006 5:14-23.

118. Gardner also discloses the above limitations in, for example, Figure 6, shown below, which depicts the transmission spectrums of two different antennas in Gardner’s system:

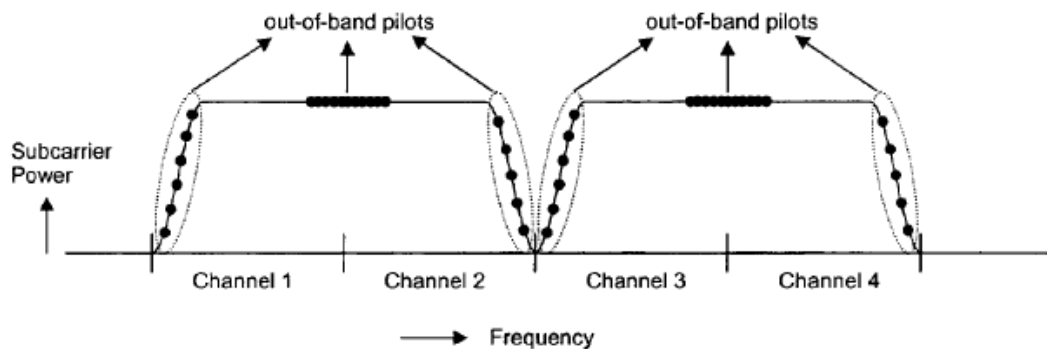


FIG. 6

119. Given the motivations to combine described above, a POSITA would find the above claim limitation obvious over Ishikawa in view of Gardner or Walton in view of Maltsev. For at least these reasons, a POSITA would understand that Walton, Walton in view of Maltsev, Ishikawa and/or Ishikawa in view of Gardner disclose all the elements of this claim limitation.

9. Claim 2. The method of claim 1, further comprising switching between the first mode and the second mode based on operating conditions.

120. As has been discussed previously, Walton discloses multiple modes. This is further disclosed in the following excerpt: "FIG. 7 shows plots that illustrate the

spectral efficiency achievable with some of the operating modes of a communications system in accordance with one embodiment." (Walton, 30).

121. Walton further describes switching modes in the following excerpt" "The communications system of the invention provides the above-described features and advantages, and is capable of supporting different types of services having disparate requirements. The features are achieved by employing antenna, frequency, or temporal diversity, or a combination thereof. In some embodiments of the invention, antenna, frequency, or temporal diversity can be independently achieved and dynamically selected." (Walton, 42)

122. Ishikawa discloses switching between a first and second mode: "The transmitter 100 can use four radio communication systems. The first case is a space multiplex case, namely, a case in which different information (transmission signal A≠transmission signal B) is transmitted from two antennas 106 and 116 with the same frequency (for example, FIG. 3). The second case is a frequency multiplex case, namely, a case in which different information (transmission signal A≠transmission signal B) is transmitted from two antennas 106 and 116 with the different frequencies (for example, FIG. 4). ... The control section 123 adaptively switches among these four radio communication methods based on the interference detection result (presence or absence of the interference wave of each system) from

the receiver 200 installed on the same radio communication apparatus and the error detection result (error rate of each system). (Ex.1006 5:14-37)

123. For at least these reasons, a POSITA would understand that Walton alone discloses all the elements of this claim limitation.

124. Furthermore, a POSITA would understand that Ishikawa alone discloses all the elements of this claim limitation.

10. Claim 3. The method of claim 2, wherein the switching between the first mode and the second mode is performed automatically based on the operating conditions including a signal to noise ratio and an interference.

125. Walton discloses switching between diversity/MIMO modes to provide improved performance: “Techniques to obtain higher spectral efficiency are described in further detail below. Improved performance may be quantified, for example, by a lower bit-error-rate (BER) or frame-error-rate (FER) for a given link carrier-to-noise-interference ratio (C/I). And enhanced flexibility is characterized by the ability to accommodate multiple users having different and typically disparate requirements. These goals may be achieved, in part, by employing multi-carrier modulation, time division multiplexing (TDM), multiple transmit and/or receive antennas, and other techniques. The features, aspects, and advantages of the invention are described in further detail below.”(Walton, 31).

126. Ishikawa discloses switching between a first and second mode: "The transmitter 100 can use four radio communication systems. The first case is a space multiplex case, namely, a case in which different information (transmission signal A≠transmission signal B) is transmitted from two antennas 106 and 116 with the same frequency (for example, FIG. 3). The second case is a frequency multiplex case, namely, a case in which different information (transmission signal A≠transmission signal B) is transmitted from two antennas 106 and 116 with the different frequencies (for example, FIG. 4). ... The control section 123 adaptively switches among these four radio communication methods based on the interference detection result (presence or absence of the interference wave of each system) from the receiver 200 installed on the same radio communication apparatus and the error detection result (error rate of each system). (Ex.1006 5:14-37)

127. For at least these reasons, a POSITA would understand that Walton alone discloses all the elements of this claim limitation. Furthermore, a POSITA would understand that Ishikawa alone discloses all the elements of this claim limitation.

11. Claim 4. The method of claim 1, wherein, in the first mode, the first transmitters and the second transmitters modulate and transmit the separate first mode transmit symbols during a same period of time.

128. Walton discloses frequency division multiplexing: "In accordance with an aspect of the invention, the channel data streams are modulated using multi-carrier

modulation (e.g., orthogonal frequency division multiplexing (OFDM) modulation). The multi-carrier modulation partitions the system operating bandwidth, W , into a number of (L) sub-bands. Each sub-band is associated with a different center frequency and corresponds to one sub-channel.” (Walton, 16).

129. A POSITA would understand that frequency division multiplexing is used to handle signals sent at the same period of time, but with different frequencies.

130. Walton also discloses time division multiplexing: "Time division multiplexing (TDM) may also be used to increase flexibility, especially for traffic data transmission. The channel data streams may thus be transmitted in time slots, with each time slot having a duration that is related to, for example, the length of a modulation symbol." (Watson, 19). A POSITA would understand that time division multiplexing uses small time slots within the same period of time.

131. Further, Maltsev discloses that a receiver “may simultaneously receive RF signals over one or more subchannels,” Maltsev 11:30-31, and that subchannels may comprise “a plurality of spatial channels.” Maltsev 12:48.

132. A POSITA would further understand that spatial multiplexing and improved frequency utilization, such as that disclosed in Ishikawa, inherently require multiple transmitters modulating and transmitting signals at the same period of time.

133. Given the previously discussed motivations to combine, a POSITA would have found the above limitations obvious based on Walton in view of Maltsev. For

at least these reasons, a POSITA would understand that Walton, Walton in view of Maltsev, and Ishikawa individually disclose all the elements of this claim limitation.

12. Claim 5. The method of claim 1, wherein when transmitting in the second mode the first spectrum of frequencies and the second spectrum of frequencies are non-adjacent.

134. Walton discloses this limitation. For example: "The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on." (Walton 49)

135. Sub-channel 1 at time slot 1 and sub-channel 5 at time slot 2 are non-adjacent. Similarly, sub-channels 4 and 6 are non-adjacent.

136. The non-adjacent nature of the first and second spectrum is also disclosed in the following excerpt: "The overall transmission channel occupies the total operating bandwidth of W , and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the" (Walton, 48)

137. Furthermore, Maltsev discloses the non-adjacent first and second spectrums: "In some embodiments, receiver 100 may be a wideband channel receiver for receiving OFDM signals in a wideband channel comprising one or more of the frequency-separated subchannels."(Maltsev 4:15-18). As discussed in section III.D of this declaration, a POSITA would have been motivated to combine Walton and Maltsev. Specifically, a POSITA would have found it obvious to combine the transmitting in non-adjacent sub-bands disclosed by Walton with the "wideband channel comprising one or more ... frequency-separated subchannels" disclosed by Maltsev. This combination would have provided separation between data transmissions preventing signal overlap.

138. Further, Gardner discloses Figure 5 below, where "different channels may be used by different devices, but it is also possible that the same device transmits on several channels simultaneously. For instance, one device may transmit on channels 1 and 4 simultaneously, while channels 2 and 3 are used by other devices." Ex.1008 3:36-40.

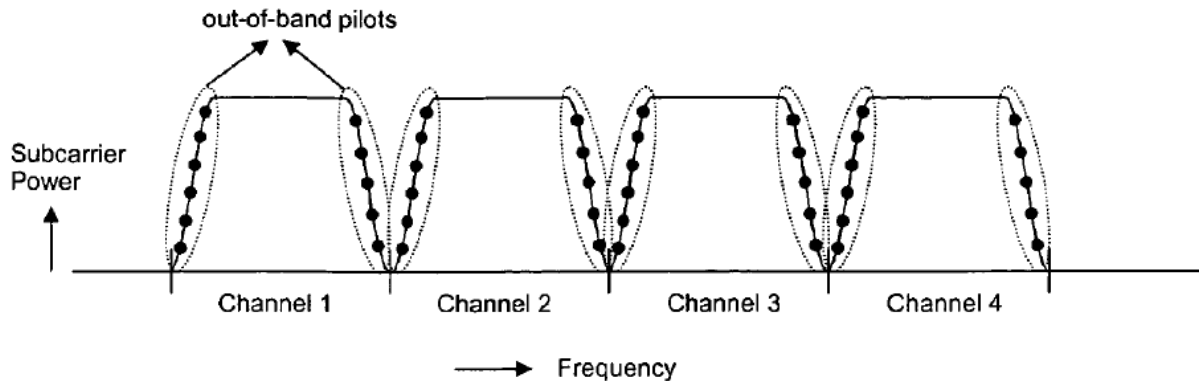


FIG. 5

139. Given the motivations to combine discussed above, a POSITA would find the above claim limitation obvious over Walton in view of Maltsev or Ishikawa in view of Gardner.

140. For at least these reasons, a POSITA would understand that Walton, Walton in view of Maltsev, and/or Ishikawa in view of Gardner disclose all the elements of this claim limitation.

13. Claim 6 The method of claim 1, further comprising: performing a gap filling between the first spectrum of frequencies and the second spectrum of frequencies.

141. Walton discloses using sub-channels (gaps): “The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. (Walton, 81)” Figure 2 of Walton is shown here:

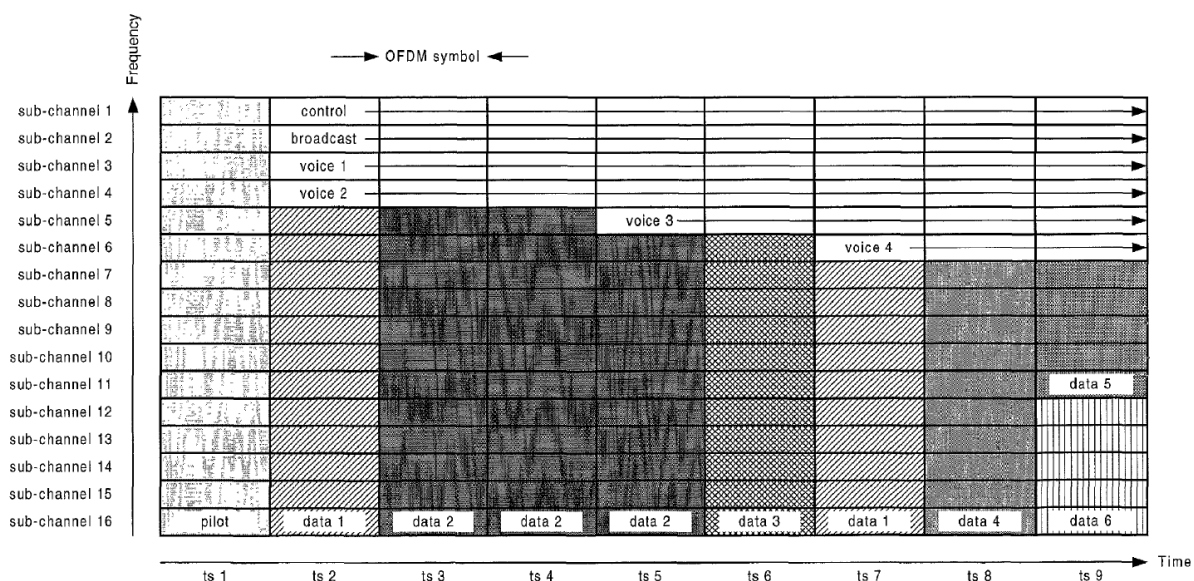


FIG. 2

142. The use of sub-channels/gaps is further disclosed in the following excerpt from Walton: “The communications system of the invention flexibly supports the transmissions of traffic data. As shown in FIG. 2, a particular data transmission (e.g., data 2) may occur over multiple sub-channels and/or multiple time slots, and multiple data transmissions (e.g., data 5 and 6) may occur at one time slot. A data transmission (e.g., data 1) may also occur over non-contiguous time slots. The system can also be designed to support multiple data transmissions on one sub-channel. For example, voice data may be multiplexed with traffic data and transmitted on a single subchannel. (Walton, 85)

143. Maltsev also discloses gap filling with subchannels “FIG. 1 is a block diagram of a receiver in accordance with some embodiments of the present invention. Receiver 100 may be part of a wireless communication device and may receive

orthogonal frequency division multiplexed (OFDM) communication signals. In some embodiments, receiver 100 may receive an OFDM symbol on a wideband communication channel. The wideband channel may comprise one or more subchannels. The subchannels may be frequency-division multiplexed (i.e., separated in frequency) and may be within a predetermined frequency spectrum. The subchannels 20 may comprise a plurality of orthogonal subcarriers. In some embodiments, the orthogonal subcarriers of a subchannel may be closely spaced OFDM subcarriers.” (2:10-14)

144. Gardner also discloses gap filling with subchannels. For example, referring to Figure 6 below, “If two adjacent channels are used simultaneously by one device, then there is no need to attenuate the “out-of-band subcarriers” in the middle of this 40 MHz band.” Ex.1008 ¶ 6:41-43. “[A]dditional data can be carried on [unattenuated out-of-band subcarriers] to increase the datarate.” Ex.1008 ¶ 6:60-61.

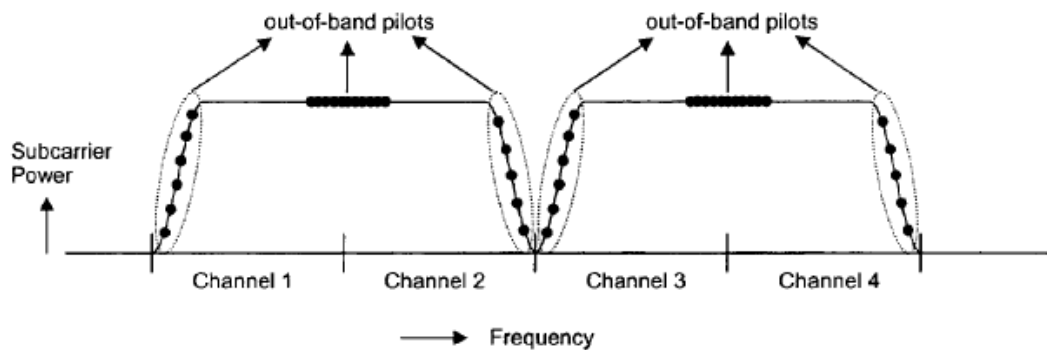


FIG. 6

145. Given the motivations to combine described above, a POSITA would find the above claim limitations obvious over Walton in view of Maltsev or Ishikawa in view of Gardner.

146. For at least these reasons, a POSITA would understand that Walton alone or combined with Maltsev and/or Ishikawa combined with Gardner disclose all the elements of this claim limitation.

14. Claim 7pre: A method of operation of a transceiver in a plurality of modes including at least a first mode and a second mode, the method comprising:

147. Walton discloses: "Transmitter and receiver units for use in a communications system and configurable to provide antenna, frequency, or temporal diversity, or a combination thereof, for transmitted signals." (Walton, Abstract).

148. Walton further discloses a plurality of modes: "*Various communications modes* (e.g., diversity and MIMO) may be supported and are described in greater detail below." (Walton 17, emphasis added). The plurality of modes is disclosed in multiple places in Walton including: "The communications system of the invention can be *designed and operated in a number of different communications modes*, with each communications mode employing antenna, frequency, or temporal diversity, or a combination thereof. The communications modes include, for example, a diversity communications mode and a MIMO communications mode. Various combinations of the diversity and MIMO communications modes can also be Supported by the

communications System. Also, other communications modes can be implemented and are within the scope of the present invention." (Walton, 53, emphasis added).

149. Figure 1 of Walton, shown below is described as follows "FIG. 1 is a diagram of a multiple-input multiple output (MIMO) communications system 100 capable of implementing Some embodiments of the invention. Communications system 100 can be operative to provide a combination of antenna, frequency, and temporal diversity to increase spectral efficiency, improve performance, and enhance flexibility" (Walton 37).

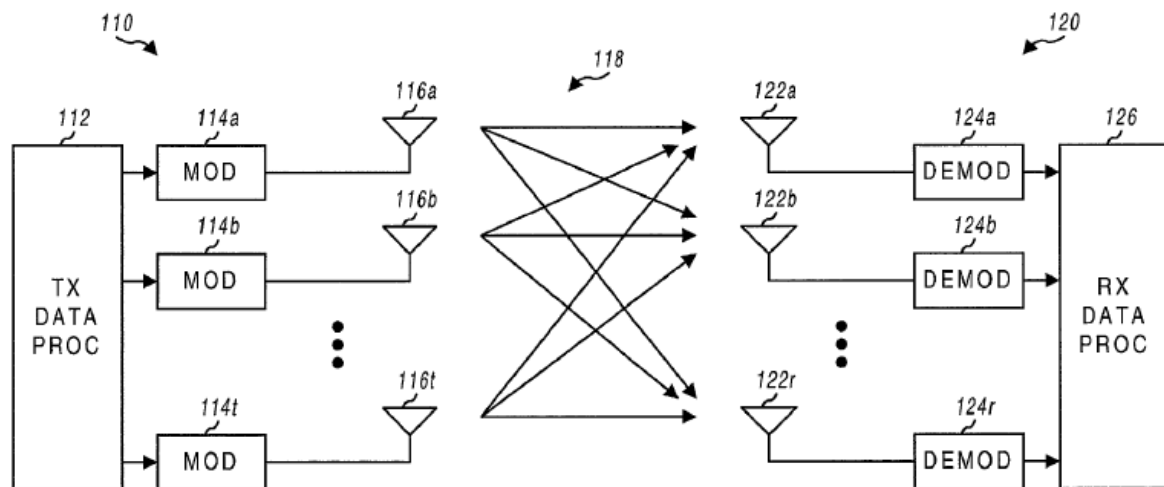


FIG. 1

150. Walton describes a temporal diversity mode (Walton, 12; 13; 17; 21; 22; 31; 32; 36; etc.)

151. For at least these reasons, a POSITA would understand that Walton discloses all the elements of this claim limitation.

152. Moreover, a POSITA would understand that Ishikawa discloses all the elements of this limitation based on the discussion regarding claim 1pre, as 1pre and 7pre are substantially similar except that claim 1 is a transmitter claim and claim 7 is a receiver claim.

15. Claim 7a: in the first mode based on spatial multiplexing:

153. As was discussed in reference to 1pre, Walton discloses a first and second mode. Walton also discloses spatial multiplexing. For example, "For example, transmit diversity refers to the use of more than one transmit antenna in a manner to improve the reliability of the communications link, receive diversity refers to the use of more than one receive antenna in a manner to improve the reliability of the communications link, and *spatial diversity refers to the use of multiple transmit and receive antennas to improve the reliability and/or increase the capacity of the communications link.*" (Walton,43, emphasis added)

154. Walton also discloses spatial multiplexing in the following excerpt "The MIMO communications mode, which may also be referred to herein as the spatial communications mode, employs one or more processing modes to be described below." (Walton, 56). Spatial multiplexing is also disclosed in Walton 111, 112, 115, and 119.

155. Furthermore, Walton discloses MIMO (Walton 53, 56, 57, 58, 60, 74, 75, 77).

A POSITA would readily understand that MIMO is spatial multiplexing^{14,15,16}.

156. For at least these reasons, a POSITA would understand that Walton discloses all the elements of this claim limitation.

157. Moreover, a POSITA would understand that Ishikawa discloses all the elements of this limitation based on the discussion regarding claim 1a, as 1a and 7a are substantially similar except that claim 1 is a transmitter claim and claim 7 is a receiver claim.

16. Claim 7b: receiving separate first mode symbols with first receivers of the transceiver and second receivers of the transceiver via a first set of antennas and a second set of antennas across a spectrum of frequencies that is same for each of the first receivers and the second receivers; and

158. Walton discloses different modes receiving symbols. This begins in the abstract: "the system data processor receives and partitions an input data stream into a number of channel data streams and further processes the channel data streams to generate one or more modulation symbol vector streams." (Walton, Abstract)

159. The receiving of symbols is further disclosed in the following excerpt from Walton: "The System data processor receives and partitions an input data Stream into a number of (K) channel data streams and further processes the channel data

¹⁴ https://web.stanford.edu/~dntse/Chapters_PDF/Fundamentals_Wireless_Communication_chapter7.pdf

¹⁵ https://web.ecs.baylor.edu/faculty/dong/paper/polar_conf.pdf

¹⁶ <https://wireless-systems.ece.gatech.edu/6604/2019-lectures/week14.pdf>

streams to generate one or more (NT) modulation Symbol Vector Streams. Each modulation Symbol vector Stream includes a Sequence of modulation Symbol vectors representative of data in one or more channel data Streams." (Walton 13)

160. Receiving symbols is also disclosed in Walton 14,15, 17, 19, 20, 22, 32, 33, 64, 66, 68, 74, 80, etc.

161. Walton also discloses receiving symbols across first and second sets of antennas over the same frequency. For example, Walton's disclosure of spatial multiplexing would render receiving on the same frequency band obvious to a POSITA.

162. As another example, Walton notes that frequency diversity "may" be used in conjunction with other forms of diversity. (Walton 47). This would suggest to a POSITA that frequency diversity could be disabled within Walton's system.

163. For at least these reasons, a POSITA would understand that Walton alone discloses all the elements of this claim limitation.

164. Furthermore, a POSITA would understand that Ishikawa alone discloses all the elements of this claim limitation for substantially the same reasons as previously discussed regarding claim 1c, as claim 1 is simply a transmitter claim and claim 7 a receiver claim.

17. Claim 7c: in the second mode based on the spatial multiplexing and bandwidth expansion:

165. As was discussed previously, Walton discloses multiple modes. Furthermore, Walton discloses “In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation Scheme. One Such Scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel Sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the Sub-channels occupies a Sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the Sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation Scheme, as described below.” (Walton, 48)

166. A POSITA would understand that the parallel sub channels are a method of bandwidth expansion. Walton also discloses MIMO itself increasing capacity (i.e. expanding bandwidth): “The MIMO communications mode employs antenna diversity at both ends of the communication link and is generally used to improve both the reliability and increase the capacity of the communications link.” (Walton,

56). Furthermore, Walton discloses MIMO (Walton 53, 56, 57, 58, 60, 74, 75, 77).

A POSITA would readily understand that MIMO is spatial multiplexing^{17,18,19}.

167. Further, Maltsev discloses the above limitations. For example, Walton discloses the reception of an OFDM symbol on a wideband communication channel comprising multiple standard-width channels. Maltsev 2:14-16, 4:17-23. Maltsev also discloses spatial multiplexing where “each of a plurality of spatially diverse antennas may receive signals from one spatial channel.” Maltsev 12:47-50. Each subchannel of Walton’s wideband communication channel may be further divided into spatial channels. Maltsev 8:36-39. Given the motivations to combine described previously, a POSITA would find the above limitations obvious based on the combination of Walton and Maltsev.

168. For at least these reasons, a POSITA would understand that Walton and/or Walton in view of Maltsev discloses all the elements of this claim limitation.

169. Moreover, a POSITA would understand that Ishikawa and/or Ishikawa in view of Gardner disclose all the elements of this limitation based on the discussion regarding claim 1d, as 1d and 7c are substantially similar except that claim 1 is a transmitter claim and claim 7 is a receiver claim.

¹⁷ https://web.stanford.edu/~dntse/Chapters_PDF/Fundamentals_Wireless_Communication_chapter7.pdf

¹⁸ https://web.ecs.baylor.edu/faculty/dong/paper/polar_conf.pdf

¹⁹ <https://wireless-systems.ece.gatech.edu/6604/2019-lectures/week14.pdf>

18. Claim 7d: receiving separate second mode symbols with the first receivers of the transceiver via the first set of antennas across a first spectrum of frequencies; and

170. As was discussed previously, Walton discloses first and second modes as well as first and second sets of antennas. Furthermore, Walton discloses separate second mode symbols. This claim limitation is also disclosed in the following excerpt: "As shown in FIG. 1, each receive antenna 122 may receive signals from one or more transmit antennas 116 depending on a number of factors such as, for example, the operating mode used at system 110, the directivity of the transmit and receive antennas, the characteristics of the communications links, and others. Each demodulator 124 demodulates the respective received signal using a demodulation scheme that is complementary to the modulation scheme used at the transmitter."(Walton, 33)

171. Further, as previously discussed, Maltsev discloses a mode wherein spatial multiplexing and bandwidth expansion occur simultaneously. For at least these reasons, a POSITA would understand that Walton and/or Walton in view of Maltsev disclose all the elements of this claim limitation.

172. Moreover, a POSITA would understand that Ishikawa discloses all the elements of this limitation based on the discussion regarding claim 1f, as 1f and 7d are substantially similar except that claim 1 is a transmitter claim and claim 7 is a receiver claim.

19. Claim 7e: receiving the separate second mode symbols with the second receivers of the transceiver via the second set of antennas across a second spectrum of frequencies, wherein the first spectrum of frequencies does not overlap with the second spectrum of frequencies.

173. As was discussed previously, Walton discloses first and second modes as well as first and second sets of antennas. Furthermore, Walton discloses separate second mode symbols. This claim limitation is also disclosed in the following excerpt: "As shown in FIG. 1, each receive antenna 122 may receive signals from one or more transmit antennas 116 depending on a number of factors such as, for example, the operating mode used at system 110, the directivity of the transmit and receive antennas, the characteristics of the communications links, and others. Each demodulator 124 demodulates the respective received signal using a demodulation scheme that is complementary to the modulation scheme used at the transmitter."(Walton, 33)

174. Further, as previously discussed, Maltsev discloses a mode wherein spatial multiplexing and bandwidth expansion occur simultaneously. For at least these reasons, a POSITA would understand that Walton and/or Walton in view of Maltsev disclose all the elements of this claim limitation.

175. Moreover, a POSITA would understand that Ishikawa and Gardner disclose all the elements of this limitation based on the discussion regarding claim 1g, as 1g

and 7e are substantially similar except that claim 1 is a transmitter claim and claim 7 is a receiver claim.

20. Claim 8: The method of claim 7, wherein each of the first spectrum of frequencies and the second spectrum of frequencies comprises a plurality of frequency subbands.

176. As was discussed earlier in this declaration, Walton discloses a plurality of frequency subbands: "In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation Scheme. One Such Scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel Sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the Sub-channels occupies a Sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the Sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly

177. A POSITA would recognize the sub-channels are subbands.

178. Maltsev also discloses subbands: "In some embodiments, receiver 100 may be a wideband channel receiver for receiving OFDM signals in a wideband channel comprising one or more of the frequency-separated subchannels. In these

embodiments, each subchannel lowpass filter may be associated with one of the subchannels" (Maltsev 4:15-19)

179. A POSITA would further recognize that any continuous bandwidth could be further divided into a series of subbands. For example, a POSITA would recognize that the 20 MHz frequency bands suggested by Ishikawa could be divided into a plurality of subbands. Ex.1006 1:28-29.

180. For at least these reasons, a POSITA would understand that Walton, Walton in view of Maltsev, and Ishikawa disclose all the elements of this claim limitation.

21. Claim 9: The method of claim 7, wherein, in the first mode, the first receivers and the second receivers receive the separate first mode symbols during a same period of time.

181. Walton discloses frequency division multiplexing: "In accordance with an aspect of the invention, the channel data streams are modulated using multi-carrier modulation (e.g., orthogonal frequency division multiplexing (OFDM) modulation). The multi-carrier modulation partitions the system operating bandwidth, W , into a number of (L) sub-bands. Each sub-band is associated with a different center frequency and corresponds to one sub-channel." (Walton, 16).

182. A POSITA would understand that frequency division multiplexing is used to handle signals sent at the same period of time, but with different frequencies.

183. Walton also discloses time division multiplexing: "Time division multiplexing (TDM) may also be used to increase flexibility, especially for traffic data

transmission. The channel data streams may thus be transmitted in time slots, with each time slot having a duration that is related to, for example, the length of a modulation symbol." (Watson, 19) A POSITA would understand that time division multiplexing uses small time slots within the same period of time.

184. Further, Maltsev discloses that a receiver "may simultaneously receive RF signals over one or more subchannels," Maltsev 11:30-31, and that subchannels may comprise "a plurality of spatial channels." Maltsev 12:48.

185. For at least these reasons, a POSITA would understand that Walton or Walton in view of Maltsev disclose all the elements of this claim limitation.

186. Moreover, a POSITA would understand that Ishikawa discloses all the elements of this limitation based on the discussion regarding claim 4, as claims 4 and 9 are substantially similar except that claim 4 is a transmitter claim and claim 9 is a receiver claim.

22. Claim 10: The method of claim 7, wherein the first spectrum of frequencies and the second spectrum of frequencies are non-adjacent.

187. Walton discloses this limitation. For example: "The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be

transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on." (Walton 49)

188. Sub-channel 1 at time slot 1 and sub-channel 5 at time slot 2 are non-adjacent. Similarly, sub-channels 4 and 6 are non-adjacent.

189. The non-adjacent nature of the first and second spectrum is also disclosed in the following excerpt: "The overall transmission channel occupies the total operating bandwidth of W , and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the" (Walton, 48)

190. Furthermore, Maltsev discloses the non-adjacent first and second spectrums: "In some embodiments, receiver 100 may be a wideband channel receiver for receiving OFDM signals in a wideband channel comprising one or more of the frequency-separated subchannels." (Maltsev 4:15-18). As discussed in section III.D of this declaration, a POSITA would have been motivated to combine Walton and Maltsev.

191. For at least these reasons, a POSITA would understand that Walton or Walton in view of Maltsev disclose all the elements of this claim limitation.

192. Moreover, a POSITA would understand that Ishikawa in view of Gardner discloses all the elements of this limitation based on the discussion regarding claim

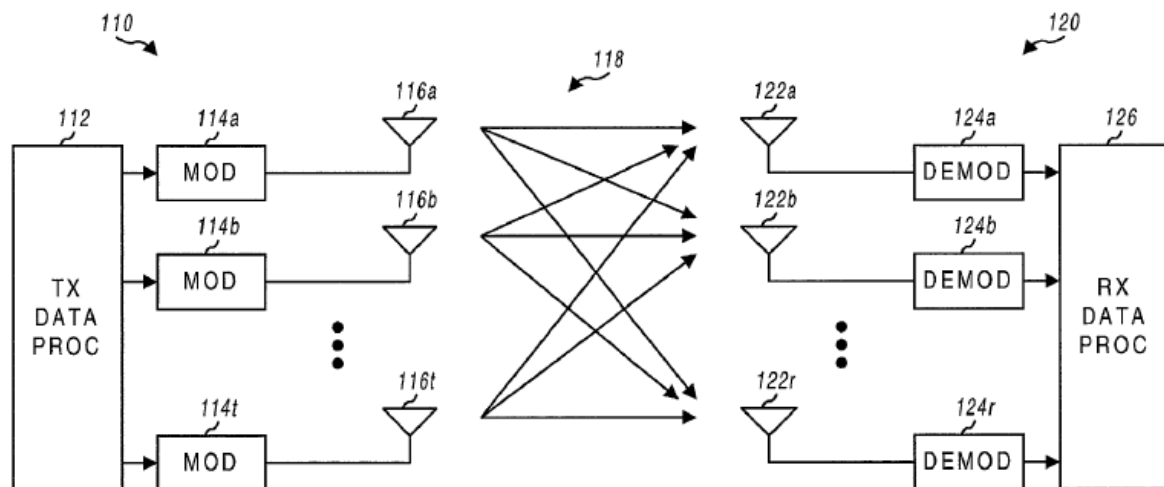
5, as claims 5 and 10 are substantially similar except that claim 5 is a transmitter claim and claim 10 is a receiver claim.

23. Claim 11 pre: An article of manufacture including a non-transitory computer-readable medium having instructions stored thereon that, upon execution by a computing device, cause the computing device to perform operations comprising:

193. Walton discloses: "Transmitter and receiver units for use in a communications system and configurable to provide antenna, frequency, or temporal diversity, or a combination thereof, for transmitted signals." (Walton, Abstract).

194. Walton further discloses a plurality of modes: "*Various communications modes* (e.g., diversity and MIMO) may be supported and are described in greater detail below." (Walton 17, emphasis added). The plurality of modes is disclosed in multiple places in Walton including: "The communications system of the invention can be *designed and operated in a number of different communications modes*, with each communications mode employing antenna, frequency, or temporal diversity, or a combination thereof. The communications modes include, for example, a diversity communications mode and a MIMO communications mode. Various combinations of the diversity and MIMO communications modes can also be Supported by the communications System. Also, other communications modes can be implemented and are within the scope of the present invention." (Walton, 53, emphasis added).

195. Figure 1 of Walton, shown below is described as follows "FIG. 1 is a diagram of a multiple-input multiple output (MIMO) communications system 100 capable of implementing Some embodiments of the invention. Communications system 100 can be operative to provide a combination of antenna, frequency, and temporal diversity to increase spectral efficiency, improve performance, and enhance flexibility" (Walton 37).



196. Walton describes a temporal diversity mode (Walton, 12; 13; 17; 21; 22; 31; 32; 36; etc.)

197. For at least these reasons, a POSITA would understand that Walton discloses all the elements of this claim limitation.

198. Moreover, a POSITA would understand that Ishikawa discloses all the elements of this limitation based on the discussion regarding claim 1pre, as 1pre and 11pre are substantially similar except that claim 1 is a method claim and claim 11 is a system claim.

24. Claim 11a: generating separate first mode transmit symbols by first transmitters and second transmitters of a transceiver;

199. Walton discloses transmit symbols. This begins in the abstract: "the system data processor receives and partitions an input data stream into a number of channel data streams and further processes the channel data streams to generate one or more modulation symbol vector streams." (Walton, Abstract)

200. The transmit symbols are further disclosed in the following excerpt from Walton: "The System data processor receives and partitions an input data Stream into a number of (K) channel data streams and further processes the channel data streams to generate one or more (NT) modulation Symbol Vector Streams. Each modulation Symbol vector Stream includes a Sequence of modulation Symbol vectors representative of data in one or more channel data Streams." (Walton 13)

201. Transmit symbols are also disclosed in Walton 14,15, 17, 19, 20, 22, 32, 33, 64, 66, 68, 74, 80, etc.

202. For at least these reasons, a POSITA would understand that Walton renders all the elements of this claim limitation obvious.

203. Moreover, a POSITA would understand that Ishikawa discloses all the elements of this limitation based on the discussion regarding claim 1b, as 1b and 11a are substantially similar except that claim 1 is a method claim and claim 11 is a system claim.

25. Claim 11b: transmitting in a first mode the separate first mode transmit symbols from the first transmitters and the second transmitters over a first set of antennas and a second set of antennas across a spectrum of frequencies that is same for each of the first transmitters and the second transmitters;

204. Walton discloses different modes transmitting symbols. This begins in the abstract: "the system data processor receives and partitions an input data stream into a number of channel data streams and further processes the channel data streams to generate one or more modulation symbol vector streams." (Walton, Abstract)

205. The transmitting of symbols are further disclosed in the following excerpt from Walton: "The System data processor receives and partitions an input data Stream into a number of (K) channel data streams and further processes the channel data streams to generate one or more (NT) modulation Symbol Vector Streams. Each modulation Symbol vector Stream includes a Sequence of modulation Symbol vectors representative of data in one or more channel data Streams." (Walton 13)

206. Transmitting symbols is also disclosed in Walton 14,15, 17, 19, 20, 22, 32, 33, 64, 66, 68, 74, 80, etc.

207. Moreover, a POSITA would understand that Ishikawa discloses all the elements of this limitation based on the discussion regarding claim 1c, as 1c and 11b are substantially similar except that claim 1 is a method claim and claim 11 is a system claim.

208. For at least these reasons, a POSITA would understand that Walton alone discloses all the elements of this claim limitation. Furthermore, a POSITA would understand that Ishikawa alone discloses all the elements of this claim limitation.

26. Claim 11c: generating separate second mode transmit symbols by the first transmitters and the second transmitters;

209. As was previously described in this declaration, Walton discloses first and second modes as well as symbols sent and received by transmitters.

210. Furthermore, Walton discloses "As described above, each sub-channel at each time slot is associated with *a modulation symbol that is selected from some alphabet such as M-PSK or M-QAM*. In certain embodiments, the modulation symbol in each of the L sub-channels can be selected Such that the most efficient use is made of that Sub-channel. *For example, Sub-channel 1 can be generated using QPSK, Sub-channel 2 can be generate using BPSK, Sub-channel 3 can be generated using 16-QAM, and so on*. Thus, for each time slot, up to L modulation symbols for the L sub-channels are generated and combined to generate the modulation symbol vector for that time slot."(Walton, 134, emphasis added)

211. For at least these reasons, a POSITA would understand that Walton discloses all the elements of this claim limitation.

212. Moreover, a POSITA would understand that Ishikawa discloses all the elements of this limitation based on the discussion regarding claim 1e, as 1e and 11c are substantially similar except that claim 1 is a method claim and claim 11 is a system claim.

27. Claim 11d: transmitting in a second mode the separate second mode transmit symbols from the first transmitters over the first set of antennas across a first spectrum of frequencies; and

213. As was discussed previously, Walton discloses first and second modes as well as first and second sets of antennas. This claim limitation is also disclosed in the following excerpt: "As shown in FIG. 1, each receive antenna 122 may receive signals from one or more transmit antennas 116 depending on a number of factors such as, for example, the operating mode used at system 110, the directivity of the transmit and receive antennas, the characteristics of the communications links, and others. Each demodulator 124 demodulates the respective received signal using a demodulation scheme that is complementary to the modulation scheme used at the transmitter."(Walton, 33)

214. Further, as previously discussed, Maltsev discloses a mode wherein spatial multiplexing and bandwidth expansion occur simultaneously. For at least these

reasons, a POSITA would understand that Walton and/or Walton in view of Maltsev disclose all the elements of this claim limitation.

215. Moreover, a POSITA would understand that Ishikawa discloses all the elements of this limitation based on the discussion regarding claim 1f, as 1f and 11d are substantially similar except that claim 1 is a method claim and claim 11 is a system claim.

28. Claim 11e: transmitting in the second mode the separate second mode transmit symbols from the second transmitters over the second set of antennas across a second spectrum of frequencies, wherein the first spectrum of frequencies does not overlap with the second spectrum of frequencies.

216. As was discussed previously, Walton discloses first and second modes as well as first and second sets of antennas. This claim limitation is also disclosed in the following excerpt: "As shown in FIG. 1, each receive antenna 122 may receive signals from one or more transmit antennas 116 depending on a number of factors such as, for example, the operating mode used at system 110, the directivity of the transmit and receive antennas, the characteristics of the communications links, and others. Each demodulator 124 demodulates the respective received signal using a demodulation scheme that is complementary to the modulation scheme used at the transmitter."(Walton, 33)

217. Further, Maltsev discloses the above limitations. For example, Walton discloses the reception of an OFDM symbol on a wideband communication channel

comprising multiple standard-width channels. Maltsev 2:14-16, 4:17-23. Maltsev also discloses spatial multiplexing where “each of a plurality of spatially diverse antennas may receive signals from one spatial channel.” Maltsev 12:47-50. Each subchannel of Walton’s wideband communication channel may be further divided into spatial channels. Maltsev 8:36-39. Given the motivations to combine described previously, a POSITA would find the above limitations obvious based on the combination of Walton and Maltsev. For at least these reasons, a POSITA would understand that Walton and/or Walton in view of Maltsev disclose all the elements of this claim limitation.

218. Moreover, a POSITA would understand that Ishikawa and/or Ishikawa in view of Gardner discloses all the elements of this limitation based on the discussion regarding claim 1g, as 1g and 11e are substantially similar except that claim 1 is a method claim and claim 11 is a system claim.

29. Claim 12: The article of manufacture of claim 11, wherein each of the first spectrum of frequencies and the second spectrum of frequencies comprises a plurality of frequency subbands.

219. As was discussed earlier in this declaration, Walton discloses a plurality of frequency subbands: “In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation Scheme. One Such Scheme that has numerous advantages is OFDM. With OFDM modulation, the

overall transmission channel is essentially divided into a number of (L) parallel Sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the Sub-channels occupies a Sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the Sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly

220. A POSITA would recognize the sub-channels are subbands.

221. Maltsev also discloses subbands: "In some embodiments, receiver 100 may be a wideband channel receiver for receiving OFDM signals in a wideband channel comprising one or more of the frequency-separated subchannels. In these embodiments, each subchannel lowpass filter may be associated with one of the subchannels" (Maltsev 4:15-19)

222. For at least these reasons, a POSITA would understand that Walton or Walton in view of Maltsev disclose all the elements of this claim limitation.

223. Moreover, a POSITA would understand that Ishikawa discloses all the elements of this limitation based on the discussion regarding claim 8, as 8 and 12 are substantially similar except that claim 8 is a method claim and claim 12 is a system claim.

30. Claim 13: The article of manufacture of claim 11, wherein the instructions, upon execution by the computing device, cause the computing device to perform transmitting the separate first mode transmit symbols from the first transmitters and the second transmitters during a same period of time in the first mode.

224. Walton discloses frequency division multiplexing: "In accordance with an aspect of the invention, the channel data streams are modulated using multi-carrier modulation (e.g., orthogonal frequency division multiplexing (OFDM) modulation). The multi-carrier modulation partitions the system operating bandwidth, W , into a number of (L) sub-bands. Each sub-band is associated with a different center frequency and corresponds to one sub-channel." (Walton, 16).

225. A POSITA would understand that frequency division multiplexing is used to handle signals sent at the same period of time, but with different frequencies.

226. Walton also discloses time division multiplexing: "Time division multiplexing (TDM) may also be used to increase flexibility, especially for traffic data transmission. The channel data streams may thus be transmitted in time slots, with each time slot having a duration that is related to, for example, the length of a modulation symbol." (Watson, 19). A POSITA would understand that time division multiplexing uses small time slots within the same period of time.

227. Further, Maltsev discloses that a receiver “may simultaneously receive RF signals over one or more subchannels,” Maltsev 11:30-31, and that subchannels may comprise “a plurality of spatial channels.” Maltsev 12:48.

228. For at least these reasons, a POSITA would understand that Walton or Walton in view of Maltsev disclose all the elements of this claim limitation.

229. Moreover, a POSITA would understand that Ishikawa discloses all the elements of this limitation based on the discussion regarding claim 4, as 4 and 13 are substantially similar except that claim 4 is a method claim and claim 13 is a system claim.

31. Claim 14: The article of manufacture of claim 11, wherein the first spectrum of frequencies and the second spectrum of frequencies are non-adjacent.

230. Walton discloses this limitation. For example: "The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on." (Walton 49)

231. Sub-channel 1 at time slot 1 and sub-channel 5 at time slot 2 are non-adjacent. Similarly, sub-channels 4 and 6 are non-adjacent.

232. The non-adjacent nature of the first and second spectrum is also disclosed in the following excerpt: "The overall transmission channel occupies the total operating bandwidth of W , and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the" (Walton, 48)

233. Furthermore, Maltsev discloses the non-adjacent first and second spectrums: "In some embodiments, receiver 100 may be a wideband channel receiver for receiving OFDM signals in a wideband channel comprising one or more of the frequency-separated subchannels." (Maltsev 4:15-18). As discussed in section III.D of this declaration, a POSITA would have been motivated to combine Walton and Maltsev.

234. For at least these reasons, a POSITA would understand that Walton or Walton in view of Maltsev disclose all the elements of this claim limitation.

235. Moreover, a POSITA would understand that Ishikawa in view of Gardner disclose all the elements of this limitation based on the discussion regarding claim 5, as 5 and 14 are substantially similar except that claim 5 is a method claim and claim 14 is a system claim.

- 32. Claim 15: The article of manufacture of claim 11, wherein the instructions, upon execution by the computing device, cause the computing device to perform automatically switching between the first mode and the second mode based on operating conditions. signal to noise ratio and an interference.**

236. Walton discloses switching between diversity/MIMO modes to provide improved performance: "Techniques to obtain higher spectral efficiency are described in further detail below. Improved performance may be quantified, for example, by a lower bit-error-rate (BER) or frame-error-rate (FER) for a given link carrier-to-noise-interference ratio (C/I). And enhanced flexibility is characterized by the ability to accommodate multiple users having different and typically disparate requirements. These goals may be achieved, in part, by employing multi-carrier modulation, time division multiplexing (TDM), multiple transmit and/or receive antennas, and other techniques. The features, aspects, and advantages of the invention are described in further detail below."(Walton, 31).

237. Ishikawa discloses switching between a first and second mode: "The transmitter 100 can use four radio communication systems. The first case is a space multiplex case, namely, a case in which different information (transmission signal A≠transmission signal B) is transmitted from two antennas 106 and 116 with the same frequency (for example, FIG. 3). The second case is a frequency multiplex case, namely, a case in which different information (transmission signal

A≠transmission signal B) is transmitted from two antennas 106 and 116 with the different frequencies (for example, FIG. 4). ... The control section 123 adaptively switches among these four radio communication methods based on the interference detection result (presence or absence of the interference wave of each system) from the receiver 200 installed on the same radio communication apparatus and the error detection result (error rate of each system). (Ishikawa 5:14-37)

238. For at least these reasons, a POSITA would understand that Walton alone discloses all the elements of this claim limitation. Furthermore, a POSITA would understand that Ishikawa alone discloses all the elements of this claim limitation.

33. Claim 16: The article of manufacture of claim 15, wherein the instructions, upon execution by the computing device, cause the computing device to automatically switch between the first mode and the second mode based on the operating conditions including a signal to noise ratio and an interference.

239. Walton discloses switching between diversity/MIMO modes to provide improved performance: “Techniques to obtain higher spectral efficiency are described in further detail below. Improved performance may be quantified, for example, by a lower bit-error-rate (BER) or frame-error-rate (FER) for a given link carrier-to-noise-interference ratio (C/I). And enhanced flexibility is characterized by the ability to accommodate multiple users having different and typically disparate requirements. These goals may be achieved, in part, by employing multi-carrier

modulation, time division multiplexing (TDM), multiple transmit and/or receive antennas, and other techniques. The features, aspects, and advantages of the invention are described in further detail below.”(Walton, 31).

240. For at least these reasons, a POSITA would understand that Walton discloses all the elements of this claim limitation.

241. Moreover, a POSITA would understand that Ishikawa discloses all the elements of this limitation based on the discussion regarding claim 3, as 3 and 16 are substantially similar except that claim 3 is a method claim and claim 16 is a system claim.

34. Claim 17: The article of manufacture of claim 11, wherein the instructions, upon execution by the computing device, cause the computing device to perform a gap filling between the first spectrum of frequencies and the second spectrum of frequencies.

242. Walton discloses using sub-channels (gaps): “The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. (Walton, 81)” Figure 2 of Walton is shown here:

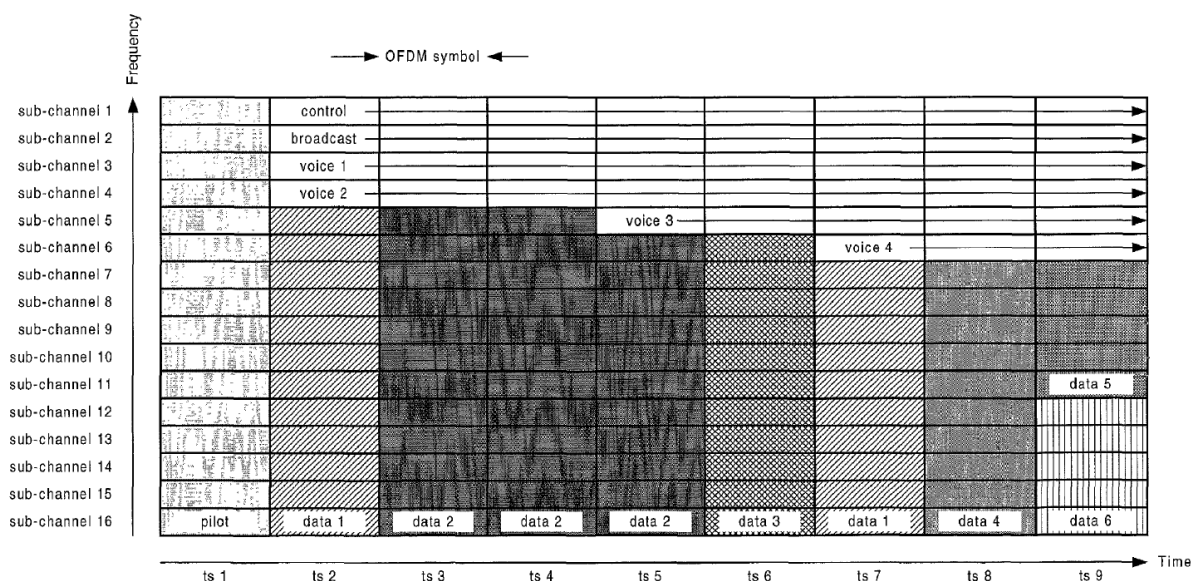


FIG. 2

243. The use of sub-channels/gaps is further disclosed in the following excerpt from Walton: “The communications system of the invention flexibly supports the transmissions of traffic data. As shown in FIG. 2, a particular data transmission (e.g., data 2) may occur over multiple sub-channels and/or multiple time slots, and multiple data transmissions (e.g., data 5 and 6) may occur at one time slot. A data transmission (e.g., data 1) may also occur over non-contiguous time slots. The system can also be designed to support multiple data transmissions on one sub-channel. For example, voice data may be multiplexed with traffic data and transmitted on a single subchannel. (Walton, 85)

244. Maltsev also discloses gap filling with subchannels “FIG. 1 is a block diagram of a receiver in accordance with some embodiments of the present invention. Receiver 100 may be part of a wireless communication device and may receive

orthogonal frequency division multiplexed (OFDM) communication signals. In some embodiments, receiver 100 may receive an OFDM symbol on a wideband communication channel. The wideband channel may comprise one or more subchannels. The subchannels may be frequency-division multiplexed (i.e., separated in frequency) and may be within a predetermined frequency spectrum. The subchannels 20 may comprise a plurality of orthogonal subcarriers. In some embodiments, the orthogonal subcarriers of a subchannel may be closely spaced OFDM subcarriers.” (2:10-14)

245. For at least these reasons, a POSITA would understand that Walton alone or combined with Maltsev discloses all the elements of this claim limitation.

246. Moreover, a POSITA would understand that Ishikawa in view of Gardner discloses all the elements of this limitation based on the discussion regarding claim 6, as 6 and 17 are substantially similar except that claim 6 is a method claim and claim 17 is a system claim.

35. Claim 18pre: An article of manufacture including a non-transitory computer-readable medium having instructions stored thereon that, upon execution by a computing device, cause the computing device to perform operations comprising:

247. Walton discloses: “Transmitter and receiver units for use in a communications system and configurable to provide antenna, frequency, or temporal diversity, or a combination thereof, for transmitted signals.” (Walton, Abstract).

248. Walton further discloses a plurality of modes: "*Various communications modes* (e.g., diversity and MIMO) may be supported and are described in greater detail below." (Walton 17, emphasis added). The plurality of modes is disclosed in multiple places in Walton including: "The communications system of the invention can be *designed and operated in a number of different communications modes*, with each communications mode employing antenna, frequency, or temporal diversity, or a combination thereof. The communications modes include, for example, a diversity communications mode and a MIMO communications mode. Various combinations of the diversity and MIMO communications modes can also be Supported by the communications System. Also, other communications modes can be implemented and are within the scope of the present invention." (Walton, 53, emphasis added).

249. Figure 1 of Walton, shown below is described as follows "FIG. 1 is a diagram of a multiple-input multiple output (MIMO) communications system 100 capable of implementing Some embodiments of the invention. Communications system 100 can be operative to provide a combination of antenna, frequency, and temporal diversity to increase spectral efficiency, improve performance, and enhance flexibility" (Walton 37).

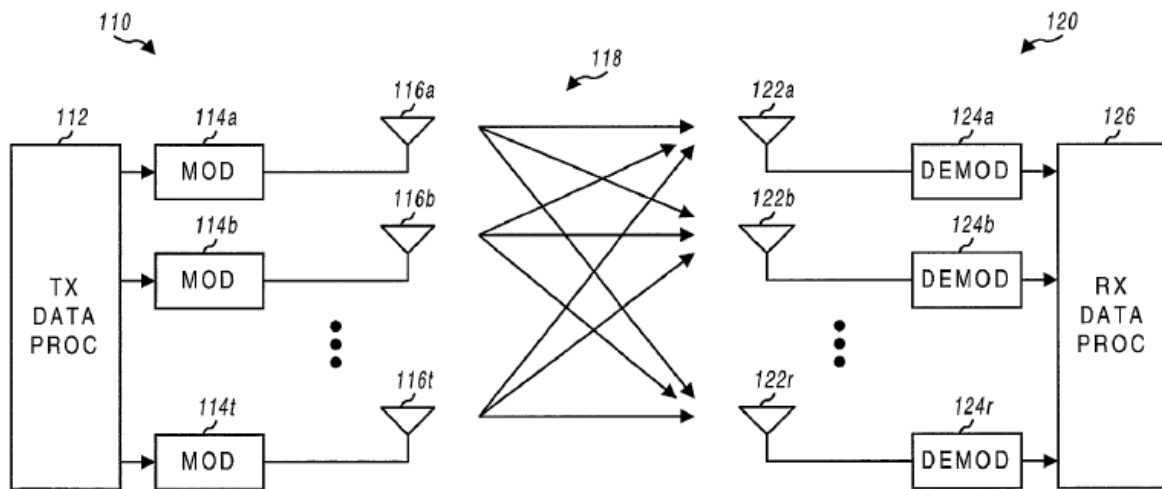


FIG. 1

250. Walton describes a temporal diversity mode (Walton, 12; 13; 17; 21; 22; 31; 32; 36; etc.)

251. For at least these reasons, a POSITA would understand that Walton discloses all the elements of this claim limitation.

252. Moreover, a POSITA would understand that Ishikawa discloses all the elements of this limitation based on the discussion regarding claim 11pre, as 11pre and 18pre are substantially similar except that claim 11 is a transmitter claim and claim 18 is a receiver claim.

36. Claim 18a: receiving in a first mode based on spatial multiplexing separate first mode symbols with first receivers of a transceiver and second receivers of the transceiver at a mobile station via a first set of antennas and a second set of antennas across a spectrum of frequencies that is same for each of the first receivers and the second receivers;

253. Walton discloses spatial multiplexing. "For example, transmit diversity refers to the use of more than one transmit antenna in a manner to improve the reliability of the communications link, receive diversity refers to the use of more than one receive antenna in a manner to improve the reliability of the communications link, and *spatial diversity refers to the use of multiple transmit and receive antennas to improve the reliability and/or increase the capacity of the communications link.*" (Walton,43, emphasis added)

254. Walton also discloses spatial multiplexing in the following excerpt "The MIMO communications mode, which may also be referred to herein as the spatial communications mode, employs one or more processing modes to be described below." (Walton, 56). Spatial multiplexing is also disclosed in Walton 111, 112, 115, and 119.

255. Furthermore, Walton discloses its system functioning as part of "a cellular system," which would render receiving at a mobile station obvious to a POSITA. (Walton 45).

256. For at least these reasons, a POSITA would understand that Walton discloses all the elements of this claim limitation.

257. Moreover, a POSITA would understand that Ishikawa discloses all the elements of this limitation based on the discussion regarding claim 11b, as 11b and 18a are substantially similar except that claim 11 is a transmitter claim and claim 18 is a receiver claim.

37. Claim 18b: receiving in a second mode based on the spatial multiplexing and bandwidth expansion separate second mode symbols with the first receivers of the transceiver at the mobile station via the first set of antennas across a first spectrum of frequencies; and

258. Ishikawa discloses this claim limitation: "The essence of the present invention is to control each transmission frequency of a plurality of antennas and the number of information transmitted from the plurality of antennas according to circumstances of a propagation path when the same or different information is transmitted using a plurality of antennas, namely, to adaptively select space multiplex where different information is transmitted from the plurality of antennas with the same frequency, frequency multiplex where different information is transmitted from the plurality of antennas with different frequencies, space diversity where the same information is transmitted from the plurality of antennas with the same frequency, and frequency diversity where the same information is transmitted from plurality of antennas with

the different frequencies according to the circumstances of the propagation path."
(Ex.1006 1:64-2:11).

259. Further, as previously discussed, Gardner discloses 802.11 devices that “might use one or more of multiple antenna techniques (MIMO), where multiple data streams are multiplexed spatially and multi-channel techniques, where an extended transmitter transmits using more than one 802.11a channel at a time.” Ex.1008 2:41-46. For at least these reasons, a POSITA would understand that Ishikawa or Ishikawa in view of Gardner disclose all the elements of this claim limitation.

260. Moreover, a POSITA would understand that Walton discloses all the elements of this limitation based on the discussion regarding claim 11d, as 11d and 18b are substantially similar except that claim 11 is a transmitter claim and claim 18 is a receiver claim.

261. A POSITA would further understand that Walton in view of Maltsev discloses the above limitations because, as previously explained with respect to claim 11e, Maltsev also discloses a mode based on spatial multiplexing and bandwidth expansion.

38. Claim 18c: receiving in the second mode the separate second mode symbols with the second receivers of the transceiver at the mobile station via the second set of antennas across a second spectrum of frequencies, wherein the first spectrum of frequencies does not overlap with the second spectrum of frequencies.

262. Ishikawa describes frequency multiplexing as follows: "...when the same or different information is transmitted using a plurality of antennas, namely, to adaptively select space multiplex where different information is transmitted from the plurality of antennas with the same frequency, frequency multiplex where different information is transmitted from the plurality of antennas with different frequencies..." (Ex.1006 2:1-6)

263. Ishikawa discloses a first and a second set of spectrum of frequencies that do not overlap: "FIG. 4 is a view explaining frequency multiplex of the radio communication system that can be performed by the radio transmitting apparatus illustrated in FIG. 1;" (Ex.1006 2:40-43). Figure 4 of Ishikawa is shown here:

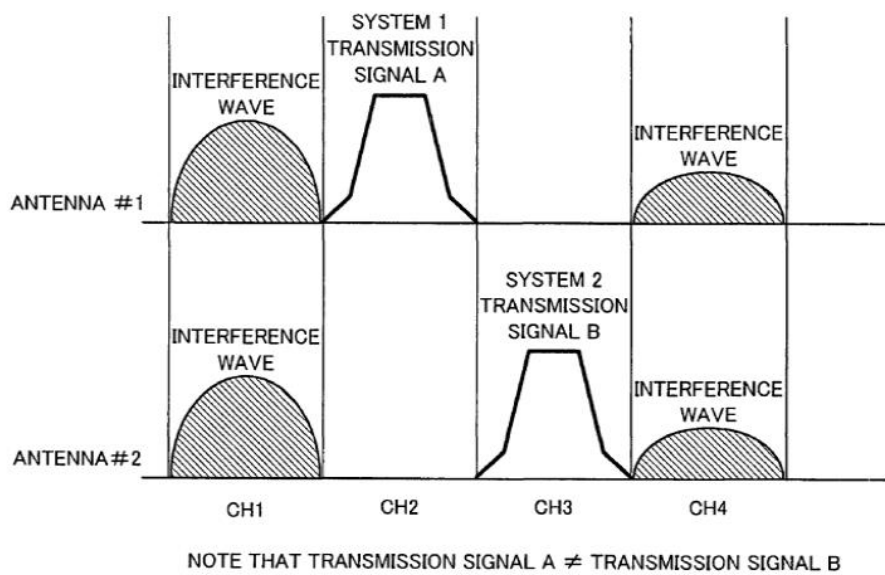


FIG.4

264. A first and a second set of spectrum of frequencies that do not overlap is further disclosed in the following excerpt from Ishikawa: "The second case is a frequency multiplex case, namely, a case in which different information (transmission signal A; transmission signal B) is transmitted from two antennas 106 and 116 with the different frequencies (for example, FIG. 4)." (Ex.1006 5:19-23)

265. Further, as discussed in the previous section, Gardner discloses a simultaneous spacial multiplexing and bandwidth expansion mode. For at least these reasons, a POSITA would understand that Ishikawa or Ishikawa in view of Gardner disclose all the elements of this claim limitation.

266. Moreover, a POSITA would understand that Walton and/or Walton in view of Maltsev disclose all the elements of this limitation based on the discussion regarding

claim 11e, as 11e and 18c are substantially similar except that claim 11 is a transmitter claim and claim 18 is a receiver claim.

39. Claim 19: The article of manufacture of claim 18, wherein each of the first spectrum of frequencies and the second spectrum of frequencies comprises a plurality of frequency subbands.

267. As was discussed earlier in this declaration, Walton discloses a plurality of frequency subbands: "In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation Scheme. One Such Scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel Sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the Sub-channels occupies a Sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the Sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly

268. A POSITA would recognize the sub-channels are subbands.

269. Maltsev also discloses subbands: "In some embodiments, receiver 100 may be a wideband channel receiver for receiving OFDM signals in a wideband channel comprising one or more of the frequency-separated subchannels. In these

embodiments, each subchannel lowpass filter may be associated with one of the subchannels" (Maltsev 4:15-19)

270. For at least these reasons, a POSITA would understand that Walton or Walton in view of Maltsev disclose all the elements of this claim limitation.

271. Moreover, a POSITA would understand that Ishikawa discloses all the elements of this limitation based on the discussion regarding claim 8, as 8 and 19 are substantially similar except that claim 8 is a method claim and claim 19 is a system claim.

40. Claim 20: The article of manufacture of claim 18, wherein the instructions, upon execution by the computing device, cause the computing device to perform receiving the separate first mode symbols with the first receivers and the second receivers during a same period of time.

272. Walton discloses frequency division multiplexing: "In accordance with an aspect of the invention, the channel data streams are modulated using multi-carrier modulation (e.g., orthogonal frequency division multiplexing (OFDM) modulation). The multi-carrier modulation partitions the system operating bandwidth, W , into a number of (L) sub-bands. Each sub-band is associated with a different center frequency and corresponds to one sub-channel." (Walton, 16).

273. A POSITA would understand that frequency division multiplexing is used to handle signals sent at the same period of time, but with different frequencies.

274. Walton also discloses time division multiplexing: "Time division multiplexing (TDM) may also be used to increase flexibility, especially for traffic data transmission. The channel data streams may thus be transmitted in time slots, with each time slot having a duration that is related to, for example, the length of a modulation symbol." (Watson, 19). A POSITA would understand that time division multiplexing uses small time slots within the same period of time.

275. Further, Maltsev discloses that a receiver "may simultaneously receive RF signals over one or more subchannels," Maltsev 11:30-31, and that subchannels may comprise "a plurality of spatial channels." Maltsev 12:48.

276. For at least these reasons, a POSITA would understand that Walton or Walton in view of Maltsev disclose all the elements of this claim limitation.

277. Moreover, a POSITA would understand that Ishikawa discloses all the elements of this limitation based on the discussion regarding claim 4, as 4 and 20 are substantially similar except that claim 4 is a method claim for a transmitter and claim 20 is a system claim for a receiver.

41. Claim 21: The article of manufacture of claim 18, wherein the first spectrum of frequencies and the second spectrum of frequencies are non-adjacent.

278. Walton discloses this limitation. For example: "The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur

over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on." (Walton 49)

279. Sub-channel 1 at time slot 1 and sub-channel 5 at time slot 2 are non-adjacent. Similarly, sub-channels 4 and 6 are non-adjacent.

280. The non-adjacent nature of the first and second spectrum is also disclosed in the following excerpt: "The overall transmission channel occupies the total operating bandwidth of W , and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the" (Walton, 48)

281. Furthermore, Maltsev discloses the non-adjacent first and second spectrums: "In some embodiments, receiver 100 may be a wideband channel receiver for receiving OFDM signals in a wideband channel comprising one or more of the frequency-separated subchannels." (Maltsev 4:15-18). As discussed in section III.D of this declaration, a POSITA would have been motivated to combine Walton and Maltsev.

282. For at least these reasons, a POSITA would understand that Walton and/or Walton in view of Maltsev disclose all the elements of this claim limitation.

283. Moreover, a POSITA would understand that Ishikawa in view of Gardner discloses all the elements of this limitation based on the discussion regarding claim 5, as 5 and 21 are substantially similar except that claim 5 is a method claim for a transmitter and claim 21 is a system claim for a receiver.

V. CONCLUSIONS

284. Based on the analysis in this declaration coupled with my extensive training, education, and experience, I have formed several expert opinions.

285. All of the claim limitations of the '845 patent are disclosed fully in Walton.

286. Many of the claim limitations of the '845 patent are disclosed fully in Ishikawa.

287. Many of the claim limitations of the '845 patent are disclosed fully in Maltsev.

288. Many of the claim limitations of the '845 patent are disclosed fully in Gardner.

289. A POSITA would have found it obvious to combine Walton and Maltsev.

290. A POSITA would have found it obvious to combine Ishikawa and Gardner.



Dr. Chuck Easttom

07 October 2025

Date