EXPERT DECLARATION OF DR. KEVIN NEGUS
FOR
INTER PARTES REVIEW OF U.S. PATENT NO. 8,737,511

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I. INTRODUCTION

1. I, Dr. Kevin Negus, submit this declaration in support of a Petition for *Inter Partes* Review of United States Patent No. 8,737,511 (the "'511 Patent"), owned by XR COMMUNICATIONS, LLC, dba VIVATO TECHNOLOGIES ("XR" or "Patent Owner"). I have been retained in this matter by counsel for Ericsson, Inc. and Nokia of America Corporation ("Petitioners"). I understand that Petitioners are the Real Party-in-Interest to this Petition.

2. I make this declaration based upon my personal knowledge. I am over the age of 21 and am competent to make this declaration.

3. The statements herein include my opinions and the bases for those opinions, which relate to at least the following documents of the pending *inter partes* review petition:

- U.S. Patent No. 8,737,511 by B. Eidson and R. Chaffee, entitled "Directed MIMO communications" (the "'511 Patent") (Ex. 1001).
- File History for U.S. Patent No. 8,737,511 (Ex. 1002).
- U.S. Patent Publication No. 2011/0150050 by H. Trigui and R. Cuthill, entitled "Digital Integrated Antenna Array for Enhancing Coverage and Capacity of a Wireless Network" ("Trigui") (Ex. 1004).
- U.S. Patent No. 6,801,790 by A. Rudrapatna, entitled "Structure for multiple antenna configurations" ("Rudrapatna") (Ex. 1005).
- *Wireless Communications*, Second Edition, by A. Molisch, ISBN: 978-0-470-74187-0, John Wiley & Sons, Ltd., Publication, and IEEE ("Molisch") (Ex. 1006).
- U.S. Patent Publication No. 2002/0132600 by A. Rudrapatna, entitled "Structure for multiple antenna configurations" (Ex. 1007).
- International Publication WO 2011/078898 by H. Trigui and R. Cuthill, entitled "Digital

Integrated Antenna Array for Enhancing Coverage and Capacity of a Wireless Network" (Ex. 1008).

- Plaintiff XR Communications, LLC's Preliminary Disclosure of Asserted Claims and Infringement Contentions (Ex. 1009).
- Jose Vilches, "Everything You Need to Know about 4G Wireless Technology," (April 29, 2010), available at: https://www.techspot.com/guides/272-everything-about-4g/ (Ex. 1010)
- Joy Huang, Commscope, "Re-shaping Wind Load Performance for Base Station Antennas," available at: https://www.commscope.com/globalassets/digizuite/762340-bsa-enhanced-wind-load-performance-wp-115177-en.pdf (Ex. 1011)
- Philip Sorrells, "The Problems with Overweight Cell Towers," (September 2, 2014), available at: https://www.commscope.com/blog/2014/the-problems-with-overweight-cell-towers/ (Ex. 1012)
- Columbia Telecommunications Corp., "Cellular Tower Requirements Study for Talbot County, Maryland" (April 2009), available at: https://talbotcountymd.gov/uploads/File/council/Cellular_Study_FINAL.pdf (Ex. 1013).
- U.S. Patent Publication No. 2003/0032424 by M. Judd et al., entitled "Shared Tower System for Accommodating Multiple Service Providers" (Ex. 1014).
- U.S. Patent Publication No. 2008/0026796 by L. Thomas, entitled "Antenna System for Shared Operation" (Ex. 1015).
- European Patent No. 0 566 603 by E. Prokkola, entitled "Radio Transceiver System" (Ex. 1016).

4. My materials considered for forming my opinions herein have included at least the above-referenced documents.

5. Although I am being compensated for my time at my normal and customary rate in preparing this declaration, the opinions herein are my own, and I have no stake in the outcome of the review proceeding. My compensation does not depend in any way on the outcome of the Petitioner's petition.

II. QUALIFICATIONS

6. I am qualified by education and experience to testify as an expert in the field of telecommunications. Attached, as Attachment A, is a copy of my resume detailing my experience and education. Additionally, I provide the following overview of my background as it pertains to my qualifications for providing expert testimony in this matter.

7. I am currently a Professor of Electrical Engineering at Montana Tech University in Butte, MT. I lead research programs at Montana Tech that include developing communications solutions for extremely low power sensors in challenging locations such as alpine mountains and watersheds including federally-designated wilderness areas and for control of critical infrastructure distributed continentally and globally including within severe environments such as arctic forests. For example, I am currently the Principal Investigator on a Montana Tech research program funded indirectly by the US military to improve wireless communications under battlefield conditions for the US Army 11th Airborne based in Alaska. I also mentor, supervise and teach both senior undergraduate and graduate students of Electrical Engineering in the general fields of telecommunications and networking with an emphasis on wireless systems.

8. In 1988, I received my Ph.D. in Engineering from the University of Waterloo in Canada. The Departments of Electrical Engineering and Mechanical Engineering jointly supervised my Ph.D. research on the modeling of bipolar semiconductor devices. My graduate course work was primarily in Electrical Engineering and included such subjects as semiconductor device physics and fabrication, wireless circuit design, and wireless propagation analysis. For my Ph.D. work, I received the Faculty Gold Medal in 1988 for the best Ph.D. thesis in the entire Faculty of Engineering across all Departments for that year. My Ph.D. thesis

research also formed the basis of a paper published in 1989 that won the award for Best Paper in 1989 for the IEEE (Institute of Electrical and Electronic Engineers) journal in which it was published.

9. In 1984 and 1985, respectively, I received the B.A.Sc. and M.A.Sc. Degrees in Mechanical Engineering from the University of Waterloo in Canada. My coursework and research work included, amongst many other topics, extensive embedded firmware development for automation applications and implementation of networks and communications protocols. For my M.A.Sc. Degree research and academic achievements, I received the prestigious University Gold Medal in 1985 for the best Masters thesis in the entire University of Waterloo for that year.

10. In 1986, I joined the Palo Alto Research Center of Fairchild Semiconductor in Palo Alto, CA. At Fairchild, I participated in the development of devices and products for high-speed applications such as wired networking, RISC microprocessors and wireless communications.

11. In 1988, I took the position of Member of the Technical Staff at Avantek, Inc. in Newark, CA. I was hired to develop products for both wireless and wired data networking applications. Some of the components I developed early in my career at Avantek were used for 1st generation wireless local area network (WLAN) products, voice band modem equipment, wired data networking both in the LAN and WAN and 1st generation cellular handsets and base stations based on AMPS or TACS.

12. In 1991, the Hewlett-Packard Company purchased Avantek, Inc. I continued to work for Hewlett-Packard until 1998 in such roles as IC Design Manager, Director of Chipset Development and Principal System Architect. In 1992, Hewlett-Packard assigned me to work on the "Field of Waves" project, which was a major multi-division effort to build WLAN products

for mobile computers. The project was cancelled in 1993. However, the work I did on the project was leveraged into producing the world's first IEEE 802.11 chipset, which my division at Hewlett-Packard first offered for sale in 1994. I led the project to develop and market this chipset for many early WLAN product companies including Proxim, Symbol (now part of Motorola) and Aironet (now part of Cisco). I also helped coordinate efforts within Hewlett-Packard to guide extensive research projects on WLAN protocols and technology at Hewlett-Packard's central research laboratories in Palo Alto, CA and Bristol, U.K.

13. In 1998, I joined Proxim, Inc. in Mountain View, CA. At that time, Proxim was engaged in the development and sale of wired and wireless products for home and enterprise networking applications based on several different wired and wireless networking protocols. I stayed at Proxim through 2002 and was the Chief Technology Officer for this publicly-traded company at the time of my departure. During my career at Proxim, I led or participated in the development of many WLAN and WWAN products and/or chipsets for network adapters, OEM design-in modules, access points, bridges, switches, and routers that used a wide variety of bus, LAN, or WAN wired interfaces. I have supervised many engineers including those responsible for embedded firmware development to implement various wired and wireless networking, reservation, and security protocols at the MAC layer and above, those responsible for HDL code creation of baseband chips to implement PHY and MAC algorithms, as well as other engineers that developed hardware reference designs, modem algorithms and chipsets.

14. Since 2002, I have been an independent consultant and have provided services to a number of companies including some that have developed IEEE 802.11 products. In particular, from 2002 until 2007 I was Chairman of WiDeFi, Inc. – a company that developed chips and embedded firmware for 802.11 repeater products based on 802.11a, b, g and draft n amendments.

From 2007-2011, I was Chairman of Tribal Shout – a company that delivered IP voice and audio streaming media using VoIP to any cellular or landline phone including those reachable only by the circuit-switched connections such as the PSTN and 2nd generation cellular radio. From 2010-2016, I was Chairman and Chief Technology Officer of CBF Networks, Inc. (dba Fastback Networks) – a company that developed fiber extension products for backhaul of data networks including Wi-Fi, HSPA, CDMA2000, WiMAX and LTE cellular radio systems.

15. I note that specific to this matter that while I was Chief Technology Officer at Fastback Networks that we developed the world's first non-line-of-sight (NLOS) point-to-point (PTP) cellular backhaul products using multiple beams and MIMO baseband signal processing. These products, which we first developed starting in 2011, were originally based on the 4G LTE standard but used many proprietary extensions that we added for increased performance. These products also utilized many of the same technology elements described and/or claimed in the '511 Patent when offered for sale and/or sold in the USA starting in 2011.

16. I have been a Board Observer on behalf of the venture capital firm Camp Ventures at two companies that develop semiconductor components including one that developed technology specifically to improve the system performance of HSPA and LTE cellular radio systems (Quantance) and another that provides system on a chip (SOC) microcontrollers, OEM design-in modules and firmware with 802.11 and wired interfaces for embedded applications (GainSpan). I have also been a technology and/or business strategy advisor to multiple early stage companies that are developing such products as new wireless communications security systems (AirTight), RFID radio systems (Mojix), time/frequency reference components (SiTime), and application of machine learning to wireless communications (Aira).

17. I have actively monitored or participated in the IEEE 802.11 standards process continuously since 1989. I am a listed contributor to the highly successful IEEE 802.11g standard published in 2003 that describes a wireless communications protocol in use worldwide by over 5 billion devices. In 2002 and 2003, I participated in the IEEE 802.11 Wireless Next Generation Committee that was responsible for launching the 802.11n standards development process.

18. I am an author or co-author of many papers that have been published in distinguished engineering journals or conferences such as those of the IEEE or ASME. An exemplary list of these publications is included in my resume.

19. I am also a former member of the Federal Communication Commission's Technological Advisory Committee as an appointee of then Chairman Michael Powell. I have also served on the Wyoming Telecommunications Council as an appointee of then Governor Jim Geringer after confirmation by the Wyoming State Senate.

20. I am named as an inventor on numerous U.S. patents all of which have related in at least some way to products for wired and/or wireless networks. I believe that the following is a complete list as of this date for my approximately 88 issued U.S. Patents: 4,839,717, 5,111,455, 5,150,364, 5,436,595, 5,532,655, 6,587,453, 7,035,283, 7,085,284, 7,187,904, 8,095,067, D704174, 8,238,318, 8,300,590, 8,311,023, 8,385,305, 8,422,540, 8,467,363, 8,502,733, 8,638,839, 8,649,418, 8,761,100, 8,811,365, 8,824,442, 8,830,943, 8,872,715, 8,897,340, 8,928,542, 8,942,216, 8,948,235, 8,982,772, 8,989,762, 9,001,809, 9,049,611, 9,055,463, 9,178,558, 9,179,240, 9,226,295, 9,226,315, 9,252,857, 9,282,560, 9,313,674, 9,325,398, 9,345,036, 9,350,411, 9,374,822, 9,408,215, 9,474,080, 9,490,918, 9,572,163, 9,577,700, 9,577,733, 9,578,643, 9,609,530, 9,655,133, 9,712,216, 9,713,019, 9,713,155,

9,713,157, 9,876,530, 10,051,643, 10,063,363, 10,129,888, 10,135,501, 10,237,760, 10,284,253, 10,306,635, 10,313,898, 10,356,782, 10,506,611, 10,548,132, 10,700,733, 10,708,918, 10,716,111, 10,720,969, 10,735,979, 10,736,110, 10,764,891, 10,785,754, 10,932,267, 10,966,201, 11,134,491, 11,160,078, 11,166,280, 11,271,613, 11,283,192, 11,303,322, 11,343,060, 11,343,684.

21. I have provided expert testimony, reports or declarations in the cases of *Agere v. Sony* (on behalf of plaintiff Agere), *Linex v. Belkin et al.* (on behalf of defendant Cisco), *CSIRO v. Toshiba et al*. (multiple related cases on behalf of plaintiff CSIRO), *Freedom Wireless v. Cingular et al.* (on behalf of plaintiff Freedom Wireless), *Rembrandt v. HP et al*. (on behalf of defendant HP), *DNT v. Sprint et al.* (on behalf of the defendants Sprint, T-Mobile, US Cellular, Verizon and Novatel), *Teles v. Cisco* (on behalf of defendant Cisco), *WiAV v. HP* (on behalf of defendant HP), *SPH v. Acer et al*. (on behalf of defendants Sony, Nokia, Motorola, Novatel, Sierra and Dell), *LSI v. Funai* (on behalf of plaintiff LSI), *WiAV v. Dell and RIM* (on behalf of the defendants Dell and RIM), *Wi-LAN v. RIM* (on behalf of defendant RIM), *LSI v. Barnes & Noble* (on behalf of plaintiff LSI), *Novatel v. Franklin and ZTE* (on behalf of plaintiff Novatel), *LSI v. Realtek* (on behalf of plaintiff LSI), *Wi-LAN v. Apple et al.* (on behalf of defendants Apple, Sierra and Novatel), *EON v. Sensus et al*. (on behalf of defendants Motorola, US Cellular and Sprint), *M2M/Blackbird v Sierra et al*. (multiple related cases on behalf of defendants Sierra and Novatel), *Intellectual Ventures v. AT&T et al*. (on behalf of defendants AT&T, T-Mobile and Sprint), *Intellectual Ventures v. Motorola* (on behalf of defendant Motorola), *TQ Beta v. DISH et al*. (on behalf of defendant DISH), *Qurio v. DISH et al*. (on behalf of defendant DISH), *Fatpipe v. Talari* (on behalf of the defendant Talari), *EON v. Apple* (on behalf of defendant Apple), *Chrimar v. Dell* (on behalf of defendant Dell), *Nokia v. LGE* (on behalf of plaintiff Nokia),

PanOptis v. Blackberry (on behalf of defendant Blackberry), *Customedia v. DISH et al.* (on behalf of defendant DISH), *Blackberry v. BLU* (on behalf of plaintiff Blackberry), *MTel v. Charter et al.* (on behalf of defendants Charter, Time Warner, Cox and Bright House), *Huawei v. Samsung* (on behalf of plaintiff Huawei), *Alacritech v. Wistron* (on behalf of defendant Wistron), *IPA v. DISH et al.* (on behalf of defendant DISH), *XR v. Ruckus et al.* (on behalf of defendants Ruckus, Netgear and Belkin), *Twilio v. Telesign* (on behalf of plaintiff Twilio), *Hera/Sisvel v. Arris et al.* (on behalf of defendants Arris/Ruckus, Netgear, Amazon, Roku and Belkin), *Intellectual Ventures v. Ericsson et al*. (on behalf of defendants Ericsson, T-Mobile and Sprint), *Sol IP v. AT&T et al*. (on behalf of defendants AT&T, Verizon and Sprint), *Soundview v DISH et al.* (on behalf of defendants DISH and Sling Media), *DISH v Peloton, iFIT and MIRROR* (on behalf of plaintiffs DISH and Sling Media), *XR v. D-Link et al.* (on behalf of defendants D-Link, HP, Netgear and Belkin), *SPV v HP* (on behalf of defendant HP), *DISH v MG et al.* (on behalf of plaintiffs DISH and Sling Media), and *Cobblestone v Cisco et al.* (on behalf of defendants Cisco and HP). I believe that the preceding list includes all cases that I have testified in as an expert at trial or by deposition at least during the past four years.

III. PERSON OF ORDINARY SKILL IN THE ART

22. I understand that the content of a patent (including its claims) and prior art should be interpreted the way a person of ordinary skill in the art (or "POSITA") would have interpreted the material at the alleged time of invention.

23. I understand that the "alleged time of invention" here is no earlier than the date that the applicants for the '511 Patent first filed an application related to the '511 Patent, namely, Apr. 13, 2012.

24. A person of ordinary skill in the art (referred to herein as a "POSITA") at the alleged time of invention for the '511 Patent would have been a person familiar with wireless communications networks, equipment and integrated circuit chips, and would have had at least a working knowledge of the design of physical layer signal processing for Multiple-Input Multiple-Output (MIMO) wireless communications including the use of antenna arrays.

25. For example, such a POSITA would have had at least a Bachelor's degree in Electrical Engineering or an equivalent field, and at least two years of work experience in developing MIMO-based wireless communications products. Alternatively, a POSITA would have had a more advanced degree, such as a Master's degree in Electrical Engineering or an equivalent field, combined with at least one year of work experience in developing MIMO-based wireless communications products.

26. In addition to my testimony as an expert, I am prepared to testify as someone who actually practiced in the field from 1986 to present, who actually possessed at least the knowledge of a POSITA within that time period including at the alleged time of invention, and who actually worked with others possessing at least the knowledge of a POSITA within that time period including at the alleged time of invention.

27. I understand that the POSITA is a hypothetical person who is assumed to be aware of all the pertinent information that qualifies as prior art. In addition, the POSITA makes inferences and takes creative steps.

IV. LEGAL UNDERSTANDING

28. I have a general understanding of validity based on my experience with patents and my discussions with counsel.

29. I understand that the claims of a patent are presumed valid. I understand that one factor to be considered in challenging this presumption of validity is whether or not prior art references cited by Petitioner are cumulative to one or more prior art references considered by the U.S. Patent and Trademark Office (the "PTO") in allowing the claims at issue. I understand that prior art references not specifically considered by the PTO are presumed to be non-cumulative. I understand that if Patent Owner contends that certain prior art references are cumulative to one or more prior art references considered by the PTO, then Patent Owner has the burden to prove this contention with specificity, and further that Petitioner and/or its experts will be allowed to rebut the Patent Owner's contention.

30. I have a general understanding of prior art and priority date based on my experience with patents and my discussions with counsel.

31. I understand that inventors may be entitled to a priority date earlier than an actual date of filing of a patent application that provides written description support for a particular claim to the extent that they can show complete possession of such a particular claimed invention at such an earlier priority date and reasonable diligence to reduce such a particular claimed invention to practice between such an earlier priority date and such an actual date of filing. I understand that if Patent Owner contends that particular claims are entitled to such an earlier priority date than such an actual date of filing, then Patent Owner has the burden to prove this contention with specificity.

32. I understand that an invention by another must be made before the priority date of a particular patent claim in order to qualify as "prior art" under 35 U.S.C. § 102 or § 103, that a printed publication must be publicly available before the priority date of a particular patent claim in order to qualify as "prior art" under 35 U.S.C. § 102(a), that a printed publication must be publicly available more than one year prior to the actual date of filing of a patent application that provides written description support for a particular claim in the United States in order to qualify as "prior art" under 35 U.S.C. § 102(b), or that the invention by another must be described in an application for patent filed in the United States before the priority date of a particular patent claim in order to qualify as "prior art" under 35 U.S.C. § 102(e). I understand that Petitioner has the burden of proving that any particular reference or product usage or offer for sale is prior art.

33. I have a general understanding of obviousness based on my experience with patents and my discussions with counsel.

34. I understand that a patent claim is invalid under 35 U.S.C. § 103 as being obvious only if the differences between the claimed invention and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person of ordinary skill in that art. An obviousness analysis requires consideration of four factors: (1) scope and content of the prior art relied upon to challenge patentability; (2) differences between the prior art and the claimed invention; (3) the level of ordinary skill in the art at the time of the invention; and (4) the objective evidence of non-obviousness, such as commercial success, unexpected results, the failure of others to achieve the results of the invention, a long-felt need which the invention fills, copying of the invention by competitors, praise for the invention, skepticism for the invention, or independent development.

35. I understand that a prior art reference is proper to use in an obviousness determination if the prior art reference is analogous art to the claimed invention. I understand that a prior art reference is analogous art if at least one of the following two considerations is met. First a prior art reference is analogous art if it is from the same field of endeavor as the claimed invention, even if the prior art reference addresses a different problem and/or arrives at a different solution. Second, a prior art reference is analogous art if the prior art reference is reasonably pertinent to the problem faced by the inventor, even if it is not in the same field of endeavor as the claimed invention.

36. I understand that it must be shown that a person of ordinary skill in the art at the time of the invention would have had a reasonable expectation that a modification or combination of one or more prior art references would have succeeded. Furthermore, I understand that a claim may be obvious in view of a single prior art reference, without the need to combine references, if the elements of the claim that are not found in the reference can be supplied by the knowledge or common sense of a person of ordinary skill in the relevant art. However, I understand that it is inappropriate to resolve obviousness issues by a retrospective analysis or hindsight reconstruction of the prior art and that the use of "hindsight reconstruction" is improper in analyzing the obviousness of a patent claim.

37. I further understand that the law recognizes several specific guidelines that inform the obviousness analysis. First, I understand that a reconstructive hindsight approach to this analysis, i.e., the improper use of post-invention information to help perform the selection and combination, or the improper use of the listing of elements in a claim as a blueprint to identify selected portions of different prior art references in an attempt to show that the claim is obvious, is not permitted. Second, I understand that any prior art that specifically teaches away from the

claimed subject matter, i.e., prior art that would lead a person of ordinary skill in the art to a specifically different solution than the claimed invention, points to non-obviousness, and conversely, that any prior art that contains any teaching, suggestion, or motivation to modify or combine such prior art reference(s) points to the obviousness of such a modification or combination. Third, while many combinations of the prior art might be "obvious to try", I understand that any obvious to try analysis will not render a patent invalid unless it is shown that the possible combinations are: (1) sufficiently small in number so as to be reasonable to conclude that the combination would have been selected; and (2) such that the combination would have been believed to be one that would produce predictable and well understood results. Fourth, I understand that if a claimed invention that arises from the modification or combination of one or more prior art references uses known methods or techniques that yield predictable results, then that factor also points to obviousness. Fifth, I understand that if a claimed invention that arises from the modification or combination of one or more prior art references is the result of known work in one field prompting variations of it for use in the same field or a different one based on design incentives or other market forces that yields predicable variations, then that factor also points to obviousness. Sixth, I understand that if a claimed invention that arises from the modification or combination of one or more prior art references is the result of routine optimization, then that factor also points to obviousness. Seventh, I understand that if a claimed invention that arises from the modification or combination of one or more prior art references is the result of a substitution of one known prior art element for another known prior art element to yield predictable results, then that factor also points to obviousness.

38. I understand that a dependent claim incorporates each and every limitation of the claim from which it depends. Thus, my understanding is that if a prior art reference fails to

anticipate an independent claim, then that prior art reference also necessarily fails to anticipate all dependent claims that depend from the independent claim. Similarly, my understanding is that if a prior art reference or combination of prior art references fails to render obvious an independent claim, then that prior art reference or combination of prior art references also necessarily fails to render obvious all dependent claims that depend from the independent claim.

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V. THE '511 PATENT

39. The '511 Patent, entitled "Directed MIMO communications" relates "to multiple-input multiple-output (MIMO) wireless communications and beamforming antennas" (see, for example, Ex. 1001 at 1:5-7).

A. Overview of the '511 Patent

40. In the "**Background**" section, the '511 Patent observes that at the time of the invention that "*Multiple-input multiple-output* (MIMO) wireless communication systems utilize *multiple transmit antennas* and *multiple receive antennas* instead of a single antenna" and "often have *multiple transmitters* (e.g., one *associated with each transmit antenna*) and *multiple receivers* (e.g., one *associated with each receive antenna*)" (emphasis added, see, for example, Ex. 1001 at 1:11-16).

41. The '511 Patent describes the term "*transceiver*" as something that "may *modulate transmit signals* and *demodulate receive signals* and may *perform further processing* of *receive signals after demodulation* and of *transmit signals prior to modulation*" (emphasis added, see, for example, Ex. 1001 at 1:16-19).

42. The '511 Patent also describes the term "*Beamforming*" as something that "utilizes *multiple antenna elements* and often a beamformer to *synthesize one or more beams*" wherein "Such a *beamforming antenna* can be called an *antenna array*" and "*Each antenna element* of the antenna array is typically the *same type of antenna*" (emphasis added, see, for example, Ex. 1001 at 1:20-24).

43. In the "**Summary**" section, the '511 Patent states that multiple "*aspects*" of a "*system*" or an "*apparatus*" that include "a *plurality* of m *antenna arrays* configured to *receive a propagating radio frequency signal*" each "provides many *advantages*" because "*MIMO and beamforming can be combined* to provide *range extension* and *throughput enhancement*

supported at either or both of a base station and mobile terminal" such that "The resulting solution is *practical and cost-effective*" (emphasis added, see, for example, Ex. 1001 at 1:28-30, 1:60-62, 2:4-6, 2:17-22).

44. In a section entitled "**Detailed Description**", the '511 Patent states that "FIG. 1 depicts an example of a *block diagram of a transceiver for extended communications range and throughput using MIMO and beamforming*" (emphasis added, see, for example, Ex. 1001 at 2:54-56, FIG. 1 as reproduced below).

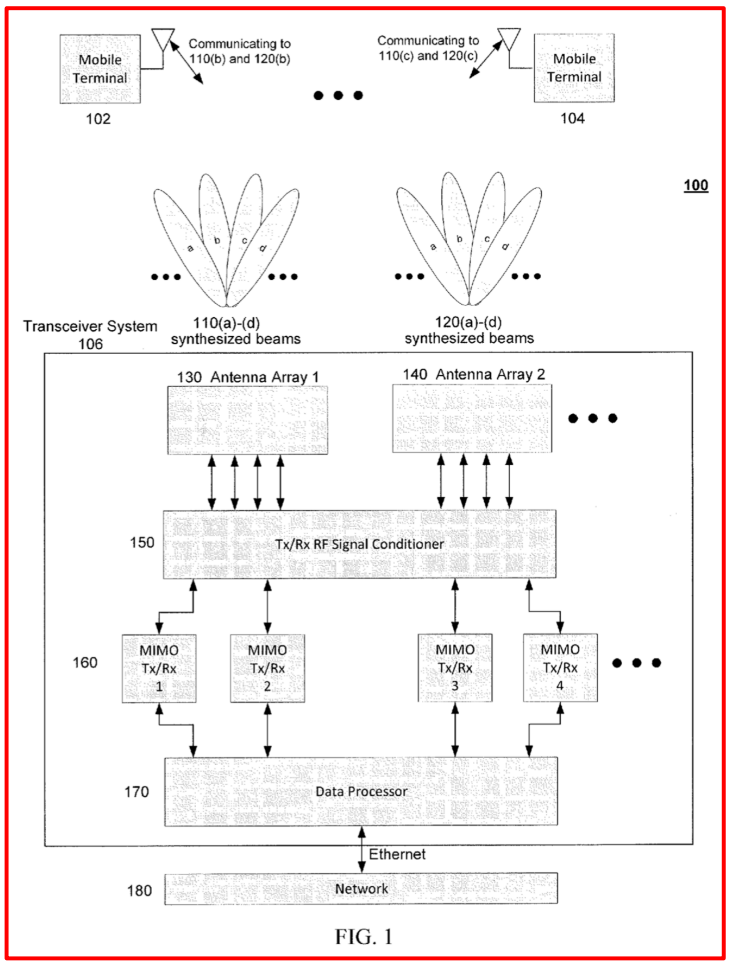


FIG. 1

45. In reference to FIG. 1 shown above, the '511 Patent explains that "*mobile terminals* **102**, **104** are in *communications* range with *transceiver system* **106**" wherein "Two

multi-beam antenna arrays **130**, **140** each *communicate* with *both mobile terminals* **102**, **104**" (emphasis added, see, for example, Ex. 1001 at 2:56-59).

46. More specifically, the '511 Patent explains that "*Signals received* from the mobile terminals and *signals to be transmitted* to the mobile terminals are *processed by transceiver radio frequency signal conditioner* (Tx/Rx RF signal conditioner) **150** and *passed from/to MIMO transceivers* **160** where the *received signals are transformed into receive data* and *transmit data is transformed into transmit signals*" while "*User data* to/from the *transceivers flows from/to the user data processor* **170**" (emphasis added, see, for example, Ex. 1001 at 2:59-67).

47. In further reference to FIG. 1 shown above, the '511 Patent explains that "*transceiver* system **106** may be implemented as a *cellular base station* of a public land mobile network and/or as a *wireless access device* (e.g., a *Wi-Fi wireless access point*) providing access to a wireless network" (emphasis added, see, for example, Ex. 1001 at 3:24-27).

48. Additionally, the '511 Patent explains that "The *received signal* may also be configured in *accordance with*" or "to substantially *comply with*" a "*standard* system specification" such as "Institute for Electrical and Electronic Engineers (IEEE) 802.11a/b/g/n/ac (*WiFi*), IEEE 802.16 (*WiMAX*), 2rd Generation Partnership Project (3GPP) Long Term Evolution (*LTE*), 3GPP LTE-Advanced, 3GPP LTE-TDD (*time division duplexing*), 3GPP LTE-FDD (*frequency division duplexing*), High Speed Packet Access (*HSPA*), HSPA+, and other commercial wireless standards, and/or proprietary standards" (emphasis added, see, for example, Ex. 1001 at 3:37-46).

49. In continued reference to FIG. 1 shown above, the '511 Patent explains that "*Antenna arrays* **130**, **140** each *synthesize a plurality of antenna beams* where *each beam* of an antenna array is designed to *provide gain in a prescribed solid angle different from the other*

beams also synthesized by the *same array*" such as when "antenna array **130**, antenna array **140** *may produce four beams each*" as depicted in FIG. 1 (emphasis added, see, for example, Ex. 1001 at 3:49-54).

50. Additionally, the '511 Patent explains that "*transceiver* system **106** is configured to allow *communication between a mobile terminal and beams of antenna arrays* **130**, **140** with the *same beam index*" such that "In the example of FIG. 1, *beams **110**(b) and **120**(b)* are configured to provide *acceptable gain in the direction of mobile terminal* **102**" or thus "the *index* for the beam of *both antenna arrays* that is communicating with mobile terminal **102** *is "b,"* as shown in FIG. 1" while "Similarly, *mobile terminal* **104** is in communication with *beams of index "c" of both antenna arrays* **130**, **140**" (emphasis added, see, for example, Ex. 1001 at 3:54-63).

51. The '511 Patent also describes for "*Antenna arrays* **130**, **140**" that "the *individual elements* of an array may each be a *dipole* antenna, *monopole* antenna, *slot* antenna, slotted *waveguide* antenna, *horn* antenna, microstrip *patch* antenna or *any other antenna type*" while being "configured with a *beamformer* that provides *fixed beams* or *steerable beams*" wherein such "Steerable beams may be *electromechanically steered* or *electronically steered*" and such "Electronically steered arrays are sometimes *referred to as phased arrays*" (emphasis added, see, for example, Ex. 1001 at 4:4-14).

52. In additional reference to FIG. 1 shown above, the '511 Patent explains that "*Tx/Rx RF signal conditioning* **150** includes *signal processing functions* that may include *filtering and amplification*, and in some implementations may also include *frequency upconversion and/or downconversion*, and the like" wherein "These functions may be performed

in the *analog domain*, may be performed *digitally*, or may be performed in a *combination thereof*" (emphasis added, see, for example, Ex. 1001 at 4:23-28).

53. Additionally, the '511 Patent states in reference to FIG. 1 that "*Multiple MIMO transceivers* are shown at **160**" wherein such "*MIMO transceivers* may *perform digital signal processing* associated with *demodulation and decoding* as well as *modulation and encoding*" (emphasis added, see, for example, Ex. 1001 at 4:29-32).

54. According to the '511 Patent, FIG. 1 also depicts "*as many MIMO transceivers* **160** *as beams supported by any one antenna*" or thus "In this configuration, the *number of antenna arrays is equal to the number of receive input and transmit output ports on each MIMO transceiver*" but "*Other configurations are also possible*" and also "*Although* Tx/Rx RF *signal conditioning* **150** and *MIMO transceivers* **160** are *shown separately* in FIG. 1, they *may be combined* into a *single component or element*" (emphasis added, see, for example, Ex. 1001 at 4:32-39).

55. The '511 Patent states that "FIG. 2 depicts an example of a *block diagram of a receiver* **200** for *extended communications range and throughput* with *three antenna arrays* **210**, **220** and **230** and *six MIMO receivers* **250**(a)-(f)" wherein "*Only the receive portion* of a transceiver is *shown* in this example to *simplify the description*" and "In this example, *each antenna array produces six independent beams* **212**(a)-(f), **222**(a)-(f), and **232**(a)-(f) although each antenna array **210**, **220**, **230** could produce a different number of beams" (emphasis added, see, for example, Ex. 1001 at 4:50-58, FIG. 2 as reproduced below).

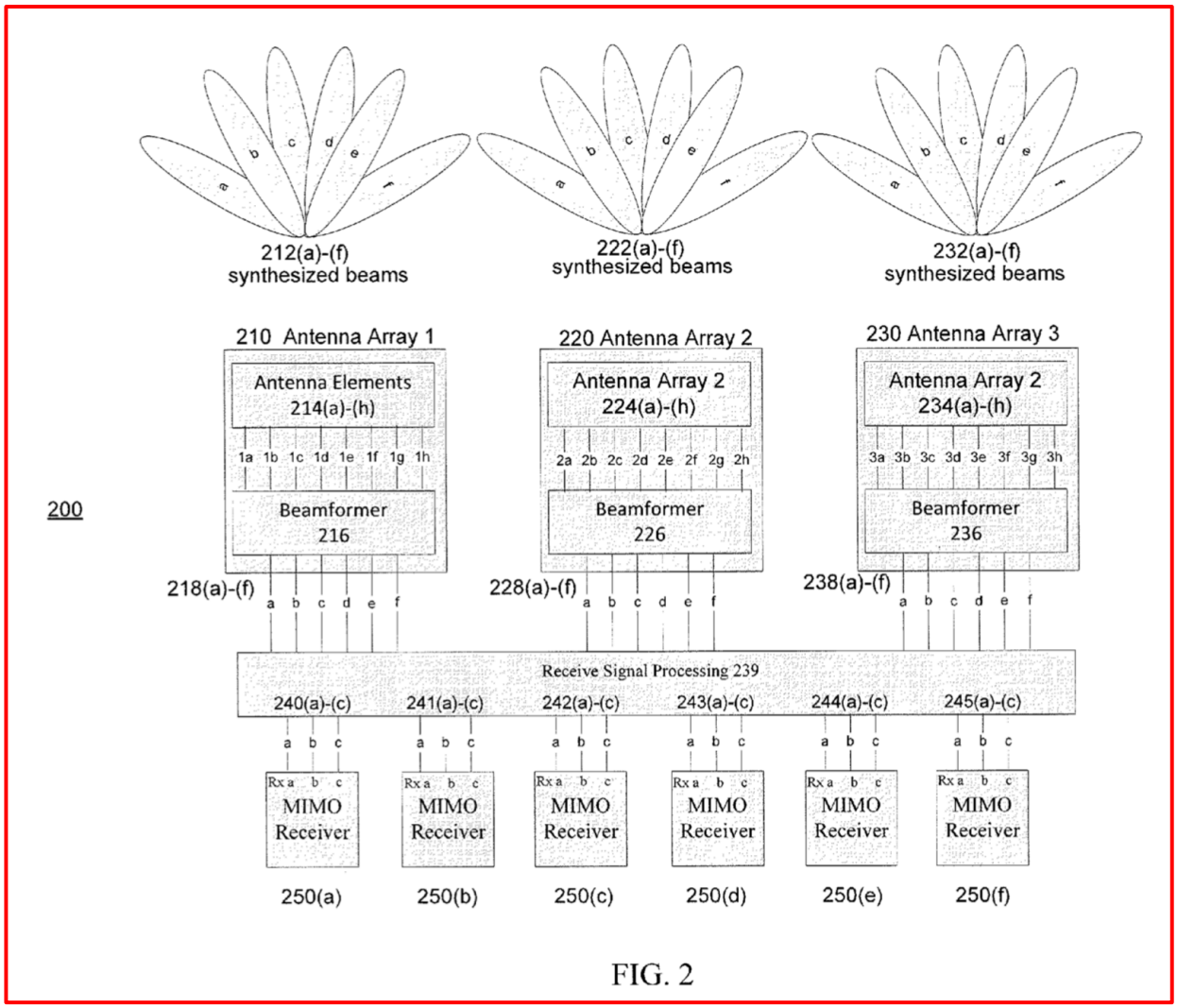


FIG. 2

56. In reference to FIG. 2 shown above, the '511 Patent explains that "The *six beams* **212**(a)-(f), **222**(a)-(f), and **232**(a)-(f) of *each antenna array* are synthesized by *antenna elements* **214**(a)-(h), **224**(a)-(h), and **234**(a)-(h), and *beamformers* **216**, **226** and **236**, respectively" wherein "Although in this example *each antenna array* **210**, **220**, and **230** is comprised of *eight antenna elements* **214**(a)-(h), **224**(a)-(h), and **234**(a)-(h), *different numbers of elements per array could be used*" (emphasis added, see, for example, Ex. 1001 at 4:61-67).

57. Additionally, the '511 Patent explains that "*Each of the six beams* of each antenna is associated with a *corresponding signal* **218**(a)-(f), **228**(a)-(f), and **238**(a)-(f)" and "*MIMO*

receivers **250**(a), **250**(b), **250**(c), **250**(d), **250**(e) and **250**(f) are *connected to beamformers* **216**, **226**, and **236** such that *beamformer output* **218**(a) corresponding to *beam* **212**(a) is *connected to MIMO receiver* **250**(a) at **240**(a)" while "Similarly, *beamformer output* **228**(a) corresponding to **beam** 222(a) is *connected to receiver* **250**(a) at **240**(b), and *beamformer output* **238**(a) corresponding to *beam* **232**(a) is *connected to MIMO receiver* **250**(a) at **240**(c)" (emphasis added, see, for example, Ex. 1001 at 5:1-10).

58. Similarly, the '511 Patent further explains that "In the same fashion, *beamformer output* **218**(b) corresponding to *beam* **212**(b) is *connected to MIMO receiver* **250**(b) at **241**(a), *beamformer output* **228**(b) corresponding to *beam* **222**(b) is *connected to MIMO receiver* **250**(b) at **241**(b), and *beamformer output* **238**(b) corresponding to *beam* **232**(b) are *connected to MIMO receiver* **250**(b) at **214**(c)" and additionally "The *same connection pattern is used for MIMO receivers* **250**(c), **250**(d), **250**(e), and **250**(f) *connected to* **242**(a)-(c), **243**(a)-(c), **244**(a)-(c), and **245**(a)-(c) corresponding to *beamformer outputs* **218**(c)-(f), **228**(c)-(f), and **238**(c)-(f) and *beams* **212**(c)-(f), **222**(c)-(f), and **232**(c)-(f)" (emphasis added, see, for example, Ex. 1001 at 5:10-22).

59. The '511 Patent states that "There are an *equal number of MIMO receivers as beams per antenna array*" and that "*multiple MIMO receivers* are implemented on a *single circuit card* and/or in a *single enclosure*" wherein "*one MIMO receiver* may be capable of *handling multiple receive channels simultaneously*" (emphasis added, see, for example, Ex. 1001 at 5:28-29, 5:33-37).

60. Also, the '511 Patent states that "the *characteristics* of beams **212**(a)-(f) including *beamwidth*, *gain* and *side lobe features*, are determined by the *type and design of each antenna element* **214**(a)-(h), the *spacing* between elements, and the *beamformer* **216**" and that "*MIMO performance is enhanced* by *placing antennas* **210**, **220** and **230**, a *distance apart* that is many

times to many thousands of times (or greater) *farther apart than the distance between elements of the array*", thereby "providing *spatial diversity*" (emphasis added, see, for example, Ex. 1001 at 5:42-54).

61. Additionally, the '511 Patent states that "In some implementations, the *antenna elements produce fixed beam directions* that cannot be changed once the antenna is mounted and aligned" but "the antenna arrays can be *aligned so that the beams with the same index of antenna arrays* **210**, **220** and **230** *point* in the a *direction* that is *parallel to each other*" (emphasis added, see, for example, Ex. 1001 at 5:55-60).

62. For example, the '511 Patent states that "*beam* **212**(a) may be *parallel to beams* **222**(a) and **232**(a)" while "Similarly, *beams* **212**(b), **222**(b), and **232**(b) may *point in parallel directions*" and accordingly, the '511 Patent contends that "*If the distance to the mobile terminal* being communicated with is *sufficiently far*, the *same beam index of all three antenna arrays* will provide *sufficient gain* to support communication" and "*Using the same beam index* for each antenna *reduces the receiver complexity*" (emphasis added, see, for example, Ex. 1001 at 5:60-67).

63. The '511 Patent states that "FIG. 4 depicts another example of a *block diagram for a time-division duplexing transceiver* for *extended communications range and throughput* using *MIMO and beamforming*" (emphasis added, see, for example, Ex. 1001 at 8:49-52, FIG. 4 as reproduced below).

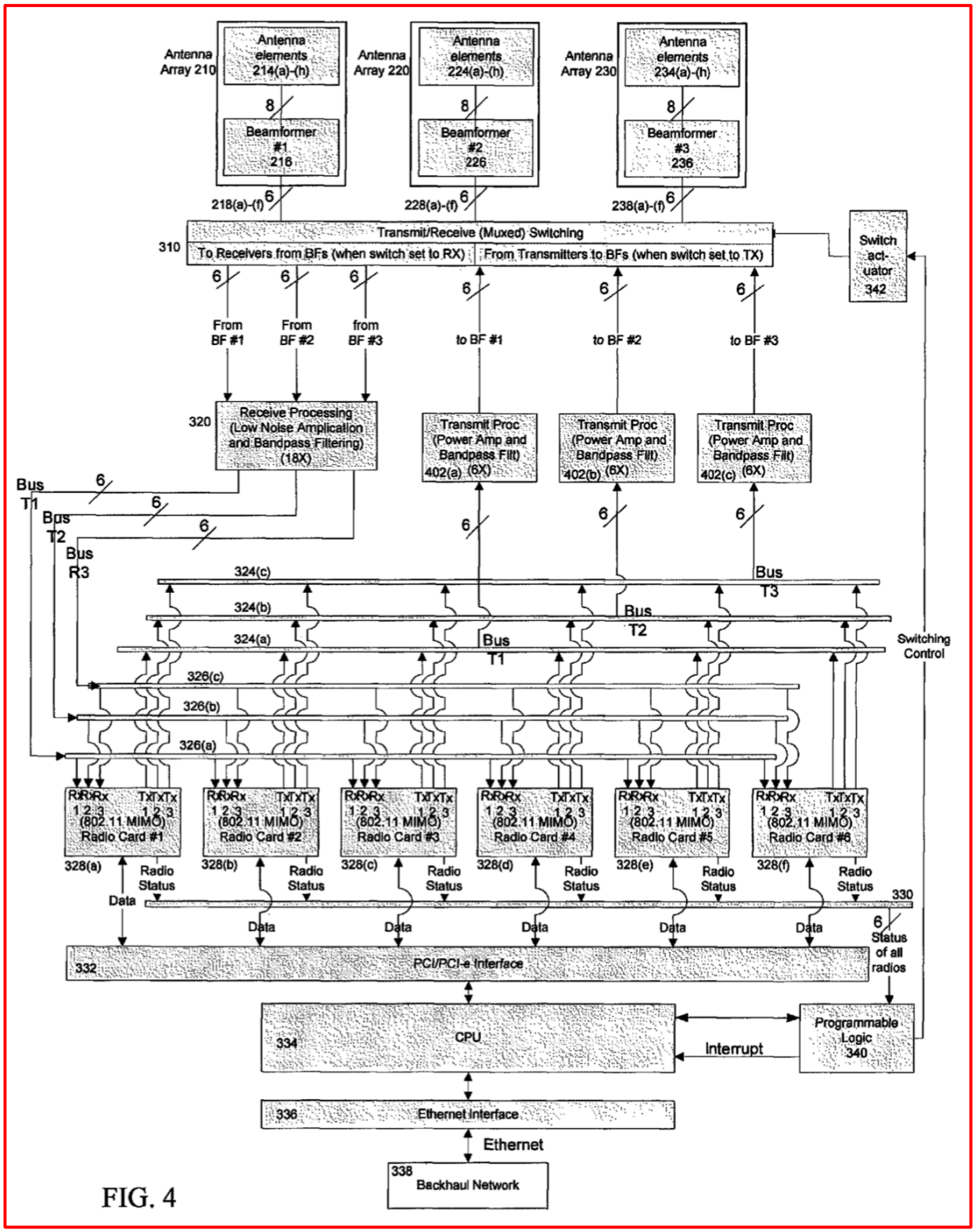

Antenna Array 210
Antenna elements 214(a)-(h)
Antenna Array 220
Antenna elements 224(a)-(h)
Antenna Array 230
Antenna elements 234(a)-(h)
8
Beamformer #1 216
Beamformer #2 226
Beamformer #3 236
218(a)-(f)
228(a)-(f)
238(a)-(f)
6
310
Transmit/Receive (Muxed) Switching
To Receivers from BFs (when switch set to RX)
From Transmitters to BFs (when switch set to TX)
Switch actuator 342
From BF #1
From BF #2
from BF #3
to BF #1
to BF #2
to BF #3
320
Receive Processing (Low Noise Amplication and Bandpass Filtering) (18X)
Transmit Proc (Power Amp and Bandpass Filt) 402(a) (6X)
Transmit Proc (Power Amp and Bandpass Filt) 402(b) (6X)
Transmit Proc (Power Amp and Bandpass Filt) 402(c) (6X)
Bus T1
Bus T2
Bus R3
Bus T3
324(c)
324(b)
324(a)
326(c)
326(b)
326(a)
Switching Control
RxRxRx 1 2 3 TxTxTx 1 2 3 (802.11 MIMO) Radio Card #1
Radio Card #2
Radio Card #3
Radio Card #4
Radio Card #5
Radio Card #6
328(a)
328(b)
328(c)
328(d)
328(e)
328(f)
Radio Status
Data
330
Status of all radios
332
PCI/PCI-e Interface
334
CPU
Interrupt
Programmable Logic 340
336
Ethernet Interface
Ethernet
338
Backhaul Network

FIG. 4

64. According to the '511 Patent, "Transceiver **400** supports *three sets of six transmit processing paths* **402**(a)-(c) for a total of *18 simultaneous transmit processing paths*" wherein "*Each group of six processing paths* **402**(a)-(c) corresponds to *signals destined for one of the antenna arrays* **210**, **220** and **230**" and "*Each* of the 18 processing *paths* includes at least a *power amplifier* and a *filter*" (emphasis added, see, for example, Ex. 1001 at 8:66-9:4).

65. The '511 Patent also contends that "Transceiver **400** may be *attractive for operation within licensed spectrum*, such as the spectrum of the *3GPP LTE-TDD standard*" and that "In some *implementations of the antenna array*, an operator may *choose to not simultaneously transmit two different signals on adjacent beams* of an antenna array due to *spatial overlap of the beams*" because "Spatial overlap results in *signal cross-talk or interference between the two beams which degrades performance* of one or both beams" (emphasis added, see, for example, Ex. 1001 at 8:62-65, 9:4-10).

B. Prosecution File History of the '511 Patent

66. I understand that on Apr. 13, 2012 that U.S. Patent Application No. 13/447,139 by B. Eidson and R. Chaffee, entitled "Directed MIMO communications" was filed (see, for example, Ex. 1001 at [22]).

67. I understand the following to be original claims 1-3 of U.S. Patent Application No. 13/447,139 (from Ex. 1002 at p. 21):

1. A system comprising:

a plurality of m antenna arrays configured to receive a propagating radio frequency signal, each of the antenna arrays comprising:

a plurality of antenna elements; and

a beamformer configured to produce n different bi-directional beams using the plurality of antenna elements; and

a plurality of n multiple-input multiple-output transceivers (MIMO), each MIMO transceiver comprising:

a MIMO receiver configured to accept m received signals, wherein the i-th input signal to the j-th MIMO receiver corresponds to the j-th beam of the i-th antenna array; and

a MIMO transmitter configured to provide m transmit signals, wherein the v-th output signal from the z-th MIMO transmitter corresponding to the z-th beam of the v-th antenna array is selected for transmission,

wherein m, n, v, and z are integer number values, and

wherein i=1, …, m, j=1, …, n, and v=1, …m.

2. The system of claim 1, wherein z = [one value between 1 and n].

3. The system of claim 1, wherein z = 1, …n.

68. I understand that in Jun. 2012 that the US PTO rejected all pending claims of U.S. Patent Application No. 13/447,139 wherein original claim 1 shown above was rejected as being unpatentable over U.S. Patent Publication No. 2009/0322608 ("Adams") in view of U.S. Patent Publication No. 2002/0132600 ("Rudrapatna") (see, for example, Ex. 1002 at p. 67).

69. For example, I note that the examiner recited that the limitation of then-pending dependent claim 6 was disclosed because "Rudrapatna teaches a *beamforming MIMO system* wherein the *antenna groups* are *separated by more the one wavelength* (*Rudrapatna [0031]*)" (italic emphasis in original, other emphasis added, see, for example, Ex. 1002 at p. 70).

70. For example, I note that the examiner recited that the limitation of then-pending dependent claim 7 was disclosed because "Adams teaches wherein the *antenna elements are less than or equal to one half wavelength apart at the carrier frequency* (*Adams [0073]*)" (italic emphasis in original, other emphasis added, see, for example, Ex. 1002 at p. 70).

71. For example, I note that the examiner recited that the limitation of then-pending dependent claim 8 was disclosed because "Adams in view of Rudrapatna teaches wherein the *beamformer is an electronic beamformer* (*Adams [0008], fig. 4; Rudrapatna [0024]*)" (italic emphasis in original, other emphasis added, see, for example, Ex. 1002 at p. 71).

72. For example, I note that the examiner recited that the limitation of then-pending dependent claim 11 was disclosed because "Adams in view of Rudrapatna teaches wherein the system *simultaneously provides MIMO and beam forming* (*Rudrapatna [0031]*)" (italic emphasis in original, other emphasis added, see, for example, Ex. 1002 at p. 71).

73. I understand that applicants provided amended claims for U.S. Patent Application No. 13/447,139 and remarks in response to the above noted rejection in Sep. 2012 (see, for example, Ex. 1002 at pp. 81-93, amended claim 1 as shown below).

1. (Currently Amended) A system comprising:

~~a plurality of~~ m antenna arrays configured to receive a propagating radio frequency signal and configured to transmit a propagating radio frequency signal, each of the antenna arrays comprising:

a plurality of antenna elements; and

a beamformer configured to produce n different bi-directional beams using the plurality of antenna elements; and

~~a plurality of~~ n multiple-input multiple-output transceivers (MIMO), each MIMO transceiver comprising:

a MIMO receiver configured to accept m received signals, wherein the i-th input signal to the j-th MIMO receiver corresponds to the j-th beam of the i-th antenna array; and

a MIMO transmitter configured to provide m transmit signals, wherein the v-th output signal from the z-th MIMO transmitter corresponding to the z-th beam of the v-th antenna array is selected for transmission,

wherein m, n, v, and z are integer number values, ~~and~~

wherein i=1, …, m, j=1, …, n, and v=1, …m, and

wherein n ≥ 2 and m ≥ 2.

74. I note that applicants did not provide written correspondence to the US PTO that expressed any disagreement with examiner's descriptions of obviousness in view of the teachings of Adams and/or Rudrapatna for the additional limitations of at least then-pending claims 6-8 and 11 for U.S. Patent Application No. 13/447,139 (see, for example, Ex. 1002 at pp. 81-93).

75. I understand that applicants informed the PTO regarding U.S. Patent Application No. 13/447,139 in the above noted Sep. 2012 correspondence that "Nowhere does Adams disclose or suggest the *interconnection of multiple antenna arrays with multiple beams to multiple MIMO transceivers each with multiple inputs and outputs*, much less the *interconnection of components as recited in claim 1*" (emphasis added, see, for example, Ex. 1002 at p. 92).

76. I understand that in Jan. 2013 that the US PTO rejected all pending claims of U.S. Patent Application No. 13/447,139 wherein amended claim 1 shown above was rejected as being unpatentable over U.S. Patent Publication No. 2009/0322608 ("Adams") in view of U.S. Patent Publication No. 2002/0132600 ("Rudrapatna") (see, for example, Ex. 1002 at p. 100).

77. I understand that the examiner wrote at least that "one can easily see that the *system of Adams includes more than one transceiver*, since the *application is intended for multiple transceivers*" and that "*Contrary to applicant assertion*, Adam does teach that there is *more than one beam per array*" because "Adams discloses *at least three radiation beams* and further discloses that *capacity can be increase by further subdividing the azimuth plane more finely to produce more beams*" (emphasis added, see, for example, Ex. 1002 at p. 103).

78. I understand that in Jan. 2013 that the US PTO repeated the same rejections for the additional limitations of then-pending dependent claims 6-8 and 11 for U.S. Patent Application No. 13/447,139 as noted above ") (see, for example, Ex. 1002 at p. 104).

79. I understand that applicants provided amended claims for U.S. Patent Application No. 13/447,139 and remarks in response to the above noted rejection in Mar. 2013 (see, for example, Ex. 1002 at pp. 114-127, amended claim 1 as shown below).

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1. (Currently Amended) A system comprising:

m antenna arrays configured to receive a propagating radio frequency signal and configured to transmit a propagating radio frequency signal, each of the antenna arrays comprising:

a plurality of antenna elements; and

a beamformer configured to produce n different bi-directional beams using the plurality of antenna elements; and

n multiple-input multiple-output transceivers (MIMO), each MIMO transceiver comprising:

a MIMO receiver configured to ~~accept~~ process m different received signals, wherein ~~the~~ an i-th ~~input~~ received signal to a ~~the~~ j-th MIMO receiver corresponds to ~~the~~ a j-th beam of an ~~the~~ i-th antenna array; and

a MIMO transmitter configured to ~~provide~~ process m different transmit signals, wherein ~~the~~ a v-th ~~output~~ transmit signal from ~~the~~ a z-th MIMO transmitter ~~corresponding~~ corresponds to ~~the~~ a z-th beam of ~~the~~ a v-th antenna array ~~is selected for transmission~~,

wherein m, n, v, and z are integer number values,

wherein i=1, …, m, j=1, …, n, and v=1, …m, and

wherein n ≥ 2 and m ≥ 2.

80. I note that applicants again did not provide written correspondence to the US PTO that expressed any disagreement with examiner's descriptions of obviousness in view of the teachings of Adams and/or Rudrapatna for the additional limitations of at least then-pending claims 6-8 and 11 for U.S. Patent Application No. 13/447,139 (see, for example, Ex. 1002 at pp. 114-127).

81. I understand that applicants informed the PTO regarding U.S. Patent Application No. 13/447,139 in the above noted Mar. 2013 correspondence that "**nowhere does Adams describe an implementation where the number of beams per antenna array is equal to the number of MIMO transceivers**" and "**nowhere does Adams describe an implementation where the number of inputs/outputs per MIMO transceiver is equal to the number of antenna arrays**" (bold emphasis in original, see, for example, Ex. 1002 at p. 124).

82. I understand that in Sep. 2013 that applicants again provided amended claims for U.S. Patent Application No. 13/447,139 wherein "**The instant amendments reflect the amendments that the Examiner suggested may be allowable**" (bold emphasis in original, see, for example, Ex. 1002 at pp. 141-149, amended claim 1 as shown below).

1. (Currently Amended) A system comprising:

m antenna arrays configured to receive a propagating radio frequency signal and configured to transmit a propagating radio frequency signal, each of the antenna arrays comprising:

a plurality of antenna elements; and

a beamformer configured to produce n different bi-directional beams using the plurality of antenna elements; and

n multiple-input multiple-output transceivers (MIMO), each MIMO transceiver comprising:

a MIMO receiver configured to process m different received signals, wherein an i-th received signal to a j-th MIMO receiver corresponds to a j-th beam of an i-th antenna array; and

a MIMO transmitter configured to process m different transmit signals, wherein a v-th transmit signal from a z-th MIMO transmitter corresponds to a z-th beam of a v-th antenna array,

wherein m, n, v, and z are integer number values,

wherein i=1, …, m, j=1, …, n, and v=1, …m, ~~and~~

wherein $n \geq 2$ and $m \geq 2$, and

wherein z equals one or more values between 2 and n.

83. I understand that in Oct. 2013 that the US PTO notified the applicants of U.S. Patent Application No. 13/447,139 that then-pending claims, as amended by the examiner, were allowable (see, for example, Ex. 1002 at pp. 161-179, examiner amended claim 1 as shown below).

1. (Currently Amended) A system comprising:

m antenna arrays configured to receive a propagating radio frequency signal and configured to transmit a propagating radio frequency signal, each of the antenna arrays comprising:

a plurality of antenna elements; and

a beamformer configured to produce n different bi-directional beams using the plurality of antenna elements; and

n multiple-input multiple-output transceivers (MIMO), each MIMO transceiver comprising:

a MIMO receiver configured to process m different received signals, wherein an i-th received signal to a j-th MIMO receiver corresponds to a j-th beam of an i-th antenna array; and

a MIMO transmitter configured to process m different transmit signals, wherein a v-th transmit signal from a z-th MIMO transmitter corresponds to a z-th beam of a v-th antenna array,

wherein m, n, v, and z are integer number values,

wherein i=1, …, m, j=1, …, n, and v=1, …m, ~~and~~

wherein n ≥ 2 and m ≥ 2, ~~and~~

wherein z =1, …., w, and

wherein n ≥ w ≥ 2. ~~Equal one or more values between 2 and n.~~

84. I understand that the examiner allowed Claim 1 of U.S. Patent Application No. 13/447,139 because the combination of Adams and Rudrapatna fails to teach "*a beam configured to produce n different bi-directional beams using the plurality of antenna elements: and n multiple input multiple-output transceivers*", which the examiner stated "would not have been obvious to one having ordinary skill in the art" (emphasis added, see, for example, Ex. 1002 at p. 177).

85. I understand that U.S. Patent Application No. 13/447,139 issued as U.S. Patent No. 8,737,511 on May 27, 2014 (see, for example, Ex. 1001 at [45]).

C. Asserted Claims and Priority Date

86. The '511 Patent includes 20 claims. I understand that Claims 1-2, 4-6, 9-11, 13-15 and 18-20 of the '511 Patent are asserted in the District Court litigation (see, for example, Ex. 1009 at p. 1) and are subject to this *Inter Partes* Review petition. Accordingly, I may refer to Claims 1-2, 4-6, 9-11, 13-15 and 18-20 of the '511 Patent as the "challenged claims" herein.

87. The '511 Patent was filed on Apr. 13, 2012 (see, for example, Ex. 1001 at [22]). and I understand that in the District Court litigation that the Patent Owner alleges the priority date of at least the challenged claims of the '511 Patent to be Apr. 13, 2012 (see, for example, Ex. 1009 at p. 6).

D. Objective Indicia of Non-obviousness

88. I understand that in the District Court litigation, Patent Owner has not yet provided any information regarding this topic. As of this writing, I am unaware of any information that would provide objective indicia of non-obviousness for any of the challenged claims of the '511 Patent. However, to the extent that Patent Owner (or its expert) provides opinions and/or analysis with respect to this topic, I reserve the right to supplement my opinions and analyses on this topic.

VI. CLAIM CONSTRUCTION

89. I understand that claim construction is a matter of law. I further understand that in a *Inter Partes* Review proceeding that the claims are to be given their ordinary and customary (or "plain and ordinary") meaning, as would be understood by a POSITA in the context of the entire disclosure and intrinsic record. I also understand that limitations from the specification of the patent are not to be read into the claims, and that conversely, not all claims necessarily encompass all material disclosed within the specification. The specification, however, can inform a POSITA as to the plain and ordinary meaning of the claims. In addition, I understand that a POSITA would look to statements made by the applicants during the prosecution file history to inform as to the plain and ordinary meaning of the claims.

90. I understand that at least indefiniteness and lack of written description and/or enablement are potential invalidity issues that cannot be addressed as part of an *Inter Partes* Review proceeding. Therefore, solely for the purposes of my prior art invalidity analyses herein as relevant to this *Inter Partes* Review proceeding, I have assumed claim constructions as appropriate for an *Inter Partes* Review proceeding even for such claims and/or claim elements that I may otherwise believe to be indefinite, lacking written description and/or non-enabled as may be set forth in the District Court litigation.

91. I understand that in the District Court litigation involving the Petitioner that Patent Owner has not, as of this writing, identified any claim terms alleged to require constructions nor proposed any claim constructions thereof for the '511 Patent. However, Patent Owner has provided an allegation of infringement for at least the challenged claims of the '511 Patent. Thus, Patent Owner appears to believe that the claim terms of the challenged claims of

the ‘511 Patent are at least as broad as would be necessary for such allegation of infringement to apply.

92. I have applied a plain and ordinary meaning to all claim terms for the purposes of this *Inter Partes* Review proceeding. In my opinion, my analyses of obviousness herein would apply to any reasonable construction of the claim terms as well.

93. In the event that one or more of these constructions is changed, or in the event that additional terms not specifically construed herein receive a proposed construction, I reserve the right to revisit my analysis under such additional construction(s).

VII. STATE OF THE ART

94. As of the possible priority date of the '511 Patent, the state of the art in the field of multiple-input multiple-output (MIMO) wireless communications and beamforming antennas already fully encompassed the elements of the asserted claims of the '511 Patent, as evidenced in even the small sample of the art described herein.

A. Trigui (Ex. 1004)

95. For example, amongst the numerous prior art references in this field, U.S. Patent Publication No. 2011/0150050 by H. Trigui and R. Cuthill, entitled "Digital Integrated Antenna Array for Enhancing Coverage and Capacity of a Wireless Network" ("Trigui") was filed on Dec. 23, 2009 and published on Jun. 23, 2011 (see, for example, Ex. 1004 at [22], [43]). Thus, I understand that Trigui qualifies as prior art to the '511 Patent at least under 35 U.S.C. §§ 102(a) and 102(e). I note that substantially the same disclosure of Trigui is found in International Publication WO 2011/078898 published on Jun. 30, 2011 (see, for example, Ex. 1008 at p. 1). In some instances where more legible figures of identical content appear in WO 2011/078898 (Ex. 1008) compared to Trigui, I have excerpted such figures in my description herein of Trigui.

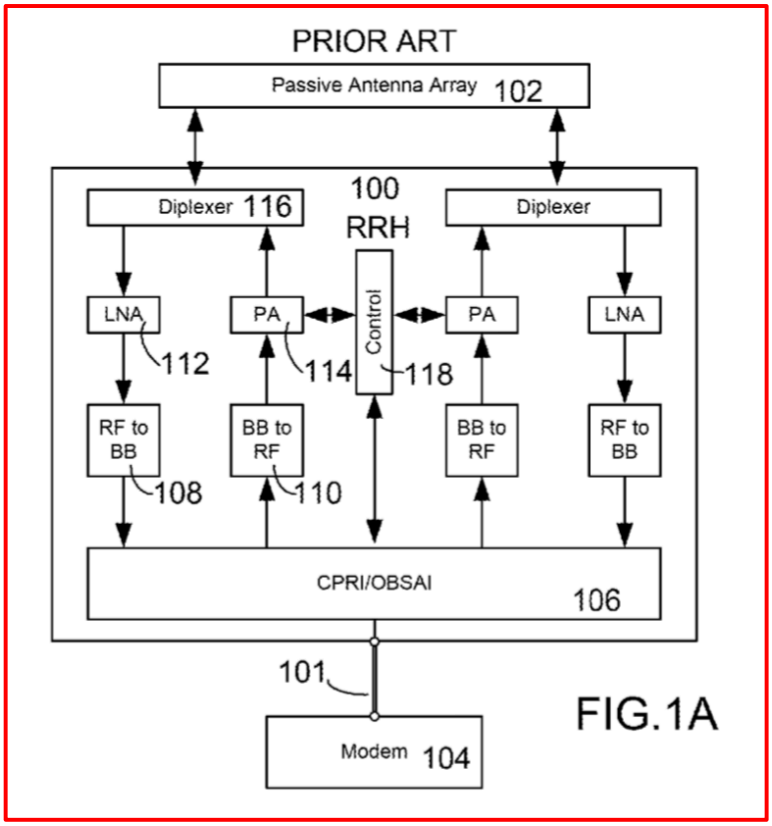
96. Trigui relates "to using a *digital integrated antenna array* for *enhancing coverage and capacity* of a wireless network" and for "*sharing antenna elements and active electronics between multiple operators* servicing the same geographic area" (emphasis added, see, for example, Ex. 1004 at [0002]). I note that in the context of Trigui that a POSITA would understand the term "*operator*" to be a reference to a cellular service provider. For example, at the time of the alleged invention of the '511 Patent, a POSITA would understand that "*Cellular or wireless telephone towers* typically are stand-alone facilities *shared by multiple service providers* that serve as access points for communicating with subscribers' handheld and mobile cellular devices" and that "*operators*" include well known service providers including "*Verizon, AT&T, Sprint*, and CellularOne" (emphasis added, see, for example, Ex. 1013 at pp. 3, 10). Additionally, I note that at the time of the alleged invention of the '511 Patent that a POSITA would know that "an *antenna system for shared operation by multiple operators*" such as an "antenna assembly having a *plurality of antenna stacks within a radome*" would provide "a

solution to the problem of limiting site and antenna numbers" as had been known since at least 1992 when Prokkola disclosed that "a *common antenna* and a common-antenna filter are *used for the base stations of mobile telephone systems of different types*" (emphasis added, see, for example, Ex. 1015 at [0001-3], Ex. 1016 at 2:40-45). Moreover, a POSITA would also know that the prior art specifically teaches "an *array*" of "RF link sector *antennas*" to be "*shared by multiple service providers*" as an approach to address the problems of "*wind resistance* for towers that must withstand 60 mile/hour winds", "*physical strain* on a tower" due to "*antenna weight*" and "*ice*", and the desire of each "*service provider*" to have their "*antennas positioned at* or very close to the *top of the tower*", which thereby "*increases the revenues paid* by each service provider *to the tower owner*" (emphasis added, see, for example, Ex. 1014 at [0004, 6, 26]). Accordingly, a POSITA would understand that by proposing a new approach to "*sharing antenna elements and active electronics between multiple operators* servicing the same geographic area" that Trigui is disclosing an improved solution to this known technical field of "an *antenna system for shared operation by multiple operators*".

97. In the "**Description of the Related Art**" section, Trigui observes that "A *key factor* in network design is the *cost per bit of transmitted data*" and accordingly recommends "adopting the most *spectrally efficient air interface* (for example, *orthogonal frequency-division multiplexing (OFDM)*), and *multiple input multiple output (MIMO) antenna techniques* by an advanced wireless system such as *WiMAX or 3rd Generation Partnership Project Long Term Evolution (3GPP LTE)*" (emphasis added, see, for example, Ex. 1004 at [0004]).

98. For example, Trigui describes "FIG. 1A" as a "*conventional approach*" that uses "a *remote radio head* ("*RRH*")" for a "*2×2 MIMO system*" with a "*pair of transmission/reception paths*" wherein "a *single modem* **104** is *connected* via a fiber optic

interface **101** *to an RRH* **100**" that "is *connected to a passive antenna array* **102** for transmitting/receiving RF signals" via "a *circuit* **110** for *converting the signals from baseband to RF*, and then passed through a *power amplifier* **114**" for "*transmit*" or via "a *low-noise amplifier* **112**" and "then passed through a *circuit* **108** for *converting RF to baseband*" for "*receive*" (emphasis added, see, for example, Ex. 1004 at [0005-9], FIG. 1A as reproduced below).



99. In reference to the prior art FIG. 1A, Trigui further describes "a *2×2 MIMO system* in which the *pair of transmission/reception paths are multiplexed*" such that "In the *transmit direction*, the *digital signals received from the modem* **104** are *de-multiplexed*, converted to RF, routed to the two power amplifiers **114**, and finally to the passive antenna array **102**" while "*Received digital streams along the two reception paths are multiplexed* before being *transmitted* via the optical fiber cable **101** *to the modem* **104**" where "*interference cancellation algorithms* are implemented at *baseband* for each *active user*" such that "*cancellation* of

interfering signals may be *possible in the uplink*" while "*reduction* of probability of *interference* occurrence in the *downlink is possible*" (emphasis added, see, for example, Ex. 1004 at [0009, 14]).

100. For example, Trigui observes that "*Beamforming* is a general signal processing technique *used to control the directionality of the reception or transmission of a signal on a transducer array*" such that "the *majority of signal energy* can be *transmitted* from a group of transducers (such as radio antenna) in a *chosen angular direction*" (emphasis added, see, for example, Ex. 1004 at [0015]).

101. However, Trigui also informs that at least because "*per user beamforming* requires the development of *more expensive base stations* that provide meaningful business only in specific cases" that "*Sub-sectorization*" using an "*antenna array* to create sub-sectors with *specified radiation patterns* to serve a desired number of subscribers" is a "*more economical hotspot solution* addressing the unbalanced traffic demand across the network" (emphasis added, see, for example, Ex. 1004 at [0016, 17]).

102. In the "**Summary**" section, Trigui proposes "to *integrate a passive antenna array with radio transceivers in a single physical package* and to distribute the design to increase the degrees of freedom to offer more *control flexibility*", or more specifically, "a *digital integrated antenna array system* having *one or more antenna modules*, *one or more transceiver modules* each having *one or more signal processing paths for transmitting data to or receiving data* from the one or more antenna modules, and a *signal processing unit* able to *process data for each the one or more signal processing paths* of the one or more transceiver modules such that the data transmitted from the one or more transceiver modules to the one or more antenna modules is

radiated by the one or more antenna modules into one or more radiation patterns" (emphasis added, see, for example, Ex. 1004 at [0020-21]).

103. Therefore, in my opinion, a POSITA would understand even before considering the detailed disclosure of Trigui to follow that Trigui is from the same field of endeavor as the '511 Patent and that Trigui is reasonably pertinent to the problem faced by the '511 Patent (see, for example, ¶¶ 40-43 above regarding the '511 Patent in comparison with the above-summarized Description of the Related Art and Summary of Trigui). Accordingly, Trigui is analogous art to the '511 Patent.

104. In the "**Detailed Description of the Invention**" section, Trigui states that "FIG. 2A illustrates a general *high-level implementation of the digital integrated antenna array ("DIAA")* and represents a *single MIMO branch of a DIAA system*" (emphasis added, see, for example, Ex. 1004 at [0036], FIG. 2A as reproduced below).

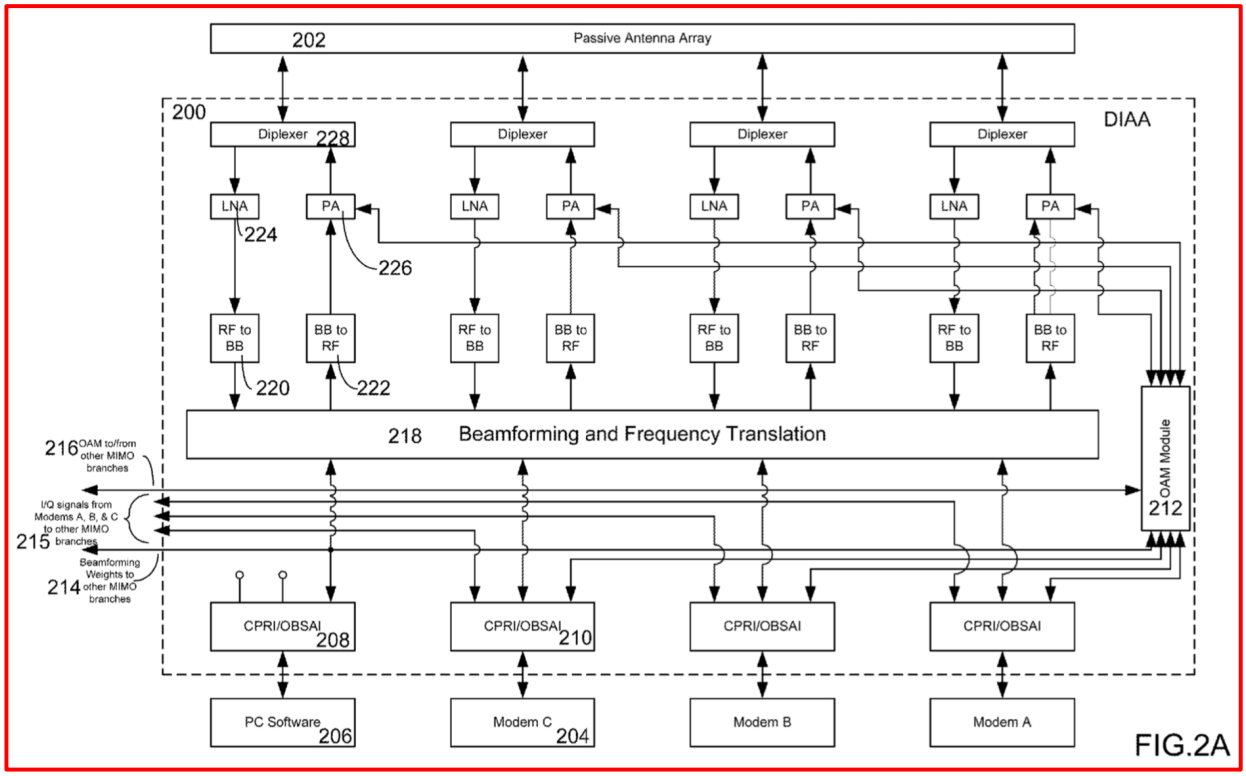


FIG.2A

105. In reference to FIG. 2A shown above, Trigui explains that "*one or more modems* **204**, such as, for example, *baseband modules of cellular base stations*, are *connected via one or more fiber optic interfaces*, respectively, to *one or more digital interface cores* **208**, **210** within the DIAA **200**" while "*one of the digital interface cores* **208** is *connected* via a fiber optic interface or Ethernet or the like *to a server based software interface* **206**" (emphasis added, see, for example, Ex. 1004 at [0037-38]).

106. More specifically, Trigui teaches that "The *server based software calculates the ideal beamforming weights* **214** that best approximate the *desired radiation pattern* and the *weights are passed to the DIAA* **200**" wherein such "Beamforming weights are computed and provided to the DIAA **200** to *improve the performance of the wireless network by improving coverage and quality, and increasing capacity*, or the like" (emphasis added, see, for example, Ex. 1004 at [0038]).

107. Additionally, Trigui teaches that "Although FIG. 2A illustrates only a *single MIMO branch DIAA*, the present invention *contemplates the use of multiple MIMO branches*" and accordingly, "*I/Q signals* **215** *from any of the modems*, as well as the *beamforming weights* **214**, can be *sent to other MIMO branches*" (emphasis added, see, for example, Ex. 1004 at [0041]).

108. For example, Trigui describes that "*each of the modem signals* are transmitted to the *beamforming and frequency translation module* **218** where the signals are frequency shifted and *split into a number of signals* equal to the number of transceiver paths of the DIAA **200**" and then "Each set of the modem signals, after split, is *multiplied by the beamforming and calibration weights* such that when applied to the passive antenna array **202**, a *user-specified*

radiation pattern is formed; the user-specified radiation pattern may have *one or more subsector radiation patterns*" (emphasis added, see, for example, Ex. 1004 at [0044]).

109. Next, Trigui describes that "*After processing in the beamforming* and frequency *module* **218**, each of the *modem signals along the transceiver paths* are passed though a *circuit* **220** for *converting the baseband signals to RF signals* and then passed through a *power amplifier* **226**" and then subsequently "passed through a *diplexer* **228** before being *transmitted to the passive antenna array* **202**" (emphasis added, see, for example, Ex. 1004 at [0045]).

110. Similarly, Trigui describes that "In the *receive direction*, *signals from the passive antenna array* **202** are passed through the *diplexer* **228** before entering a *low-noise amplifier* **224**" and then subsequently being "*converted from RF to baseband by a circuit* **220** before being fed to the *beamforming and frequency translation module* **218** where *beamforming* and calibration *weights are applied* to the received signals to *form modem signals*" (emphasis added, see, for example, Ex. 1004 at [0046]).

111. Alternatively, Trigui discloses "in the *beamforming core* **218**, *each branch of the modem signal* is *multiplied by a complex-valued number* such that *when applied to the antenna array*, along with the other branches of the modem signal, a *specified radiation pattern is formed*" wherein "*transmit and receive beamforming weights for each modem are the same*" (emphasis added, see, for example, Ex. 1004 at [0052, 55]).

112. Trigui also explains that "An exemplary implementation of a *2×N MIMO DIAA*, essentially including *multiples of the hardware of FIG. 2A*" is "illustrated FIG. 6" while "exemplary implementations of *4×N MIMO DIAAs*, essentially including *multiples of the hardware of FIG. 2A*" are "illustrated by FIGS. 7-11" (emphasis added, see, for example, Ex. 1004 at [0036]).

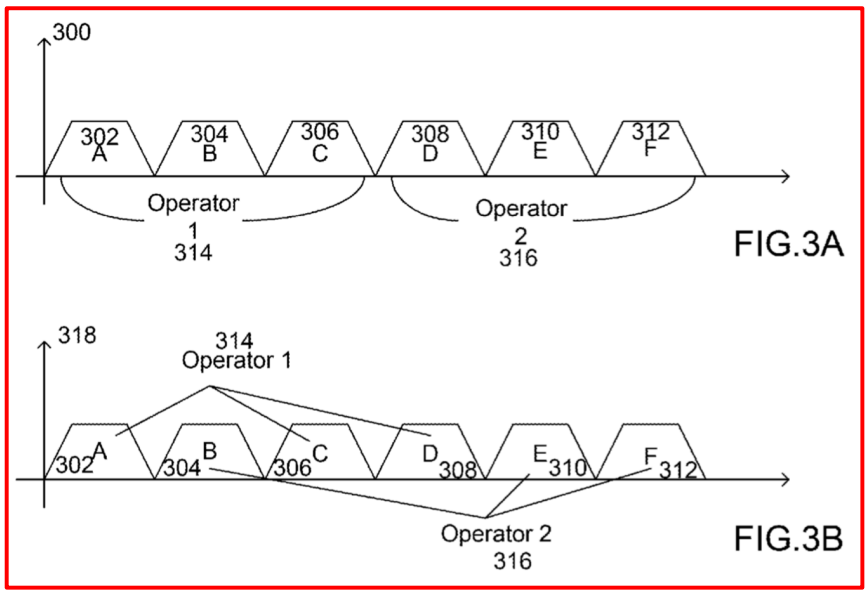
113. Additionally, Trigui explains that "In discussing a *2×N or a 4×N system DIAA*, it should be noted that *N is the number of transceivers at the subscriber station*" (emphasis added, see, for example, Ex. 1004 at [0036]).

114. For example, Trigui explains that the depicted "*antenna arrays*" consist of "*sub-arrays where the antenna elements* of each sub-array are *combined passively* to achieve a *predefined pattern*" and accordingly, "the *antenna array elements* are *closely spaced to avoid grating lobes* when *steering a beam* off boresight direction" (emphasis added, see, for example, Ex. 1004 at [0050]). Note also that as filed claims 1 and 2 of Trigui recite "one or more *antenna modules*" each including "columns or *groups of passive antenna elements*" (emphasis added, see, for example, Ex. 1004 at Claims 1-2).

115. As noted above, Trigui is directed to "enabling *multiple operator sharing* of a *passive antenna array, transceivers, and the total available power* of the DIAA" wherein "*splitting resources between the multiple operators is flexible* and should be done on the basis of the *individual operator needs*" (emphasis added, see, for example, Ex. 1004 at [0048]).

116. Accordingly, Trigui states that "FIG. 3A and FIG. 3B illustrate two exemplary *frequency allocations in a two operator system*", or more specifically, "In FIG. 3A, a *frequency allocation* **300** for Operator **1 314** and Operator **2 316** are *shown*" wherein Operator **1** *broadcasts subsector signals* A **302**, B **304**, and C **306**, and Operator 2 *broadcasts subsector signals* D **308**, E **310**, and F **312**" while "FIG. 3B illustrates a *second possible frequency allocation* **318** in which Operator **1 314** *broadcasts subsector signals* A **302**, C **306**, and D **308**, and Operator **2 316** *broadcasts subsector signals* B **306**, E **310**, and F **312**" and both "FIG. 3A and FIG. 3B illustrate Operator **1 314** and Operator **2 316** *broadcasting subsector signals in MIMO mode*" and that "Operator **1 314** and Operator **2 316** could *operate different radio access technologies*

(RAT)" (emphasis added, see, for example, Ex. 1004 at [0060], FIG. 3A and FIG. 3B as reproduced below).



117. Moreover, Trigui also states that "FIG. 4A and FIG. 4B illustrate possible *beam patterns* **400 402** of the broadcast *subsector signals* of Operator **1 314** and Operator **2 316**, respectively, based on the *frequency allocation* **300** of FIG. 3A" and notes that "While shown as *separate beam patterns*, it should be noted that beam patterns **400** and **402** are able to *propagate over the same region and overlap each other*, therefore *enabling sharing of a passive antenna, transceivers, and the total power of the DIAA*" (emphasis added, see, for example, Ex. 1004 at [0062], FIG. 4A and FIG. 4B as reproduced below).

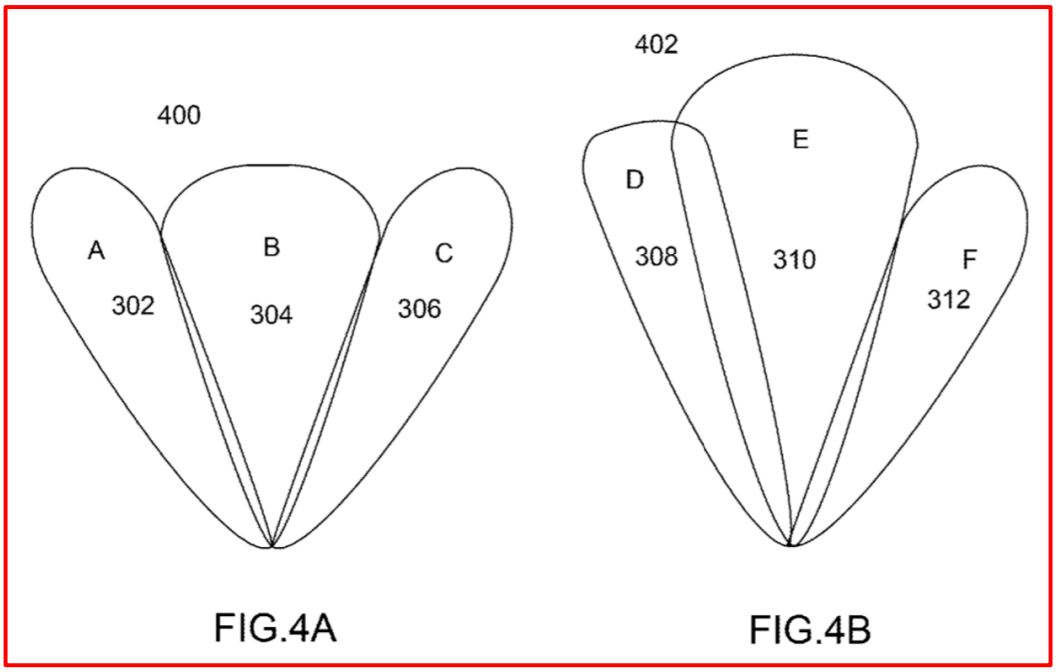


FIG.4A FIG.4B

118. Additionally, Trigui concludes that "the *DIAA is capable of creating customized coverage areas* per *RF carrier* and to *allocate them to operators* according to the *operators' frequency spectrum*" and to decide "*whether the coverage will support MIMO*" (emphasis added, see, for example, Ex. 1004 at [0070]).

119. Trigui also notes that "the *DIAA is designed to comply with* mobile *WiMAX (IEEE802.16e), UMTS, and LTE base stations* supporting space time transmit diversity ("STTD") and *spatial multiplexing* ("SM")" (emphasis added, see, for example, Ex. 1004 at [0074]).

120. Trigui explains that "The *flexibility of the DIAA is illustrated in FIGS. 6-11* as alternate *embodiments of the DIAA as partially shown* in FIG. 2A" wherein "*Identical components* to those *described above with respect to FIG. 2 will not be described*" (emphasis added, see, for example, Ex. 1004 at [0080]).

121. For example, Trigui states that "FIG. 6 illustrates a *2×N MIMO DIAA system*" and explains that "The primary difference between the DIAA of FIG. 6 and that of the other

illustrated embodiments is that FIG. 6 *illustrates two MIMO branches* configured to provide a *2×N MIMO DIAA system*" wherein "*each antenna sub-array* of FIG. 6 may *provide a specified polarization* as required by an application" (emphasis added, see, for example, Ex. 1004 at [0081], FIG. 6 as reproduced below).

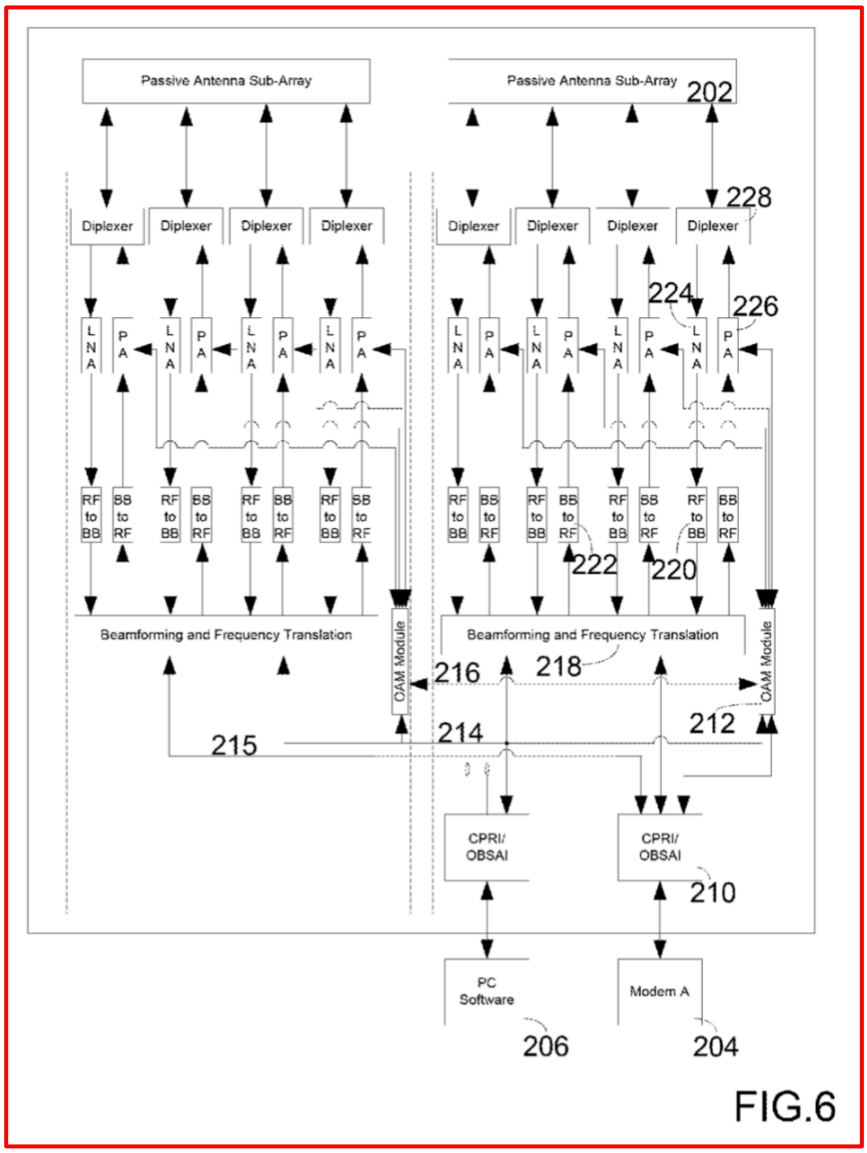


FIG.6

122. For example, Trigui states that "FIG. 7 illustrates a *4×N MIMO DIAA system*" and explains that "The primary difference between the DIAA of FIG. 7 and that of the other illustrated embodiments is that FIG. 7 *illustrates a 4×N MIMO DIAA system implemented as two*

independent 2×N MIMO DIAAs such that communication between the *two 2×N MIMO DIAAs* is not necessary" wherein "the two DIAAs may *use two different passive antenna sub-arrays*" (emphasis added, see, for example, Ex. 1004 at [0082], FIG. 7 as reproduced below).

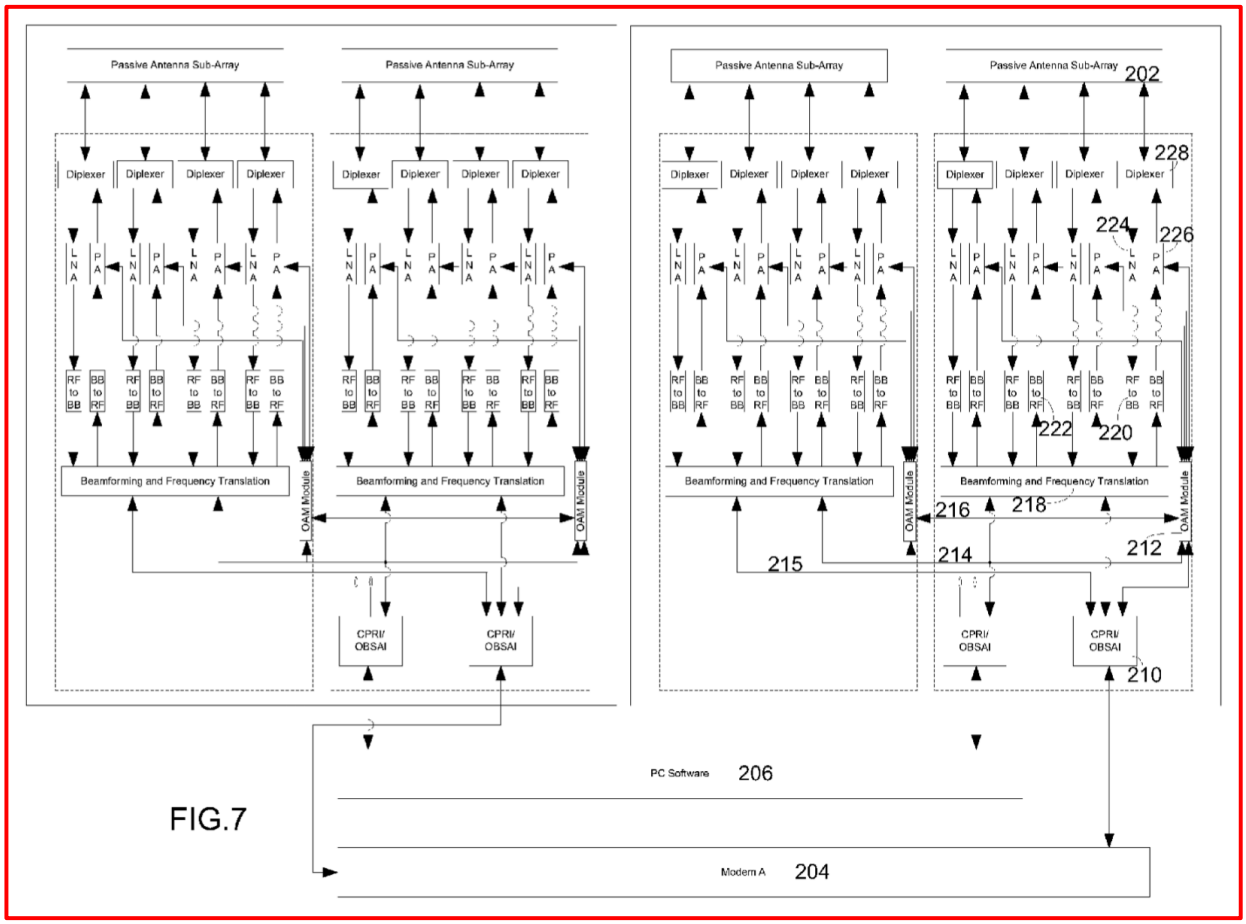


FIG.7

123. For example, Trigui states that "FIG. 8 illustrates a *4×N MIMO DIAA system*" and explains that "The primary difference between the DIAA of FIG. 8 and that of the other illustrated embodiments is that FIG. 8 illustrates a *4×N MIMO DIAA system in which communication between two 2×N MIMO DIAAs is established to pass necessary digital signals as well as control signals* used to operate the *4×N MIMO DIAA system*" (emphasis added, see, for example, Ex. 1004 at [0083], FIG. 8 as reproduced below).

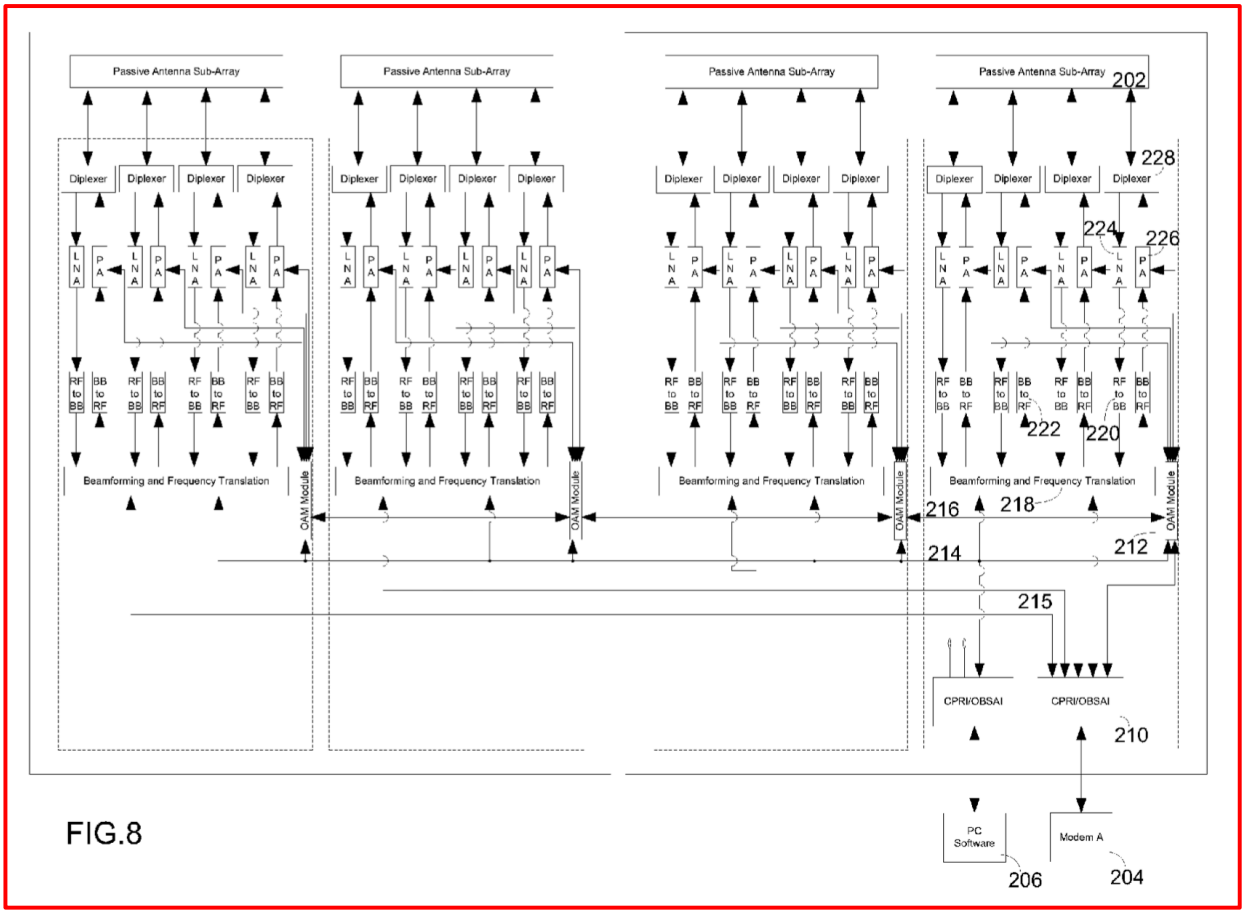


FIG.8

124. For example, Trigui states that "FIG. 9 illustrates a *4×N MIMO DIAA system*" and explains that "The primary difference between the DIAA of FIG. 9 and that of the other illustrated embodiments is that FIG. 9 illustrates a *4×N MIMO DIAA system in a single physical package*" (emphasis added, see, for example, Ex. 1004 at [0084], FIG. 9 as reproduced below).

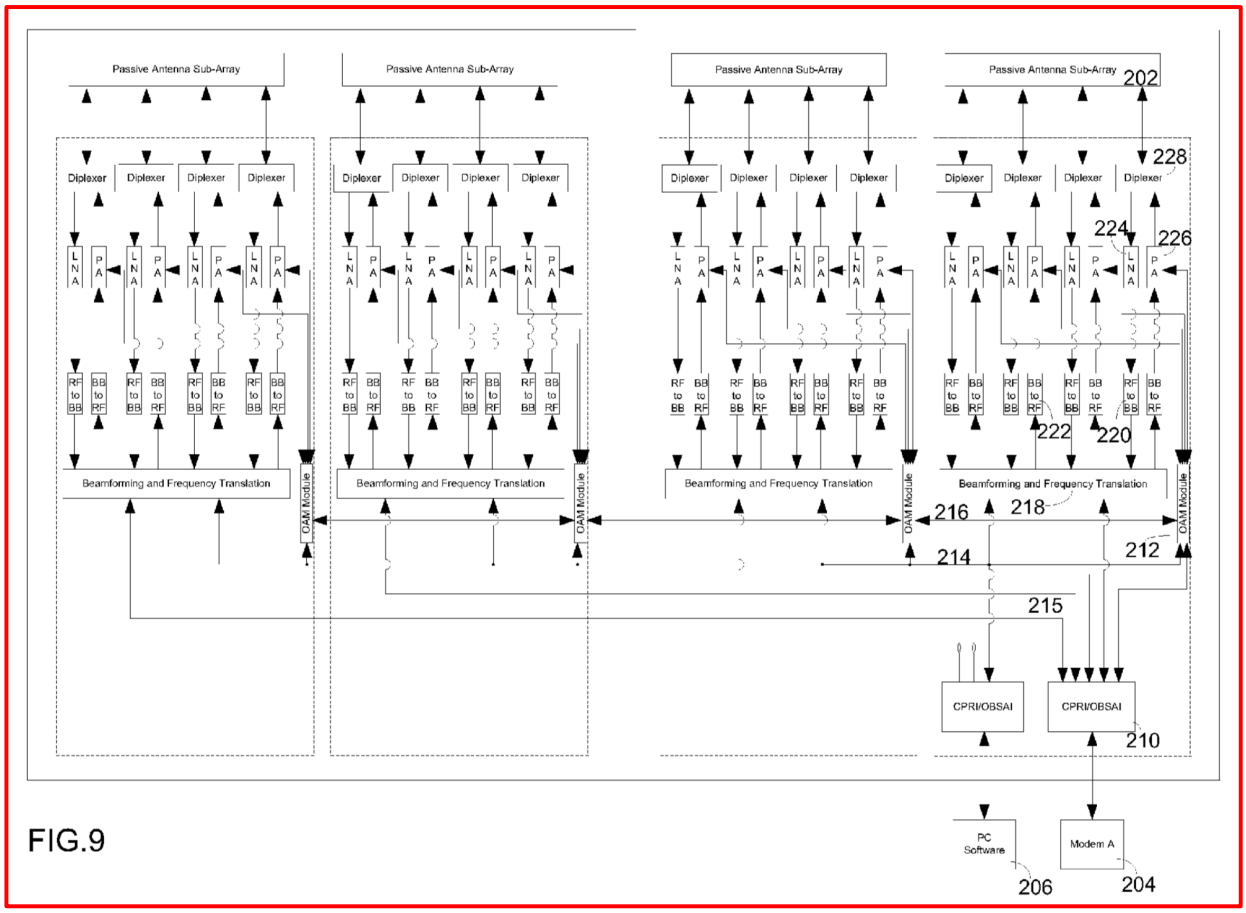


FIG.9

125. More specifically, in reference to FIG. 9 shown above, Trigui teaches that "the *main design change* over the *4×N MIMO DIAA of FIG. 8* is the *implementation of the passive antenna sub-arrays*" wherein "One possible way to alter the configuration is to *migrate from a dual-poles antenna array to two dual-poles side by side as a means of providing four branches required by 4×N MIMO operation*" but "Alternatively, it would be *obvious to one of ordinary skill in the art* that there are *other possibilities to alter the configurations*, for example, having *four sub-arrays side by side but with alternate polarization*" (emphasis added, see, for example, Ex. 1004 at [0084]).

126. For example, Trigui states that "FIG. 10 illustrates a *4×N MIMO DIAA system*" and explains that "The primary difference between the DIAA of FIG. 10 and that of the other

illustrated embodiments is that FIG. 10 illustrates *each MIMO branch having an OBSAI/CPRI core*" (emphasis added, see, for example, Ex. 1004 at [0085], FIG. 10 as reproduced below).

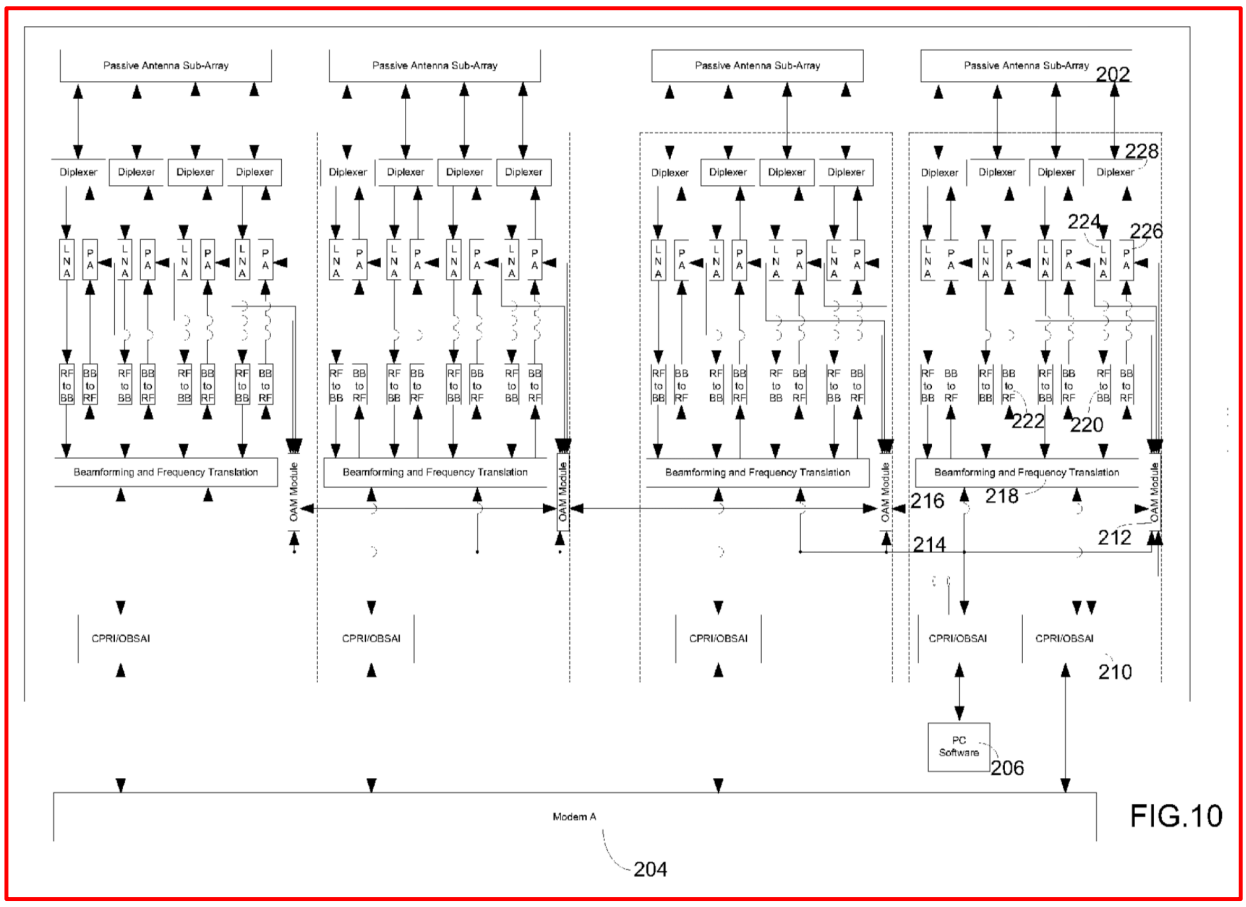


FIG.10

127. Similarly, Trigui describes another "*4×N MIMO DIAA system*" by FIG. 11 wherein relative to FIG. 10 there is "*an OBSAI/CPRI core per two MIMO branches*" (emphasis added, see, for example, Ex. 1004 at [0086]).

B. Rudrapatna (Ex. 1005)

128. For example, amongst the numerous prior art references in this field, U.S. Patent No. 6,801,790 by A. Rudrapatna, entitled "Structure for multiple antenna configurations" ("Rudrapatna") was filed on Jan. 17, 2001 and issued on Oct. 5, 2004 (see, for example, Ex. 1005 at [22], [45]). Thus, I understand that Rudrapatna qualifies as prior art to the '511 Patent at least under 35 U.S.C. §§ 102(b) and 102(e).

129. I note that U.S. Patent Publication No. 2002/0132600 by A. Rudrapatna, entitled "Structure for multiple antenna configurations" (Ex. 1007 herein) was also cited by the PTO during examination of the '511 Patent (see, for example, ¶¶ 68-74 above). Based upon my inspection, Rudrapatna (as in U.S. Patent No. 6,801,790 or Ex. 1005 herein) is substantially similar to U.S. Patent Publication No. 2002/0132600 subject to format change, formal drawings for the figures and typographical corrections.

130. Rudrapatna "generally relates to a *multiple antenna system* that can operate in either *multiple input multiple output (MIMO) mode*, a *beam forming/steering mode* or a *diversity mode*" (emphasis added, see, for example, Ex. 1005 at 1:7-10).

131. In the "**Description of the Related Art**" section, Rudrapatna observes that "wireless communication systems use *antennas* to convey (i.e., *transmit and receive*) communication *signals*" wherein a "*plurality of antennas*, commonly referred to as an *antenna array*, is often used to *increase* the amount of information (e.g., *information transfer rate or throughput*) that is being conveyed or to *improve the quality of a signal* being transmitted (or received)" by using "*spatial diversity*" (emphasis added, see, for example, Ex. 1005 at 1:12-24).

132. More specifically, Rudrapatna observes that "A *signal transmitted* with a *spatially diverse* structure will have the signal *taking different paths to its ultimate destination*" but "To

further *improve the quality of a transmitted spatially diverse signal*, the transmitted diverse signal can also be processed by a *beam forming/steering* device" which "controls the *relative phase of the signal being transmitted by each antenna* in order to *form a focused beam in a particular direction* in space" (emphasis added, see, for example, Ex. 1005 at 1:27-40).

133. Additionally, Rudrapatna observes that "Another technique used with *antenna arrays* is called *multiple input multiple output (MIMO)*" which uses "an antenna array coupled to a signal processing device (including transmission and reception circuitry) to *simultaneously transmit and/or receive multiple distinct signals*" (emphasis added, see, for example, Ex. 1005 at 1:51-57).

134. Moreover, Rudrapatna observes that "for *voice signals* where the quality of the voice signal being transmitted and the capacity (i.e., number of voice users supported) are crucially important, it is typically *advantageous to use beam forming/steering*" while "In other situations in which *data signals* (i.e., text, graphics, Internet data) are being transmitted, the issue of information throughput is often paramount compared with other factors thus making *usage of MIMO techniques desirable in such circumstances*" (emphasis added, see, for example, Ex. 1005 at 2:22-30). Rudrapatna further observes that "*Signal correlation* is a phenomenon whereby the *variations in the parameters* (i.e., amplitude and phase) of a *first signal* of a first antenna *track the variations in the parameters of a second signal* of a second antenna in the vicinity of the first antenna" such that "In general, *as the spacing between antennas increases*, the *correlation between signals being transmitted (or received) by the antennas decreases*" or "Conversely, as the *spacing between antennas decreases*, the *correlation between signals being transmitted (or received) by the antennas increases*" (emphasis added, see, for example, Ex. 1005 at 2:36-45).

135. Accordingly, Rudrapatna is specifically directed to "an *antenna array*, which *simultaneously performs beam forming/steering, MIMO, diversity operations or any combination thereof*" (emphasis added, see, for example, Ex. 1005 at 3:20-22).

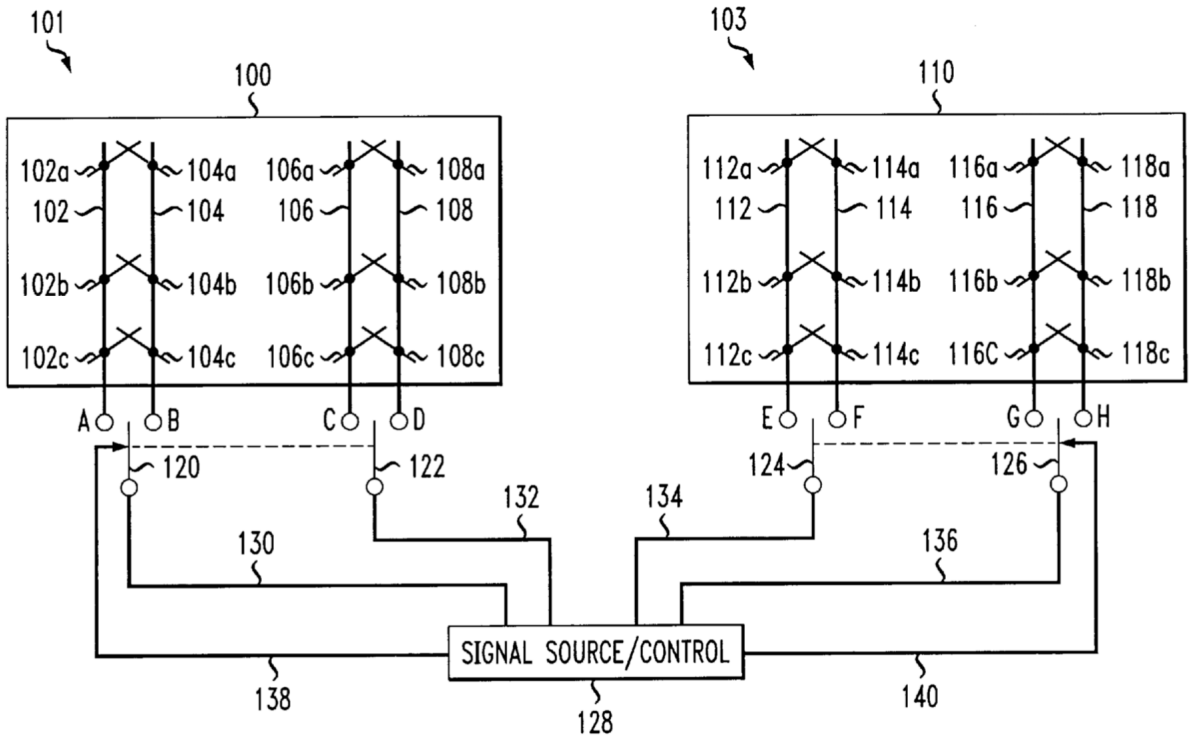
136. Therefore, in my opinion, a POSITA would understand even before considering the detailed disclosure of Rudrapatna to follow that Rudrapatna is from the same field of endeavor as the '511 Patent and that Rudrapatna is reasonably pertinent to the problem faced by the '511 Patent (see, for example, ¶¶ 40-43 above regarding the '511 Patent in comparison with the above-summarized Description of the Related Art of Rudrapatna). Accordingly, Rudrapatna is analogous art to the '511 Patent.

137. In the "**Detailed Description**" section, Rudrapatna describes "an *antenna array comprising at least two antenna groups* where *each group comprises at least two pairs of antennas*" and "*Each pair* of antennas within a group is *orthogonally polarized with respect to each other*" while "*One antenna* from at least one of the pairs in the group *is similarly polarized to one antenna from at least one other pair* in the group" and "A *first group of antennas* is *positioned* with *respect to a second group* of antennas such that there is *relatively low correlation or no correlation* between signals to be transmitted (or being received) by any one of the *antennas from different groups*" (emphasis added, see, for example, Ex. 1005 at 4:5-18).

138. According to Rudrapatna, "FIG. 1 shows *two groups of antennas* where *each group* contains *two pairs of antennas*" wherein "The *first group* (**101**) comprises a *first pair* of antennas (antennas **102** and **104**) and a *second pair* of antennas (antennas **106** and **108**)", wherein such "*first group of antennas* is enclosed within an *enclosure* **100** called a *radome*", and "*each antenna has a multiple of antenna elements*" such as "antenna **102** is shown to have *three antenna elements*, viz., antenna elements **102a**, **102b** and **102c**" but "The present invention is *not*

limited to any particular number of antenna elements contained in each antenna" (emphasis added, see, for example, Ex. 1005 at 4:50-52, 4:63-5:3, 5:23-24, FIG. 1 as reproduced below).

FIG. 1



139. Rudrapatna explains in reference to FIG. 1 shown above that "*Each antenna pair in each group* has *orthogonally polarized antennas*" because "It is *well known* that *signals transmitted* into a multipath environment *from orthogonally polarized antennas* (*regardless* of the respective *distances between the orthogonally polarized antennas*) are *uncorrelated to each other*" (emphasis added, see, for example, Ex. 1005 at 5:8-17).

140. Rudrapatna teaches that "The *antenna array of the present invention* is further configured such that *similarly polarized antennas within a group are positioned with respect to each other* such that they are able to *transmit (or receive) signals* which are relatively *highly*

correlated to allow for beam forming/steering operations" (emphasis added, see, for example, Ex. 1005 at 5:25-30).

141. More specifically, Rudrapatna teaches that "Preferably, the *distance separating similarly polarized antennas* is $\frac{\lambda}{2}$ or less" where "λ" is "the *corresponding wavelength of the signal* to be transmitted (or being received) by the antenna" (emphasis added, see, for example, Ex. 1005 at 4:30-41, 5:35-42).

142. In further reference to FIG. 1 shown above, Rudrapatna teaches that "The *first group of antennas* has *switches* **120** and **122** positioned to *select either antennas in each of the antenna pairs*" such as when "a signal on path **138** causes *switch* **120** to be *set to position A or B* and *switch* **122** to be *set to position C or D*", and wherein such "*switches are operated* either *electronically, electrically or electromechanically* through means *well known to those skilled in the art*" (emphasis added, see, for example, Ex. 1005 at 5:62-6:4).

143. For example, Rudrapatna teaches that "when *switch* **120** is *set to position A* and *switch* **122** is *set to position C*, the *first group can perform beam forming/steering* between signals on paths **130** and **132** since *both signals are similarly polarized* (both horizontally polarized) by antennas **102** and **106** respectively" while "when *switch* **120** is *set to position A* and *switch* **122** is *set to position D* antennas **102** and **108** are selected and are activated by signals on paths **130** and **132** respectively" wherein such "*signals can be distinct signals* that are to be *transmitted* or are being *received using* a BLAST code reuse technique or *any other MIMO technique*" (emphasis added, see, for example, Ex. 1005 at 7:31-36, 7:46-52).

144. Rudrapatna further explains in reference to FIG. 1 shown above that "the *second of group* (**103**) of *antennas*" comprises "*orthogonally polarized antenna pairs* **112**, **114** and **116**,**118** *each of which comprises three antenna elements* (i.e., **122a-c**, **114a-c**, **116a-c** and **118a-**

c)" and "*All* of the *antennas* in the *second group* are *located within radome* **110**" (emphasis added, see, for example, Ex. 1005 at 7:65-8:2).

145. Rudrapatna teaches that "The *second group* (**103**) is *positioned with respect to the first group* such *signals from any antenna in the second group is uncorrelated with any signals from any antenna in the first group*" such that "*both groups can perform MIMO operations or beam forming/steering operations*" (emphasis added, see, for example, Ex. 1005 at 8:3-6, 8:12-15).

146. More specifically, Rudrapatna teaches that "Accordingly, the *second group of antennas is preferably located a distance of at least* 10λ *from the first group*" such that "*any antenna in the first group* is positioned at a *distance of at least* 10λ f*rom any antenna in the second group*" although "*other distances* (e.g., 5λ, 6λ, 15λ) may be used to *achieve de-correlation between signals from the different groups* based on propagation environment" (emphasis added, see, for example, Ex. 1005 at 8:6-10, 8:17-20).

147. Additionally, Rudrapatna explains that "*Antenna group* **103** operates in the *same manner as antenna group* **101**" such that "when the *second group operates in a MIMO mode* (or diversity), *switch* **124** is *set to position E* while *switch* **126** is *set to position H*" or alternatively "*switch* **124** is *set to position F* while *switch* **126** is *set to position G*" (emphasis added, see, for example, Ex. 1005 at 8:24-30).

148. Finally, Rudrapatna observes with reference to FIG. 1 shown above that "It will be readily understood that *not all of the antennas from all the groups of the antenna array have to be activated*" because "*Beam forming/steering*, diversity *and/or MIMO operations can be performed* in an array where *some antennas in certain groups are not activated* or where *all*

antennas in certain groups are not activated" (emphasis added, see, for example, Ex. 1005 at 8:43-48).

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C. Molisch (Ex. 1006)

149. For example, amongst the numerous prior art references in this field, *Wireless Communications*, Second Edition, by A. Molisch, ISBN: 978-0-470-74187-0, John Wiley & Sons, Ltd., Publication, and IEEE ("Molisch") was "First edition published 2005" and "This edition first published 2011" (see, for example, Ex. 1006 at pp. i-iv). Thus, I understand that Molisch qualifies as prior art to the '511 Patent at least under 35 U.S.C. §§ 102(a) and/or 102(b).

150. Molisch states that "The book is written for *advanced undergraduate and graduate students*, as well as for *practicing engineers and researchers*" such that "Readers are assumed to have an *understanding of elementary communication theory*, like *modulation/demodulation* as well as of *basic aspects of electromagnetic theory*" (emphasis added, see, for example, Ex. 1006 at p. xxv).

151. In a section entitled "**Antennas for Base Stations**", Molisch teaches that "*Array antennas* are *often used for BS antennas*" because "They result in an *antenna pattern that can be more easily shaped*" wherein "This *shaping* can *either* be done in a *predetermined* way" or "*adaptively*" (emphasis added, see, for example, Ex. 1006 at p. 175).

152. For example, Molisch teaches that "The *pattern of an antenna array* can be written as the *product of the pattern of a single element* and the *array factor*" wherein "the *array factor of a uniform linear array* is" given in Eq. 9.16 "where d_a is the *distance between the antenna elements*" and "w_n are the *complex weights of element excitations*" (emphasis added, see, for example, Ex. 1006 at p. 175, Eq. 9.16 as reproduced below).

$$M(\phi) = \sum_{n=0}^{N_r-1} w_n \exp\left[-j\cos(\phi)\, 2\pi d_a n/\lambda\right] \qquad (9.16)$$

153. Specifically, Molisch teaches that "*Distance is usually chosen* as $d_a = \lambda/2$" because "$d_a \leq \lambda/2$ is *necessary to avoid spatial aliasing* – i.e., periodicities in the antenna pattern" where "λ is the *wavelength*" (emphasis added, see, for example, Ex. 1006 at pp. 38, 175).

154. In a section entitled "**Spatial Diversity**", Molisch teaches that "*Spatial diversity* is the oldest and *simplest form of diversity*" where "*irrespective of the processing method*, *performance* is *influenced by correlation* of the signals *between the antenna elements*" and "This relationship is *different for BS antennas and MS antennas*" (where "BS" means "***Base Stations***" and "MS" means "***Mobile Stations***") (emphasis added, see, for example, Ex. 1006 at p. 252).

155. For example, Molisch explains that for "*BSs in cellular systems*" that "Interacting *Objects* (IOs) are *typically concentrated around the MS*" and thus "the *antenna spacing* required to obtain *sufficient decorrelation increases*" such that "antenna spacing *has to be on the order of 2–20 wavelengths* for angular spreads between 1º and 5º in order to *achieve decorrelation*" (emphasis added, see, for example, Ex. 1006 at pp. 252-253).

156. In a section entitled "**Multiple Input Multiple Output Systems**", Molisch teaches that "MIMO systems are systems with *Multiple Element Antennas* (MEAs) at *both* link ends" (emphasis in original, see, for example, Ex. 1006 at p. 464).

157. For example, Molisch teaches that such "*Multiple Element Antennas*" or "MEAs of a *MIMO system* can be used for *four different purposes*: (i) *beamforming*, (ii) *diversity*, (iii) *interference suppression*, and (iv) *spatial multiplexing*" wherein such "*spatial multiplexing*" in particular "allows *direct improvement of capacity* by *simultaneous transmission of multiple data streams*" (emphasis added, see, for example, Ex. 1006 at p. 465).

158. More specifically, Molisch describes the "generic system" for MIMO via a "block diagram" of "Figure 20.10" wherein "*At the TX*, the *data stream enters an encoder*, whose *outputs are forwarded* to N_t *transmit antennas*" from which "the signal is sent through the *wireless propagation channel*" according to the "h_{ij}" that represent the "*complex channel gains* (transfer functions) from the jth *transmit* to the ith *receive antenna*" resulting in "signals *received* by N_r *antenna elements*" (emphasis added, see, for example, Ex. 1006 at p. 466, Figure 20.10 as reproduced below).

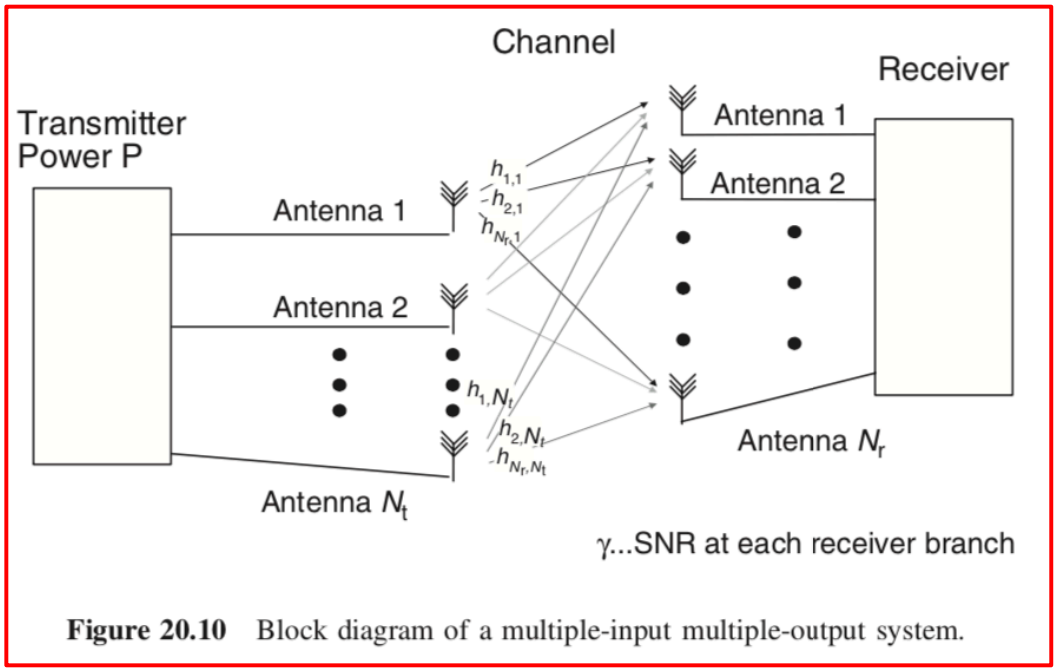


Figure 20.10 Block diagram of a multiple-input multiple-output system.

159. With respect to the MIMO system shown above, Molisch teaches that "*Correlation of the signals at different antenna elements* can *significantly reduce the capacity* of a *MIMO system*" wherein such "*Correlation* is *influenced by the angular spectrum* of the channel as well as the *arrangement and spacing of antenna elements*" (emphasis added, see, for example, Ex. 1006 at pp. 473-474).

160. For example, Molisch describes that "Figure 20.15" shows the "*capacity of a 4 × 4 MIMO system* with uniform linear arrays at the TX and RX as a *function of angular spread at*

one link end" under the assumption of "*no mutual coupling* between antenna elements" which would be "*introducing pattern diversity*" (emphasis added, see, for example, Ex. 1006 at p. 474, Figure 20.15 as reproduced below).

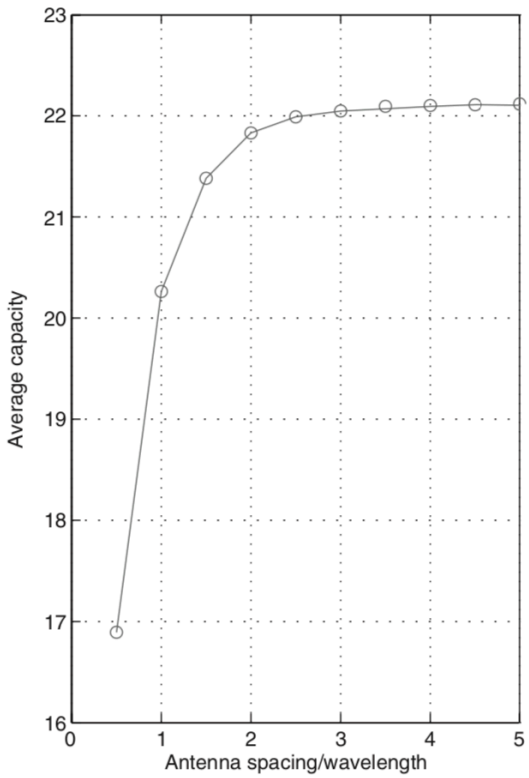


Figure 20.15 Average capacity of a 4 × 4 multiple-input-multiple-output system with a 10° root-mean-square angular spread as seen from the base station as a function of antenna spacing at the BS.

161. Additionally, Molisch teaches that "*MIMO systems* can be used to achieve *spatial multiplexing, diversity, and/or beamforming*" but "it is *not possible to attain all of those goals simultaneously at their full extent*" because "there is a *tradeoff between beamforming and diversity* gain" (emphasis added, see, for example, Ex. 1006 at p. 484).

VIII. OBVIOUSNESS OF THE '511 PATENT UNDER 35 U.S.C. § 103 DUE TO TRIGUI AND/OR RUDRAPATNA

162. In my opinion, Trigui renders obvious at least Claims 1-2, 4-6, 9-11, 13-15 and 18-20 of the '511 Patent for at least the reasons described herein.

163. In my opinion, Trigui in view of Rudrapatna renders obvious at least Claims 1-2, 4-6, 9-11, 13-15 and 18-20 of the '511 Patent for at least the reasons described herein.

164. Trigui is analogous art to the '511 Patent (see ¶ 103 above). Similarly, Rudrapatna is also analogous art to the '511 Patent (see ¶ 136 above).

165. A general overview of Trigui is given at ¶¶ 95-125 above.

166. A general overview of Rudrapatna is given at ¶¶ 128-148 above.

167. My specific analyses of Trigui in view of Rudrapatna and/or the knowledge of a POSITA, with respect to the challenged claims of the '511 Patent is given herein.

168. Note that for purposes of my analysis herein that I have provided subsection headings for claim elements in the form "1(a)", "1(b)", etc. for the convenience of the reader even though such headings do not exist in the actual '511 Patent claims themselves.

‘511 Patent: Claim 1

1. A system comprising:

a) m antenna arrays configured to receive a propagating radio frequency signal and configured to transmit a propagating radio frequency signal, each of the antenna arrays comprising:

a plurality of antenna elements; and

a beamformer configured to produce n different bi-directional beams using the plurality of antenna elements; and

b) n multiple-input multiple-output transceivers (MIMO), each MIMO transceiver comprising:

a MIMO receiver configured to process m different received signals, wherein an i-th received signal to a j-th MIMO receiver corresponds to a j-th beam of an i-th antenna array; and

a MIMO transmitter configured to process m different transmit signals, wherein a v-th transmit signal from a z-th MIMO transmitter corresponds to a z-th beam of a v-th antenna array,

c) wherein m, n, v, and z are integer number values,
wherein i=1, . . . , m, j=1, . . . , n, and v=1, . . . m,
wherein n≥2 and m≥2,
wherein z=1, . . . , w, and
wherein n≥w≥2.

1. A system comprising:

169. In my opinion, this preamble claim element expresses no limitations.

170. However, I have considered that this preamble claim element may be limiting.

171. For example, Trigui discloses exemplary embodiments of a “*4×N MIMO DIAA system*” for “*cellular base stations*” (see, for example, ¶¶ 105 and 122-127 above).

172. In my opinion, a POSITA would understand that Trigui’s disclosure of this “***MIMO DIAA system***” as summarized herein would at least constitute a “**system**”.

173. Thus, Trigui discloses a “**system**” (for example, the exemplary embodiments of a 4×N MIMO DIAA system directed to cellular base stations in Trigui).

174. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element, if any.

175. At least because Trigui renders obvious the limitations of this claim element, if any, then Trigui in view of Rudrapatna and the knowledge of a POSITA also renders obvious the limitations of this claim element, if any.

1(a) m antenna arrays configured to receive a propagating radio frequency signal and configured to transmit a propagating radio frequency signal, each of the antenna arrays comprising:

a plurality of antenna elements; and

a beamformer configured to produce n different bi-directional beams using the plurality of antenna elements;

176. A POSITA would understand that the term "**antenna array**" of this claim element is self-defined by the limitations expressed within this claim element, which is consistent with its usage in the '511 Patent specification as a "*beamforming antenna*" that "can be called an *antenna array*" and "utilizes *multiple antenna elements* and often a beamformer to *synthesize one or more beams*" (see, for example, ¶ 42 above). For example, given the "m≥2" limitation expressed in claim element 1(c) below, a POSITA would understand that the "**m antenna arrays**" of this claim element requires a showing of at least two such "**antenna arrays**".

177. A POSITA would understand that the plain, ordinary meaning of the term "**antenna element**" would include at least a structure that radiates or receives radio waves as consistent with its usage in the '511 Patent specification which recites that "the *individual elements* of an array may each be a *dipole* antenna, *monopole* antenna, *slot* antenna, slotted *waveguide* antenna, *horn* antenna, microstrip *patch* antenna or *any other antenna type*" (see, for example, ¶ 51 above).

178. A POSITA would understand that the term "**beamformer**" of this claim element is self-defined by the limitations expressed within this claim element, which is consistent with its usage in the '511 Patent specification as a structure "that provides *fixed beams* or *steerable beams*" (see, for example, ¶ 51 above).

179. A POSITA would understand that the plain, ordinary meaning of the term "**beam**" in the context of wireless communications would include at least a significant lobe of a

radiation pattern as consistent with its usage in the '511 Patent specification which recites that "*each beam* of an antenna array is designed to *provide gain in a prescribed solid angle different from the other beams*" (see, for example, ¶ 49 above). For example, given the "n≥2" limitation expressed in claim element 1(c) below, a POSITA would understand that the "**n different bi-directional beams**" of this claim element requires a showing of at least two such "**bi-directional beams**".

180. Trigui discloses in summary "a *digital integrated antenna array system* having *one or more antenna modules*, *one or more transceiver modules* each having *one or more signal processing paths for transmitting data to or receiving data* from the one or more antenna modules, and a *signal processing unit* able to *process data for each the one or more signal processing paths* of the one or more transceiver modules such that the data transmitted from the one or more transceiver modules to the one or more antenna modules is *radiated by the one or more antenna modules into one or more radiation patterns*" (see, for example, ¶ 102 above).

181. Trigui states that "FIG. 2A illustrates a general *high-level implementation of the digital integrated antenna array ("DIAA")* and represents a *single MIMO branch of a DIAA system*" (see, for example, ¶ 104 above, FIG. 2A as reproduced below).

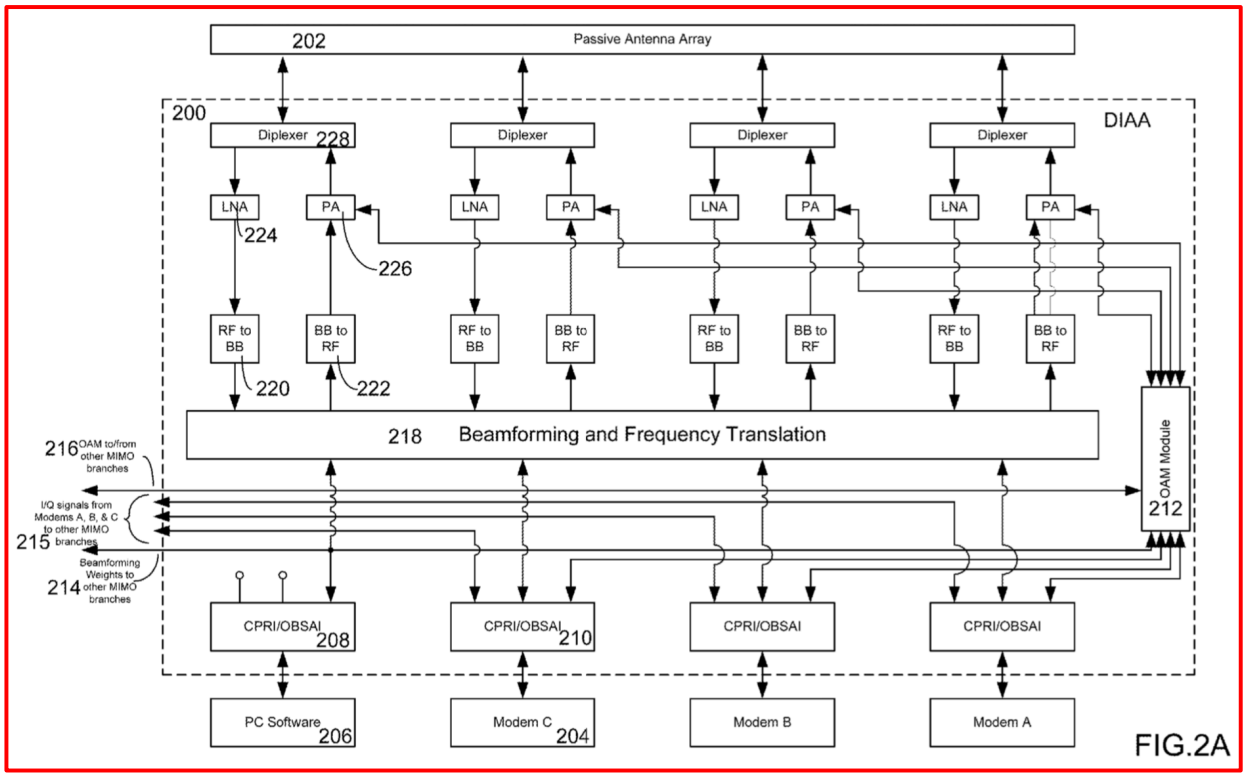


FIG.2A

182. In reference to FIG. 2A shown above, Trigui teaches that "The *server based software calculates the ideal beamforming weights* **214** that best approximate the *desired radiation pattern* and the *weights are passed to the DIAA* **200**" wherein "Each set of the modem signals, after split, is *multiplied by the beamforming and calibration weights* such that when applied to the passive antenna array **202**, a *user-specified radiation pattern is formed*; the user-specified radiation pattern may have *one or more subsector radiation patterns*" (see, for example, ¶¶ 106 and 108 above).

183. Additionally, Trigui describes that "*After processing in the beamforming* and frequency *module* **218**, each of the *modem signals along the transceiver paths* are passed though a *circuit* **220** for *converting the baseband signals to RF signals* and then passed through a *power amplifier* **226**" and then subsequently "passed through a *diplexer* **228** before being *transmitted to the passive antenna array* **202**" (see, for example, ¶ 109 above)

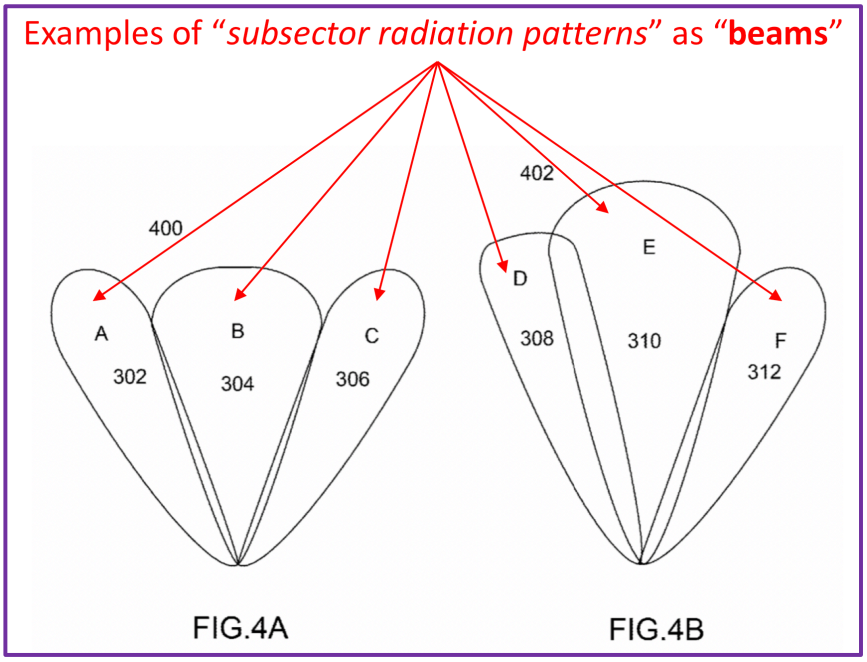
184. Similarly, Trigui describes that "In the *receive direction*, *signals from the passive antenna array* **202** are passed through the *diplexer* **228** before entering a *low-noise amplifier* **224**" and then subsequently being "*converted from RF to baseband by a circuit* **220** before being fed to the *beamforming and frequency translation module* **218** where *beamforming* and calibration *weights are applied* to the received signals to *form modem signals*" (see, for example, ¶ 110 above).

185. Also, Trigui describes the depicted "*antenna arrays*", such as those of FIG. 2A shown above, as "*sub-arrays where the antenna elements* of each sub-array are *combined passively* to achieve a *predefined pattern*" and where "the *antenna array elements* are *closely spaced to avoid grating lobes* when *steering a beam* off boresight direction" (see, for example, ¶ 114 above).

186. Accordingly, a POSITA would understand that Trigui's description of the "***digital integrated antenna array system***" such as in FIG. 2A discloses at least "**a plurality of antenna elements**" (i.e. the disclosed "***antenna elements***" or "***antenna array elements***" within the "***Passive Antenna Array* 202**" of FIG. 2A) and a "**beamformer**" (i.e. the disclosed "***beamforming***" module alone or in combination with the disclosed "***circuits***" for "***converting the baseband signals to RF signals***" when being "***transmitted***" and "***RF to baseband***" in the "***receive direction***" as well as multiples of other known front-end RF components such as "***power amplifier***", "***low-noise amplifier***" and/or "***diplexer***").

187. For example, Trigui discloses that "Operator **1** *broadcasts subsector signals* A **302**, B **304**, and C **306**, and Operator 2 *broadcasts subsector signals* D **308**, E **310**, and F **312**" wherein "FIG. 4A and FIG. 4B illustrate possible *beam patterns* **400 402** of the broadcast

subsector signals of Operator **1 314** and Operator **2 316**" (see, for example, ¶¶ 116-117 above, annotated FIGS. 4A and 4B as shown below).



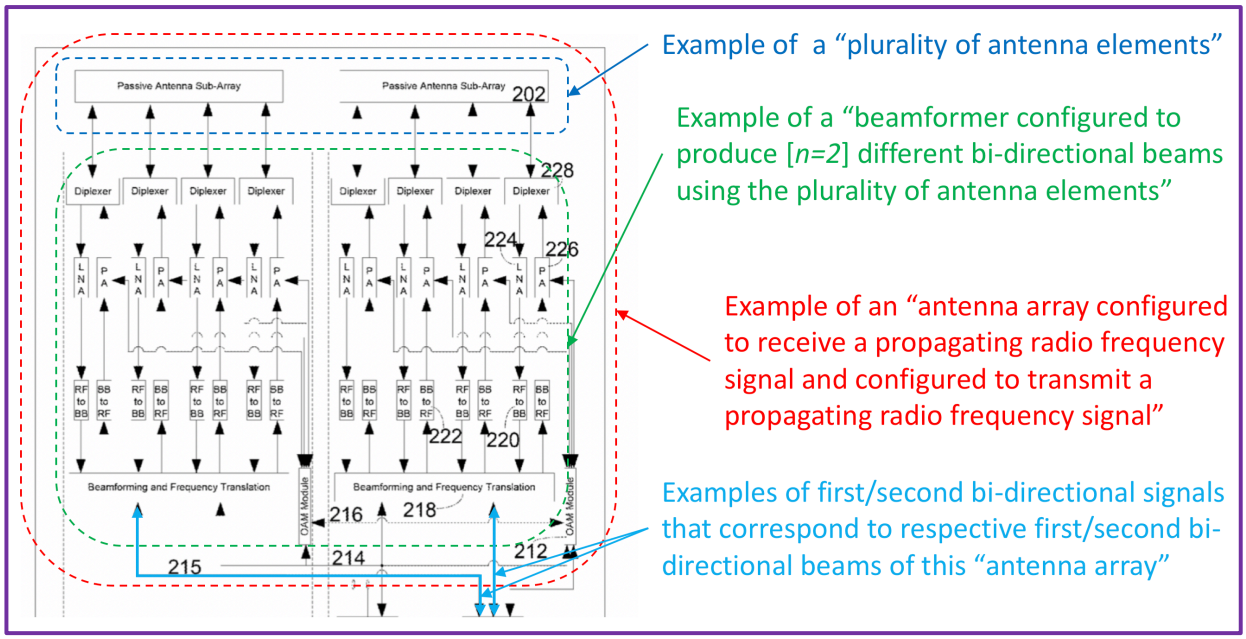
188. Thus, a POSITA would also understand Trigui's description that the "***beamforming***" module and other components listed above result in a "***user-specified radiation pattern is formed***" as "***one or more subsector radiation patterns***" both for being "***transmitted***" and for the "***receive direction***" specifically as "***subsector signals***" with corresponding "***beam patterns***" that can each "**provide gain in a prescribed solid angle different from the other**" (see ¶ 179 above) constitutes disclosure of such "**beamformer**" being "**configured to produce**" at least multiple "**different bi-directional beams using the plurality of antenna elements**".

189. Trigui discloses that "An exemplary implementation of a *2×N MIMO DIAA*, essentially including *multiples of the hardware of FIG. 2A*" is "illustrated FIG. 6" wherein "*N is the number of transceivers at the subscriber station*" and wherein "*Identical components* to those *described above with respect to FIG. 2 will not be described*" (see, for example, ¶¶ 112-113 and 120 above).

190. Trigui also notes that "the *DIAA is designed to comply with* mobile *WiMAX (IEEE802.16e), UMTS, and LTE base stations* supporting space time transmit diversity ("STTD") and *spatial multiplexing* ("SM")" such as a prior art "*2×2 MIMO system*" that includes at least "*Received digital streams along the two reception paths*" in "*the uplink*" (see, for example, ¶¶ 99 and 119 above).

191. Accordingly, a POSITA would understand for "MIMO" operation using FIG. 6 of Trigui that this describes at least the case where "$N = 2$" at least because having one or more "***subscriber stations***" comprising at least two "***transceivers***" supporting at least two "***digital streams***" for "***spatial multiplexing***" in the "***receive***" (or "***uplink***") direction was well-known in the prior art for MIMO systems such as "***WiMAX***" or "***LTE***" at the time of the alleged invention of the '511 Patent.

192. Trigui states that "FIG. 6 illustrates a *2×N MIMO DIAA system*" and explains that "The primary difference between the DIAA of FIG. 6 and that of the other illustrated embodiments is that FIG. 6 *illustrates two MIMO branches* configured to provide a *2×N MIMO DIAA system*" wherein "*each antenna sub-array* of FIG. 6 may *provide a specified polarization* as required by an application" (see, for example, ¶ 121 above, annotated FIG. 6 as shown below).



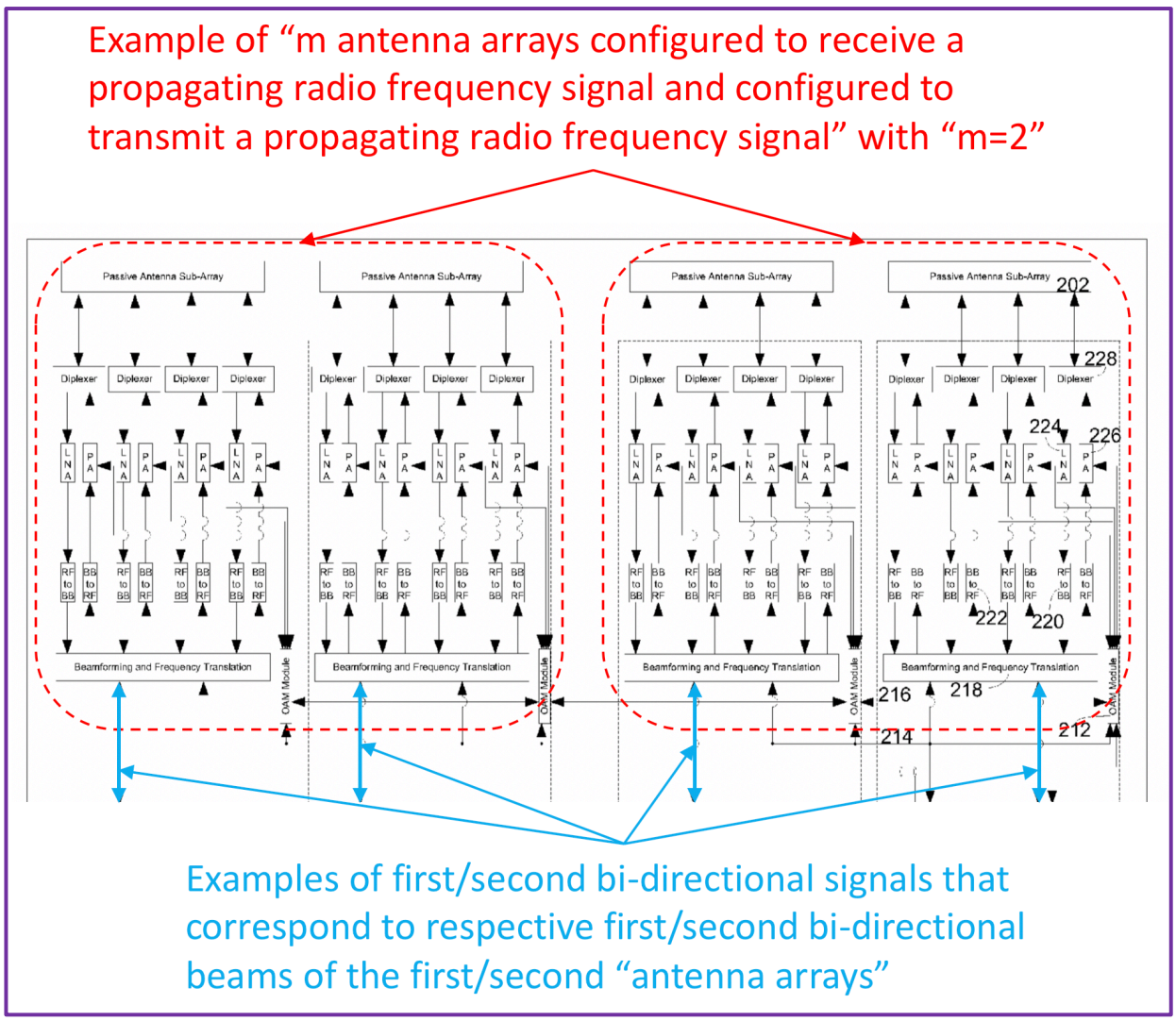
193. Accordingly, a POSITA would understand that Trigui's description of the "***2×N MIMO DIAA system***" for "$N = 2$" in FIG. 6 discloses at least an "**antenna array configured to receive a propagating radio frequency signal and configured to transmit a propagating radio frequency signal**" (i.e. the structures shown as annotated above for FIG. 6) that comprises both "**a plurality of antenna elements**" (i.e. the two instances of a "***Passive Antenna Sub-Array***" as annotated above for FIG. 6) and "**a beamformer configured to produce n different bi-directional beams using the plurality of antenna elements**" wherein "**n=2**" (i.e. the two depicted "***beamforming***" modules of FIG. 6 together or in combination with the depicted "***circuits***" for "***converting the baseband signals to RF signals***" when being "***transmitted***" and "***RF to baseband***" in the "***receive direction***" as well as multiples of other known front-end RF components such as "***power amplifier***", "***low-noise amplifier***" and/or "***diplexer***" as annotated above for FIG. 6).

194. Trigui also discloses that "exemplary implementations of *4×N MIMO DIAAs*, essentially including *multiples of the hardware of FIG. 2A*" are "illustrated by FIGS. 7-11"

wherein "*N is the number of transceivers at the subscriber station*" and wherein "*Identical components* to those *described above with respect to FIG. 2 will not be described*", and further discloses that these "*4×N MIMO DIAAs*" are "*implemented as two independent 2×N MIMO DIAAs*" (see, for example, ¶¶ 112-113, 120 and 122 above).

195. Accordingly, a POSITA would understand for "MIMO" operation using any of these "***4×N MIMO DIAAs***" depicted in FIGS. 7-11 of Trigui that this describes at least the case where "$N = 4$" at least because each of the "***two independent 2×N MIMO DIAAs***" within them includes the case where "$N = 2$" for each "***2×N***" as noted above. Additionally, a POSITA would understand that to support "MIMO" operation for each of two operators as Trigui describes extensively (see, for example, ¶¶ 96 and 115-118 above) would also require that each of the "***two independent 2×N MIMO DIAAs***" within them includes the case where "$N = 2$" for each "***2×N***".

196. For example, Trigui states that "FIG. 10 illustrates a *4×N MIMO DIAA system*" and at least in view of the description of the constituent "***two independent 2×N MIMO DIAAs***" per FIG. 6 above, a POSITA would understand that FIG. 10 depicts "**m antenna arrays**" per the limitations of this claim element wherein "**m=2**" (see, for example, ¶ 126 above, annotated FIG. 10 as shown below).



197. Accordingly, a POSITA would understand that Trigui's description of the "***4×N MIMO DIAA system***" for "$N = 4$" in FIG. 10 as a composite of "***two independent 2×N MIMO DIAAs***" each with "$N = 2$" as described above for FIG. 6 discloses at least "**m antenna arrays configured to receive a propagating radio frequency signal and configured to transmit a propagating radio frequency signal**" wherein "**m=2**" (i.e. the structures shown as annotated above for FIG. 10) wherein each such "**antenna array**" comprises both "**a plurality of antenna elements**" (i.e. the two instances of a "***Passive Antenna Sub-Array***" as annotated above for FIG. 6, and as depicted within each "**antenna array**" instance as annotated above for FIG. 10) and "**a**

beamformer configured to produce n different bi-directional beams using the plurality of antenna elements" wherein "**n=2**" (i.e. the two depicted "***beamforming***" modules of FIG. 6 together or in combination with the depicted "***circuits***" for "***converting the baseband signals to RF signals***" when being "***transmitted***" and "***RF to baseband***" in the "***receive direction***" as well as multiples of other known front-end RF components such as "***power amplifier***", "***low-noise amplifier***" and/or "***diplexer***" as annotated above for FIG. 6, and as depicted within each "**antenna array**" instance as annotated above for FIG. 10).

198. Thus, Trigui in view of the knowledge of a POSITA renders obvious "**m antenna arrays configured to receive a propagating radio frequency signal and configured to transmit a propagating radio frequency signal**" (for example, by the two independent 2×N MIMO DIAAs of the 4×N MIMO DIAA system depicted in FIGS. 7-11 of Trigui) each of the "**antenna arrays**" comprising "**a plurality of antenna elements**" (for example, the antenna elements within each of the two passive antenna sub-arrays of each of the two antenna arrays depicted in FIGS. 7-11 of Trigui) and "**a beamformer configured to produce n different bi-directional beams using the plurality of antenna elements**" (for example, the beamforming modules and/or other circuits and components that connect to modems via two bi-directional signals corresponding to two bi-directional beams within each of the two antenna arrays depicted in FIGS. 7-11 of Trigui).

199. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

200. Rudrapatna observes that "wireless communication systems use *antennas* to convey (i.e., *transmit and receive*) communication *signals*" and Rudrapatna is specifically

directed to "an *antenna array*, which *simultaneously performs beam forming/steering, MIMO, diversity operations or any combination thereof*" (see, for example, ¶¶ 131 and 135 above).

201. Rudrapatna describes "an *antenna array comprising at least two antenna groups* where *each group comprises at least two pairs of antennas*" and "*Each pair* of antennas within a group is *orthogonally polarized with respect to each other*" while "*One antenna* from at least one of the pairs in the group *is similarly polarized to one antenna from at least one other pair* in the group" and "A *first group of antennas* is *positioned* with *respect to a second group* of antennas such that there is *relatively low correlation or no correlation* between signals to be transmitted (or being received) by any one of the *antennas from different groups*" (see, for example, ¶ 137 above).

202. More specifically, Rudrapatna describes that "*each group* contains *two pairs of antennas*" or alternatively that "*each group*" comprises "a *first pair* of antennas" and "a *second pair* of antennas" wherein "*each antenna has a multiple of antenna elements*" with one example showing "*three antenna elements*" but noting that "The present invention is *not limited to any particular number of antenna elements* contained in each antenna" (see, for example, ¶ 138 above).

203. Accordingly, a POSITA would understand that each "***antenna group***" of Rudrapatna comprises a "***multiple of antenna elements***" such as "***three***" or more per each "***antenna***" within "***two pairs of antennas***" (i.e. "**a plurality of antenna elements**") and a POSITA would understand that the arrangement of such "***multiple of antenna elements***" described and depicted by FIG. 1 of Rudrapatna with a common feed would "**provide gain in a prescribed solid angle**" (see ¶ 179 above) as known in the art (see, for example, ¶¶ 141 and

152-153 above) whether arranged in the vertical (or elevation) or horizontal (or azimuthal) directions (or both), or hence would disclose to a POSITA at least a "**beam**".

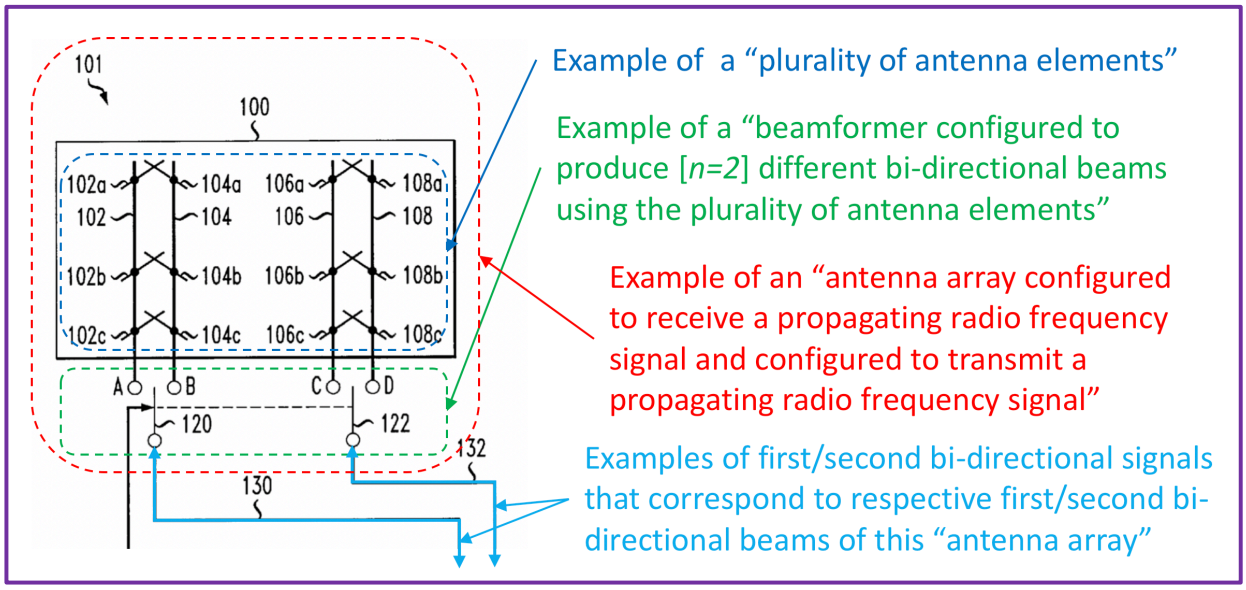
204. Moreover, a POSITA would understand that with such a "***multiple of antenna elements***" that are "***similarly polarized***" within each "***antenna***" among "***antenna groups***" that are "***positioned***" such that "***there is relatively low correlation or no correlation between signals to be transmitted (or being received) by any one of the antennas from different groups***" that these "***antennas***" would "**provide gain in a prescribed solid angle different from the other**" (see ¶ 179 above) as known in the art (see, for example, ¶¶ 141 and 152-153 above), or hence would disclose to a POSITA at least "**different bi-directional beams using the plurality of antenna elements**".

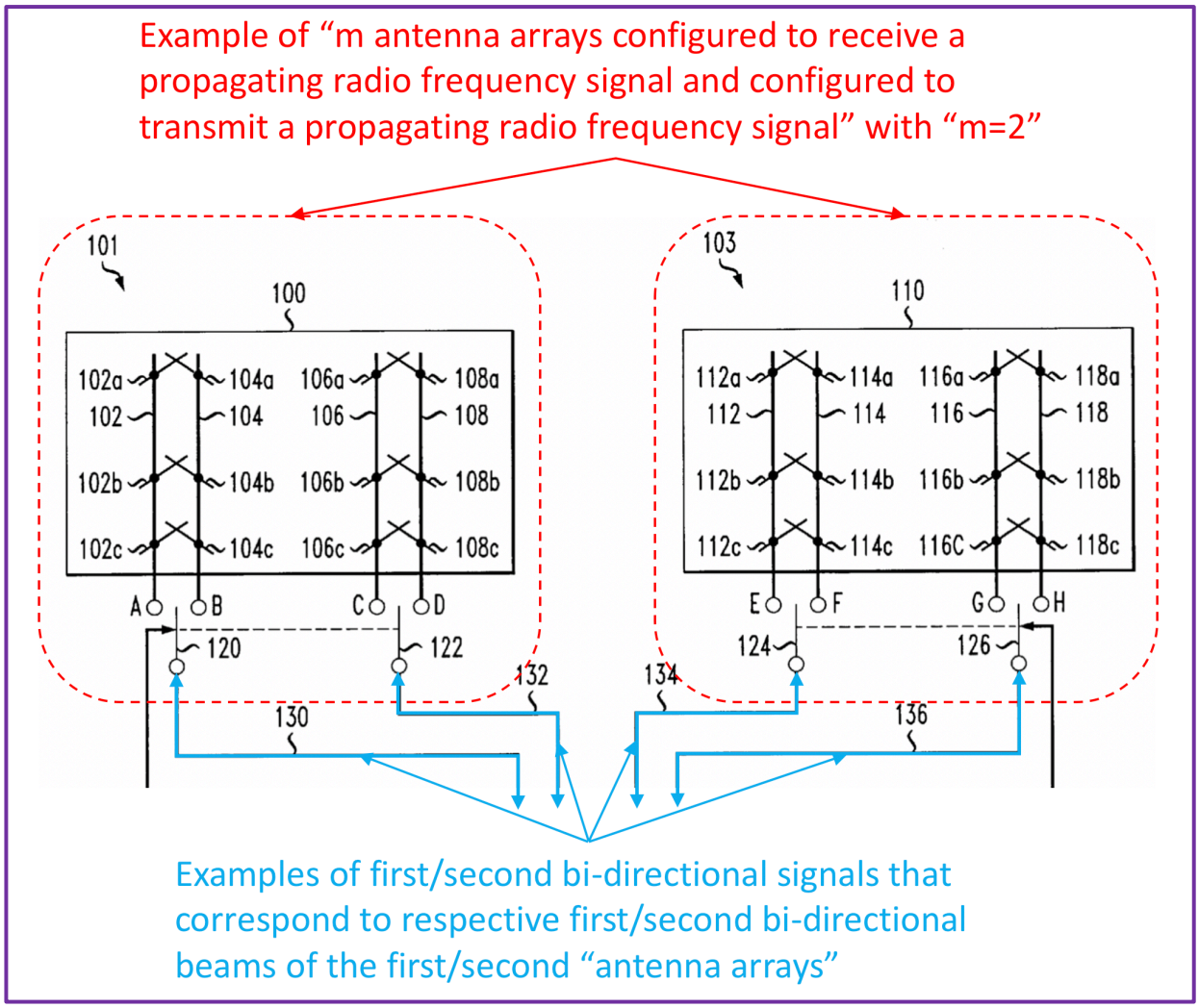
205. Additionally, Rudrapatna teaches that each "*group of antennas* has *switches*" that are "positioned to *select either antennas in each of the antenna pairs*" wherein such "*switches are operated* either *electronically, electrically or electromechanically* through means *well known to those skilled in the art*" (see, for example, ¶¶ 142-143 above).

206. Accordingly, a POSITA would understand that each such pair of "***switches***" within each "***antenna group***" of Rudrapatna that operates to "***select either antennas in each of the antenna pairs***" is an example of a "**a beamformer configured to produce n different bi-directional beams using the plurality of antenna elements**" wherein "**n=2**".

207. According to Rudrapatna, "FIG. 1 shows *two groups of antennas* where *each group* contains *two pairs of antennas*" wherein "The *first group* (**101**) comprises a *first pair* of antennas (antennas **102** and **104**) and a *second pair* of antennas (antennas **106** and **108**)" while similarly, "the *second of group* (**103**) of *antennas*" comprises "*orthogonally polarized antenna pairs* **112**, **114** and **116**,**118** *each of which comprises three antenna elements* (i.e., **122a-c**, **114a-**

c, **116a-c** and **118a-c**)" (see, for example, ¶¶ 138 and 144 above, annotated FIG. 1 as shown below in a first version depicting only the "*first group* (**101**)" and in a second version depicting both "*groups of antennas*").





208. Accordingly, a POSITA would understand that Rudrapatna's description of the "***antenna array comprising at least two antenna groups***" in FIG. 1 as described above discloses at least "**m antenna arrays configured to receive a propagating radio frequency signal and configured to transmit a propagating radio frequency signal**" wherein "**m=2**" (i.e. the structures shown as annotated above for FIG. 1) wherein each such "**antenna array**" comprises both "**a plurality of antenna elements**" (i.e. the two instances of "***two pairs of antennas***" within each "***group of antennas***" where "***each antenna***" comprises "***three antenna elements***" as annotated above for FIG. 1) and "**a beamformer configured to produce n different bi-**

directional beams using the plurality of antenna elements" wherein "**n=2**" (i.e. the two depicted "***switches***" within each "***group of antennas***" as annotated above for FIG. 1).

209. Thus, Rudrapatna in view of the knowledge of a POSITA renders obvious "**m antenna arrays configured to receive a propagating radio frequency signal and configured to transmit a propagating radio frequency signal**" (for example, by the two groups of two instances of two pairs of multi-element antennas and switches depicted in FIG. 1 of Rudrapatna) each of the "**antenna arrays**" comprising "**a plurality of antenna elements**" (for example, the antenna elements within each antenna as depicted in FIG. 1 of Rudrapatna) and "**a beamformer configured to produce n different bi-directional beams using the plurality of antenna elements**" (for example, the switches that select among two bi-directional beams within each of the two antenna groups in order to provided two bi-directional transmit/receive signals per antenna group as depicted in FIG. 1 of Rudrapatna).

210. Therefore, in my opinion, Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

211. See also ¶¶ 256-269 below regarding the combination of Trigui in view of Rudrapatna and the knowledge of a POSITA.

212. At least because either Trigui or Rudrapatna renders obvious the limitations of this claim element, then Trigui in view of Rudrapatna and the knowledge of a POSITA also renders obvious the limitations of this claim element.

1(b) n multiple-input multiple-output transceivers (MIMO), each MIMO transceiver comprising:

a MIMO receiver configured to process m different received signals, wherein an i-th received signal to a j-th MIMO receiver corresponds to a j-th beam of an i-th antenna array; and

a MIMO transmitter configured to process m different transmit signals, wherein a v-th transmit signal from a z-th MIMO transmitter corresponds to a z-th beam of a v-th antenna array,

213. A POSITA would understand that the term "**MIMO transceiver**" of this claim element is self-defined by the limitations expressed within this claim element, which is consistent with its usage in the '511 Patent specification wherein "*MIMO transceivers* may *perform digital signal processing* associated with *demodulation and decoding* as well as *modulation and encoding*" as well as "may *perform further processing* of *receive signals after demodulation* and of *transmit signals prior to modulation*" (see, for example, ¶¶ 41 and 53 above).

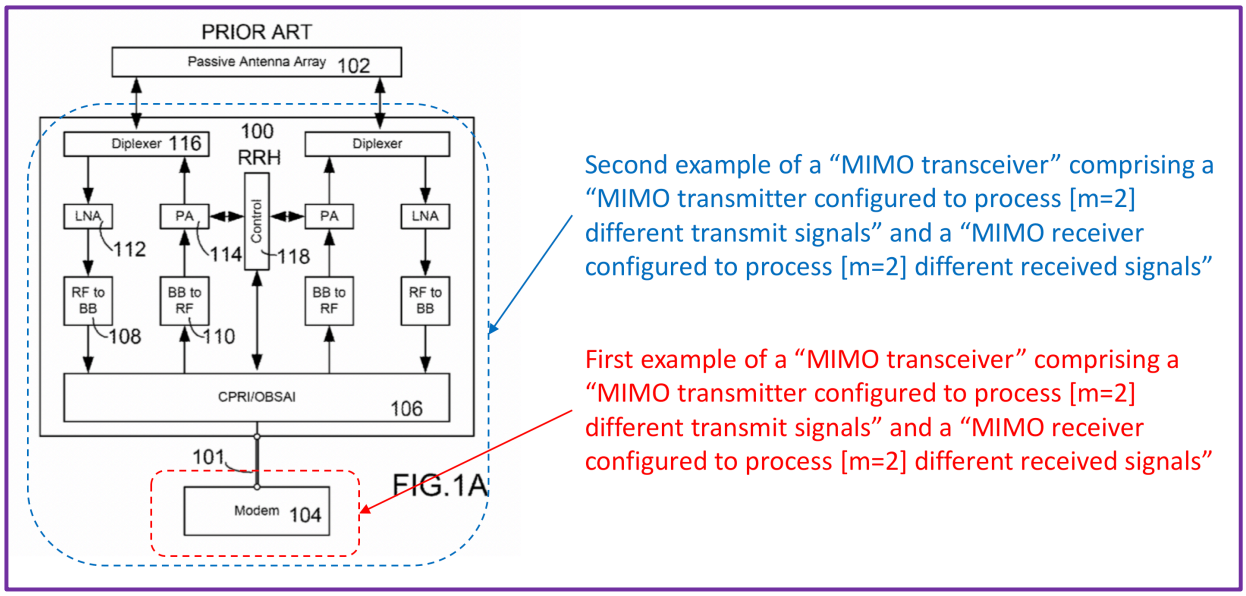
214. Additionally, I note that in the '511 Patent specification that the term "**MIMO transceiver**" is described as performing "*digital signal processing*" that is separate from that of "*Tx/Rx RF signal conditioning*" which, in contrast, "includes *signal processing functions* that may include *filtering and amplification*, and in some implementations may also include *frequency upconversion and/or downconversion*, and the like" even though the '511 Patent specification also discloses that such "*MIMO transceivers*" and "*Tx/Rx RF signal conditioning*" as "*shown separately*" in at least one embodiment "*may be combined* into a *single component or element*" in other embodiments (see, for example, ¶¶ 52 and 54 above). For example, given the "n≥2" limitation expressed in claim element 1(c) below, a POSITA would understand that the "**n multiple-input multiple-output transceivers**" of this claim element requires a showing of at least two such "**MIMO transceivers**".

215. A POSITA would understand that the terms "**MIMO receiver**" and "**MIMO transmitter**" of this claim element are self-defined by the limitations expressed within this claim element, but that otherwise a POSITA would ascribe the plain, ordinary meaning of the term "**MIMO receiver**" as the receive functionality of a "**MIMO transceiver**" and similarly "**MIMO transmitter**" as the transmit functionality of a "**MIMO transceiver**", which is consistent with exemplary usage in the '511 Patent specification wherein "*one MIMO receiver* may be capable of *handling multiple receive channels simultaneously*" (see, for example, ¶ 59 above). For example, given the "m≥2" limitation expressed in claim element 1(c) below, a POSITA would understand that the "**m different received signals**" and "**m different transmit signals**" of this claim element requires a showing that each respective "**MIMO receiver**" is "**configured to process**" at least two such respective "**different received signals**" and that each respective "**MIMO transmitter**" is "**configured to process**" at least two such respective "**different transmit signals**".

216. A POSITA would further understand that the limitations of "**an i-th received signal to a j-th MIMO receiver corresponds to a j-th beam of an i-th antenna array**" and "**a v-th transmit signal from a z-th MIMO transmitter corresponds to a z-th beam of a v-th antenna array**" are together the "***interconnection***" limitation that applicants contended to distinguish this claim from the prior art identified by the PTO during prosecution (see, for example, ¶ 75 above).

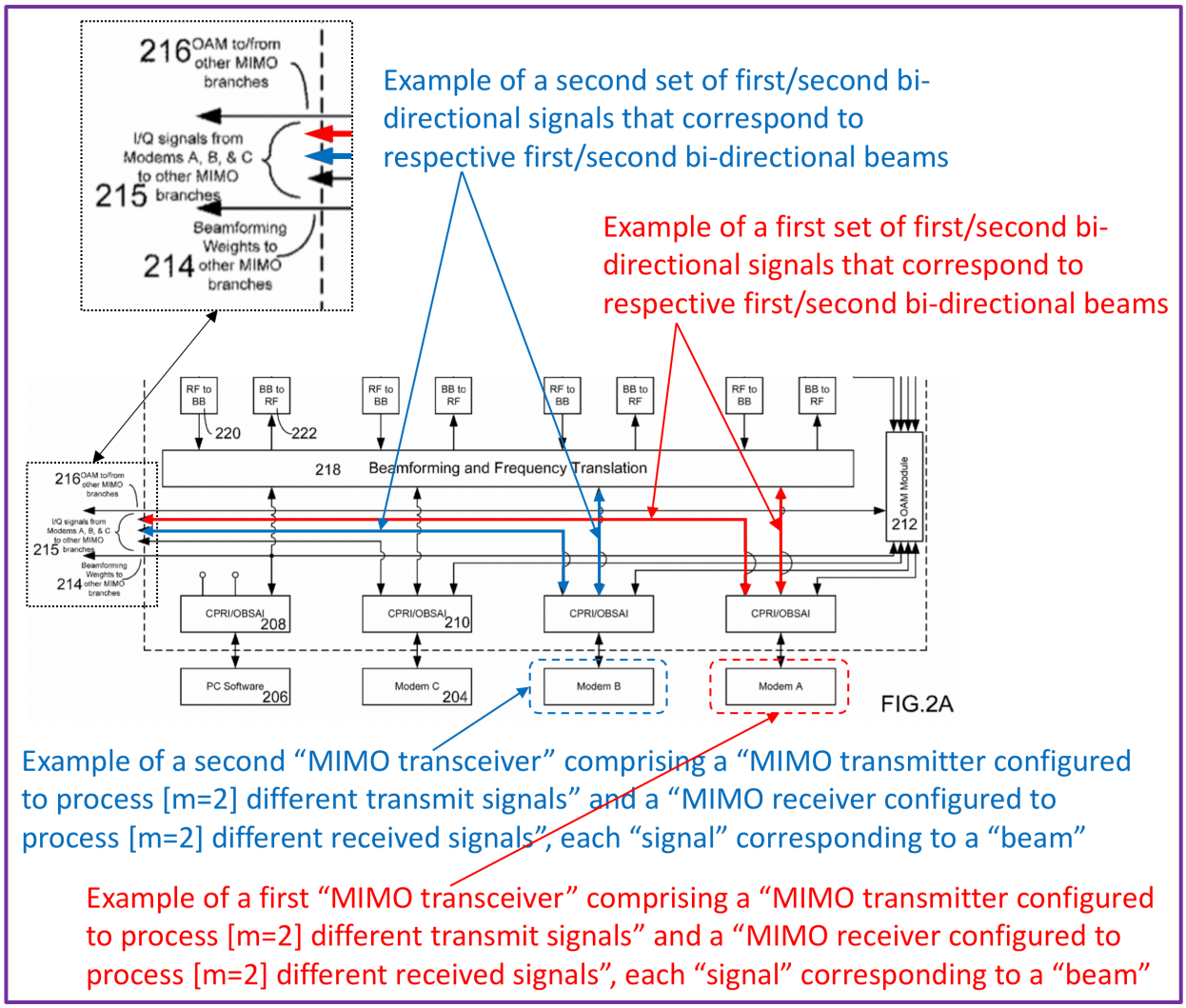
217. Trigui describes "FIG. 1A" as a "*conventional approach*" that uses "a *remote radio head* ("*RRH*")" for a "*2×2 MIMO system*" with a "*pair of transmission/reception paths*" wherein "a *single modem* **104** is *connected* via a fiber optic interface **101** *to an RRH* **100**" that "is *connected to a passive antenna array* **102** for transmitting/receiving RF signals" via "a *circuit*

110 for *converting the signals from baseband to RF*, and then passed through a *power amplifier* **114**" for "*transmit*" or via "a *low-noise amplifier* **112**" and "then passed through a *circuit* **108** for *converting RF to baseband*" for "*receive*" (see, for example, ¶ 98 above, annotated FIG. 1A as shown below).



218. Accordingly, in view of the terminology of the '511 Patent (see ¶¶ 213-215 above), a POSITA would understand that by the prior art FIG. 1A of Trigui, either a "***modem***" that processes a "***pair of transmission/reception paths***" for a "***2×2 MIMO system***" or a combination of such "***modem***", "***circuit[s]***" for "***converting the signals from baseband to RF***" and "***converting RF to baseband***" as well as other front-end components collectively discloses a "**MIMO transceiver**" comprising a "**MIMO receiver configured to process m different received signals**" and a "**MIMO transmitter configured to process m different transmit signals**" wherein "**m=2**".

219. Trigui states that "FIG. 2A illustrates a general *high-level implementation of the digital integrated antenna array ("DIAA")* and represents a *single MIMO branch of a DIAA system*" (see, for example, ¶ 104 above, annotated FIG. 2A as shown below).



220. Consistent with annotated FIG. 2A shown above, Trigui teaches that "*one or more modems* **204**, such as, for example, *baseband modules of cellular base stations*, are *connected via one or more fiber optic interfaces*, respectively, to *one or more digital interface cores* **208**, **210** within the DIAA **200**" and further that "Although FIG. 2A illustrates only a *single MIMO branch DIAA*, the present invention *contemplates the use of multiple MIMO branches*" and accordingly, "*I/Q signals* **215** *from any of the modems*, as well as the *beamforming weights* **214**, can be *sent to other MIMO branches*" (see, for example, ¶¶ 105 and 107 above). In my opinion, this disclosure from Trigui informs a POSITA specifically that each "***modem* 204**" converts data associated

with a particular "***operator***" to "***I/Q signals* 215**" and vice versa, and thus a POSITA would further understand that each "***modem* 204**" performs the "***modulation and encoding***" and "***demodulation and decoding***" functions that the '511 Patent associates with "***MIMO transceivers***" (see, for example, ¶ 213 above).

221. Accordingly, in view of FIG. 2A discussed above as well as my analysis herein for claim element 1(a), a POSITA would understand that Trigui discloses for a "***DIAA system***" that uses "***multiple MIMO branches***" that the "***one or more modems* 204**" within such a "***DIAA system***" includes a first "***modem***" (such as "***Modem A***" in annotated FIG. 2A shown above) with a first pair of bi-directional "***I/Q signals***" corresponding to a first "***pair of transmission/reception paths***" for a first "***2×2 MIMO system***" (i.e. a first "**MIMO transceiver**" comprising a "**MIMO receiver configured to process m different received signals**" and a "**MIMO transmitter configured to process m different transmit signals**" wherein "**m=2**" with each such "**signal**" corresponding to a "**beam**") and a second "***modem***" (such as "***Modem B***" in annotated FIG. 2A shown above) with a second pair of bi-directional "***I/Q signals***" corresponding to a second "***pair of transmission/reception paths***" for a second "***2×2 MIMO system***" (i.e. a second "**MIMO transceiver**" comprising a "**MIMO receiver configured to process m different received signals**" and a "**MIMO transmitter configured to process m different transmit signals**" wherein "**m=2**" with each such "**signal**" corresponding to a "**beam**").

222. Trigui is directed to "enabling *multiple operator sharing* of a *passive antenna array, transceivers, and the total available power* of the DIAA" wherein "*splitting resources between the multiple operators is flexible* and should be done on the basis of the *individual operator needs*" (see, for example, ¶ 115 above).

223. More specifically, Trigui describes a "*two operator system*" in which an "Operator **1**" "*broadcasts subsector signals*" using an "*RF carrier*" within a "*frequency allocation*" that is a different "*RF carrier*" from that of an "Operator **2**" and further wherein "Operator **1**" and "Operator **2**" use "*separate beam patterns*" that "*propagate over the same region and overlap each other*" while "*sharing*" the "*passive antenna, transceivers, and the total power of the DIAA*" (see, for example, ¶¶ 116-118 above).

224. Additionally, Trigui describes for this "*two operator system*" that both "Operator **1**" and "Operator **2**" are "*broadcasting subsector signals in MIMO mode*" even when "Operator **1**" and "Operator **2**" are configured to "*operate different radio access technologies* (RAT)" (see, for example, ¶ 116 above).

225. As noted in my analysis herein for claim element 1(a), Trigui also discloses that "exemplary implementations of *4×N MIMO DIAAs*, essentially including *multiples of the hardware of FIG. 2A*" are "illustrated by FIGS. 7-11" wherein these "*4×N MIMO DIAAs*" are "*implemented as two independent 2×N MIMO DIAAs*" (see, for example, ¶ 194 above).

226. Accordingly, a POSITA would understand that Trigui discloses for such exemplary "***4×N MIMO DIAAs***" when applied to the described "***two operator system***", including where "$N = 4$", that the "***one or more modems* 204**" within such a "***DIAA system***" would be implemented as two independent "***modems***" (i.e. as "**n multiple-input multiple-output transceivers (MIMO)**" wherein "**n=2**"), each processing a pair of bi-directional "***I/Q signals***" corresponding to a "***pair of transmission/reception paths***" for a "***2×2 MIMO system***", as shown in annotated FIG. 2A above, for at least the following reasons.

227. First, Trigui discloses that these exemplary "***4×N MIMO DIAAs***" are "***multiples of the hardware of FIG. 2A***", and as I discussed above, a POSITA would understand that the

description of such "***hardware***" for FIG. 2A discloses such two independent "***modems***", each processing a pair of bi-directional "***I/Q signals***" corresponding to a "***pair of transmission/reception paths***" for a "***2×2 MIMO system***".

228. Second, in a "***two operator system***" that is "***sharing***" the "***passive antenna, transceivers, and the total power of the DIAA***" for such exemplary "***4×N MIMO DIAAs***", a POSITA would understand that network traffic to and/or from the "***DIAA system***" for "Operator **1**" to its respective "***subscriber stations***" is unrelated to such network traffic for "Operator **2**" to its respective "***subscriber stations***", and thus common sense would suggest that each of "Operator **1**" and "Operator **2**" would have its own respective "***modem***" to process its own respective network traffic.

229. Third, in a "***two operator system***" that is "***sharing***" the "***passive antenna, transceivers, and the total power of the DIAA***" for such exemplary "***4×N MIMO DIAAs***" while both "Operator **1**" and "Operator **2**" are "***in MIMO mode***", the only possible way that two independent "***modems***" would be deployed with both "Operator **1**" and "Operator **2**" being "***in MIMO mode***" would have each "***modem***" processing its own "***pair of transmission/reception paths***". For example, if one of the two "***modems***" processed only one (or less) "***transmission/reception path***" among the four available "***transmission/reception paths***", the corresponding "***operator***" with such "***modem***" would not be "***in MIMO mode***" as disclosed.

230. Fourth, Trigui discloses further that "Operator **1**" and "Operator **2**" use different "***RF carriers***" which a POSITA would understand to provide separability for their respective "***transmission/reception paths***" without requiring a single (and more complex) "***modem***" that processes all four available "***transmission/reception paths***".

231. Fifth, Trigui discloses that "Operator **1**" and "Operator **2**" can even use "***different radio access technologies***" which a POSITA would understand to add further (and even more undesirable) complexity to any attempt to use a single "***modem***" that processes all four available "***transmission/reception paths***".

232. Sixth, Trigui discloses that such "***modems***" are implemented as "***baseband modules of cellular base stations***" and thus a POSITA would have a high expectation of success in using two simpler independent "***modems***", each processing a pair of bi-directional "***I/Q signals***" corresponding to a "***pair of transmission/reception paths***" for a "***2×2 MIMO system***".

233. As also noted in my analysis herein for claim element 1(a), Trigui discloses to a POSITA that "FIG. 6 *illustrates two MIMO branches* configured to provide a *2×N MIMO DIAA system*" wherein "*each antenna sub-array*" would "*provide a specified polarization*" (see, for example, ¶ 121 above).

234. Additionally, Trigui discloses that "having *four sub-arrays side by side but with alternate polarization*" is "One possible way" for "*a 4×N MIMO DIAA system implemented as two independent 2×N MIMO DIAAs*" but that "it would be *obvious to one of ordinary skill in the art* that there are *other possibilities to alter the configurations*" including wherein "the two DIAAs may *use two different passive antenna sub-arrays*" (see, for example, ¶¶ 122 and 125 above).

235. A POSITA would understand that for any of the exemplary "***4×N MIMO DIAAs***" as "***illustrated by FIGS. 7-11***" being "***implemented as two independent 2×N MIMO DIAAs***", or hence as comprising "**m antenna arrays configured to receive a propagating radio frequency signal and configured to transmit a propagating radio frequency signal**" wherein "**m=2**", each "**antenna array**" comprising a "**beamformer configured to produce n different bi-**

directional beams" wherein "**n=2**" as also shown in my analysis herein for claim element 1(a) (see, for example, annotated FIG. 10 at ¶ 196 above), that there would be only two possible ways to interconnect such disclosed two "***independent 2×N MIMO DIAAs***" (i.e. "**m antenna arrays**" wherein "**m=2**") with the disclosed two independent "***modems***" (i.e. as "**n multiple-input multiple-output transceivers (MIMO)**" wherein "**n=2**") for the "***two operator system***" that is "***sharing***" the "***passive antenna, transceivers, and the total power of the DIAA***".

236. In a first possible way to interconnect the two "***independent 2×N MIMO DIAAs***" with the two independent "***modems***", the respective two bi-directional signals corresponding to two bi-directional beams within each of the respective two depicted "**antenna arrays**" of annotated FIG. 10 (see, for example, ¶ 196 above) would be "direct" connected to the respective two "***transmission/reception paths***" for each respective "***modem***" (i.e. "**MIMO transceiver**") such that a first "***modem***" connects only with one "***2×N MIMO DIAA***" while the second "***modem***" connects only with the other "***2×N MIMO DIAA***".

237. In a second possible way to interconnect the two "***independent 2×N MIMO DIAAs***" with the two independent "***modems***", the respective two bi-directional signals corresponding to two bi-directional beams within each of the respective two depicted "**antenna arrays**" of annotated FIG. 10 (see, for example, ¶ 196 above) would be "cross" connected to the respective two "***transmission/reception paths***" for each respective "***modem***" (i.e. "**MIMO transceiver**") such that a first "***transmission/reception path***" of a first "***modem***" connects to one of the bi-directional signals corresponding to one of the bi-directional beams for one "***2×N MIMO DIAA***" while the second "***transmission/reception path***" of this first "***modem***" connects to one of the bi-directional signals corresponding to one of the bi-directional beams for the other "***2×N MIMO DIAA***", and similarly, a first "***transmission/reception path***" of the second

"***modem***" connects to the remaining one of the bi-directional signals corresponding to one of the bi-directional beams for one "***2×N MIMO DIAA***" while the second "***transmission/reception path***" of this second "***modem***" connects to the remaining one of the bi-directional signals corresponding to one of the bi-directional beams for the other "***2×N MIMO DIAA***".

238. In my opinion, it would have been obvious to a POSITA to adopt the second possible way (i.e. the "cross" connected approach) for at least the following reasons.

239. First, a POSITA would have known from the prior art that "*Correlation of the signals at different antenna elements* can *significantly reduce the capacity* of a *MIMO system*" wherein such "*Correlation* is *influenced by the angular spectrum* of the channel as well as the *arrangement and spacing of antenna elements*" (see, for example, ¶ 159 above).

240. Accordingly, a POSITA would have known that an interconnection approach that minimizes the "***Correlation of the signals***" among the respective two "***transmission/reception paths***" for each respective "***modem***" (i.e. "**MIMO transceiver**") in the exemplary "***4×N MIMO DIAAs***" when applied to the described "***two operator system***" of Trigui would provide best performance for the "***MIMO system***" corresponding to each "***operator***".

241. Second, a POSITA would have known from the prior art that "It is *well known* that *signals transmitted* into a multipath environment *from orthogonally polarized antennas* (*regardless* of the respective *distances between the orthogonally polarized antennas*) are *uncorrelated to each other*" (see, for example, ¶ 139 above).

242. Accordingly, a POSITA would have known that an interconnection approach that minimizes the "***Correlation of the signals***" among the respective two "***transmission/reception paths***" for each respective "***modem***" (i.e. "**MIMO transceiver**") in the exemplary "***4×N MIMO DIAAs***" when applied to the described "***two operator system***" of Trigui would at least involve

connecting one "***path***" of the respective two "***transmission/reception paths***" for each respective "***modem***" (i.e. "**MIMO transceiver**") to a "***MIMO branch***" that has an "***antenna sub-array***" of a first "***polarization***" (e.g. "***vertical***" or "***slant 45 left***") while also connecting the other "***path***" of the respective two "***transmission/reception paths***" for each respective "***modem***" (i.e. "**MIMO transceiver**") to a different "***MIMO branch***" that has an "***antenna sub-array***" of a second "***orthogonal polarization***" (e.g. "***horizontal***" or "***slant 45 right***").

243. Third, a POSITA would have known from the prior art that two "*groups of antennas*" can better "*perform MIMO operations*" with improved "*capacity*" if the "*second group*" is "*positioned with respect to the first group*" such that "*signals from any antenna in the second group is uncorrelated with any signals from any antenna in the first group*" and that "as *spacing between antennas increases*" "the *correlation between signals* being" "*received*" "by the antennas *decreases*", and thus to "*achieve de-correlation between signals from the different groups*" that the two "*groups of antennas*" are "*located a distance*" or placed at an "*antenna spacing*" that is a significant multiple of the "*wavelength*" at which the "*groups of antennas*" are operated (see, for example, ¶¶ 134, 145-146, 154-155 and 160 above).

244. Accordingly, a POSITA would have known that an interconnection approach that minimizes the "***Correlation of the signals***" among the respective two "***transmission/reception paths***" for each respective "***modem***" (i.e. "**MIMO transceiver**") in the exemplary "***4×N MIMO DIAAs***" when applied to the described "***two operator system***" of Trigui would at least involve connecting one "***path***" of the respective two "***transmission/reception paths***" for each respective "***modem***" (i.e. "**MIMO transceiver**") to a "***MIMO branch***" that has an "***antenna sub-array***" that is maximally separated from the "***MIMO branch***" and corresponding "***antenna sub-array***"

connected to the other "***path***" of the respective two "***transmission/reception paths***" for such respective "***modem***".

245. Fourth, a POSITA would have known from the prior art that for "*BSs in cellular systems*" that "Interacting *Objects* (IOs) are *typically concentrated around the MS*" and thus "the *antenna spacing* required to obtain *sufficient decorrelation increases*" such that "antenna spacing *has to be on the order of 2–20 wavelengths* for angular spreads between 1º and 5º in order to *achieve decorrelation*" (see, for example, ¶ 155 above).

246. Accordingly, a POSITA would have known that for the "***four sub-arrays side by side***" configuration as "***illustrated by FIGS. 7-11***" for the "***4×N MIMO DIAAs***" of Trigui that an interconnection approach that "direct" connected the respective two bi-directional signals corresponding to two bi-directional beams within each of the respective two depicted "**antenna arrays**" to the respective two "***transmission/reception paths***" for each respective "***modem***" would need to have an additional physical separation "***on the order of 2–20 wavelengths***" for each pair of "***sub-arrays***" in the "***four sub-arrays side by side***" configuration.

247. Thus, at a 700 MHz "***RF carrier***" as known to be commonly used in the USA for "***3rd Generation Partnership Project Long Term Evolution (3GPP LTE)***" operation at the time of the alleged invention of the '511 Patent (see, for example, ¶¶ 97 and 119 above, and also Ex. 1010 reciting that "the *700 MHz band* that both *Verizon and AT&T* plan to use has *enormously better range and penetration of buildings* than the same power of signal at 2.5 GHz" such that "700MHz will *require as few as one-quarter as many base stations to offer identical coverage* to 2.5 GHz"), which a POSITA would have known to have a corresponding wavelength of approximately 17 inches, this "direct" connected for the "***four sub-arrays side by side***" configuration would add an additional width to the overall physical size of the "***base station***" of

at least 2 feet (and possibly more) compared to the "cross" connected approach where separation between spatially diverse antennas for the respective two "***transmission/reception paths***" for such respective "***modem***" would be largely achieved from the width of the intervening "***sub-array***".

248. A POSITA would understand that such additional width to the overall physical size of the "***base station***" for the "direct" connected approach versus the "cross" connected approach would be highly undesirable from at least an economic consideration, a practical mounting consideration on cell station towers, and a reliability consideration for wind loading (see, for example, Ex. 1011 at p. 3 illustrating the effects of the size of base station antennas to the wind load, and also Ex. 1012 explaining why it is "important to *focus on weight and wind load* for a wireless tower" at least because "the *cost of leasing tower space* is *based largely on how much loading a base station antenna adds* to the tower structure" and because "*overweight* towers or configurations that present *wind resistance* can *cause equipment to loosen or mounts to fail*, which can represent a *danger to residents nearby*").

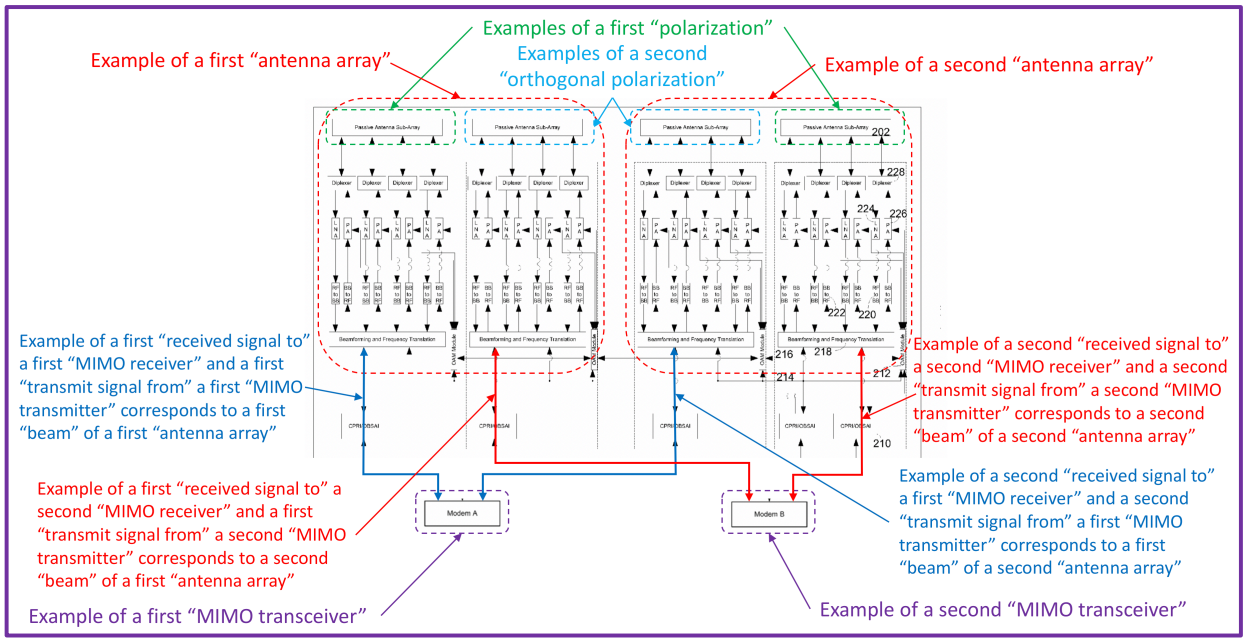
249. Fifth, in view of the above, a POSITA would have known that for the exemplary "***4×N MIMO DIAAs***" as "***illustrated by FIGS. 7-11***" being "***implemented as two independent 2×N MIMO DIAAs***" in the described "***two operator system***" of Trigui wherein each such "***DIAA system***" is depicted as having "***four sub-arrays side by side***", that this ***maximal separation*** criterion for MIMO performance is met by having a first "***modem***" (i.e. "***Modem A***" as a first "**MIMO transceiver**") corresponding to "***Operator 1***" connect its respective two "***transmission/reception paths***" to the left-most "***MIMO branch***" and corresponding "***antenna sub-array***" and to the second-from-the-right "***MIMO branch***" and corresponding "***antenna sub-array***" while also having a second "***modem***" (i.e. "***Modem B***" as a second "**MIMO**

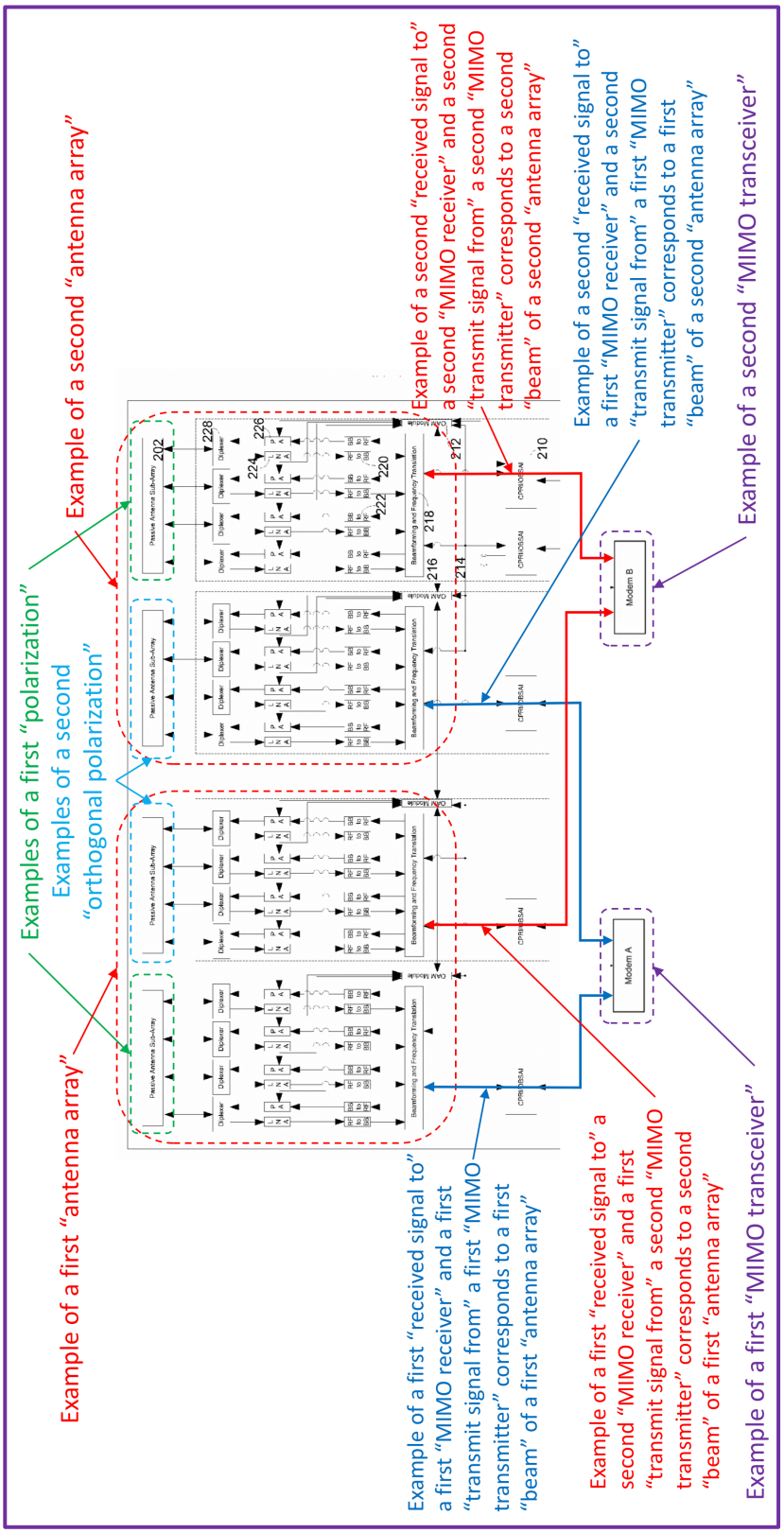
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transceiver") corresponding to "***Operator 2***" connect its respective two "***transmission/reception paths***" to the second-from-the-left "***MIMO branch***" and corresponding "***antenna sub-array***" and to the right-most "***MIMO branch***" and corresponding "***antenna sub-array***".

250. Sixth, in view of the above ***maximal separation*** criteria, a POSITA would have also known that to further meet the ***orthogonal polarization*** criterion for MIMO performance with the described "***two operator system***" of Trigui in the exemplary "***4×N MIMO DIAAs***" as "***illustrated by FIGS. 7-11***" with "***four sub-arrays side by side***" that the left-most "***MIMO branch***" and corresponding "***antenna sub-array***" must be of a first "***polarization***" (e.g. "***vertical***" or "***slant 45 left***") and the second-from-the-right "***MIMO branch***" and corresponding "***antenna sub-array***" must be of a second "***orthogonal polarization***" (e.g. "***horizontal***" or "***slant 45 right***"), and that, similarly, that the right-most "***MIMO branch***" and corresponding "***antenna sub-array***" must be of a first "***polarization***" (e.g. "***vertical***" or "***slant 45 left***") and the second-from-the-left "***MIMO branch***" and corresponding "***antenna sub-array***" must be of a second "***orthogonal polarization***" (e.g. "***horizontal***" or "***slant 45 right***"), which is consistent with the teaching of Trigui of using "***sub-arrays side by side but with alternate polarization***" and using "***two different passive antenna sub-arrays***" among the "***the two DIAAs***" of the exemplary "***4×N MIMO DIAAs***".

251. Accordingly, it would have been obvious to a POSITA to adopt the second possible way (i.e. the "cross" connected approach) for interconnecting the two "***independent 2×N MIMO DIAAs***" with the two independent "***modems***" for the "***two operator system***" of Trigui as shown, for example, in annotated FIG. 10 below (in both landscape and portrait views of the same figure):


Examples of a first "polarization"
Examples of a second "orthogonal polarization"
Example of a first "antenna array"
Example of a second "antenna array"
Example of a first "received signal to" a first "MIMO receiver" and a first "transmit signal from" a first "MIMO transmitter" corresponds to a first "beam" of a first "antenna array"
Example of a second "received signal to" a second "MIMO receiver" and a second "transmit signal from" a second "MIMO transmitter" corresponds to a second "beam" of a second "antenna array"
Example of a first "received signal to" a second "MIMO receiver" and a first "transmit signal from" a second "MIMO transmitter" corresponds to a second "beam" of a first "antenna array"
Example of a second "received signal to" a first "MIMO receiver" and a second "transmit signal from" a first "MIMO transmitter" corresponds to a first "beam" of a second "antenna array"
Example of a first "MIMO transceiver"
Example of a second "MIMO transceiver"
Modem A
Modem B
202
210
212
214
216
218
220
222
224
226
228


Examples of a first "polarization"
Examples of a second "orthogonal polarization"
Example of a first "antenna array"
Example of a second "antenna array"
Example of a first "received signal to" a first "MIMO receiver" and a first "transmit signal from" a first "MIMO transmitter" corresponds to a first "beam" of a first "antenna array"
Example of a second "received signal to" a second "MIMO receiver" and a second "transmit signal from" a second "MIMO transmitter" corresponds to a second "beam" of a second "antenna array"
Example of a first "MIMO transceiver"
Example of a second "MIMO transceiver"
Modem A
Modem B
202
210
212
214
216
218
220
222
224
226
228

252. In reference to annotated FIG. 10 shown above, a POSITA would accordingly understand that for interconnecting the two "***independent 2×N MIMO DIAAs***" with the two independent "***modems***" for the "***two operator system***" of Trigui that it would have been obvious that a first "***reception path***" to "***Modem A***" of "***Operator 1***" (i.e. "**an i-th received signal to a j-th MIMO receiver**" wherein "**i=1**" and "**j=1**") connects with a first "***receive direction***" "***beam pattern***" for the left-most "***independent 2×N MIMO DIAA***" (i.e. "**corresponds to a j-th beam of an i-th antenna array**" wherein "**i=1**" and "**j=1**"), that a second "***reception path***" to "***Modem A***" of "***Operator 1***" (i.e. "**an i-th received signal to a j-th MIMO receiver**" wherein "**i=2**" and "**j=1**") connects with a first "***receive direction***" "***beam pattern***" for the right-most "***independent 2×N MIMO DIAA***" (i.e. "**corresponds to a j-th beam of an i-th antenna array**" wherein "**i=2**" and "**j=1**"), that a first "***reception path***" to "***Modem B***" of "***Operator 2***" (i.e. "**an i-th received signal to a j-th MIMO receiver**" wherein "**i=1**" and "**j=2**") connects with a second "***receive direction***" "***beam pattern***" for the left-most "***independent 2×N MIMO DIAA***" (i.e. "**corresponds to a j-th beam of an i-th antenna array**" wherein "**i=1**" and "**j=2**"), and that a second "***reception path***" to "***Modem B***" of "***Operator 2***" (i.e. "**an i-th received signal to a j-th MIMO receiver**" wherein "**i=2**" and "**j=2**") connects with a second "***receive direction***" "***beam pattern***" for the right-most "***independent 2×N MIMO DIAA***" (i.e. "**corresponds to a j-th beam of an i-th antenna array**" wherein "**i=2**" and "**j=2**").

253. Similarly, in reference to annotated FIG. 10 shown above, a POSITA would also accordingly understand that for interconnecting the two "***independent 2×N MIMO DIAAs***" with the two independent "***modems***" for the "***two operator system***" of Trigui that it would have been obvious that a first "***transmission path***" from "***Modem A***" of "***Operator 1***" (i.e. "**a v-th transmit signal from a z-th MIMO transmitter**" wherein "**v=1**" and "**z=1**") connects with a first

"***transmit***" "***beam pattern***" for the left-most "***independent 2×N MIMO DIAA***" (i.e. "**corresponds to a z-th beam of a v-th antenna array**" wherein "**v=1**" and "**z=1**"), that a second "***transmission path***" from "***Modem A***" of "***Operator 1***" (i.e. "**a v-th transmit signal from a z-th MIMO transmitter**" wherein "**v=2**" and "**z=1**") connects with a first "***transmit***" "***beam pattern***" for the right-most "***independent 2×N MIMO DIAA***" (i.e. "**corresponds to a z-th beam of a v-th antenna array**" wherein "**v=2**" and "**z=1**"), that a first "***transmission path***" from "***Modem B***" of "***Operator 2***" (i.e. "**a v-th transmit signal from a z-th MIMO transmitter**" wherein "**v=1**" and "**z=2**") connects with a second "***transmit***" "***beam pattern***" for the left-most "***independent 2×N MIMO DIAA***" (i.e. "**corresponds to a z-th beam of a v-th antenna array**" wherein "**v=1**" and "**z=2**"), and that a second "***transmission path***" from "***Modem B***" of "***Operator 2***" (i.e. "**a v-th transmit signal from a z-th MIMO transmitter**" wherein "**v=2**" and "**z=2**") connects with a second "***transmit***" "***beam pattern***" for the right-most "***independent 2×N MIMO DIAA***" (i.e. "**corresponds to a z-th beam of a v-th antenna array**" wherein "**v=2**" and "**z=2**").

254. Thus, Trigui in view of the knowledge of a POSITA renders obvious "**n multiple-input multiple-output transceivers (MIMO)**" (for example, by the two independent modems of a two operator system for the exemplary 4×N MIMO DIAA system of Trigui), each "**MIMO transceiver**" comprising: "**a MIMO receiver configured to process m different received signals, wherein an i-th received signal to a j-th MIMO receiver corresponds to a j-th beam of an i-th antenna array**" (for example, by the two receive path MIMO processing for each of the two modems of Trigui when connected to the two independent 2×N MIMO DIAAs as shown above in annotated FIG. 10) and "**a MIMO transmitter configured to process m different transmit signals, wherein a v-th transmit signal from a z-th MIMO transmitter**

corresponds to a z-th beam of a v-th antenna array" (for example, by the two transmit path MIMO processing for each of the two modems of Trigui when connected to the two independent 2×N MIMO DIAAs as shown above in annotated FIG. 10).

255. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

256. As I have noted previously herein, Trigui proposes "to *integrate a passive antenna array with radio transceivers in a single physical package* and to distribute the design to increase the degrees of freedom to offer more *control flexibility*" for "*multiple operator sharing* of a *passive antenna array, transceivers, and the total available power* of the DIAA" wherein "*splitting resources between the multiple operators is flexible*" (see, for example, ¶¶ 102 and 115 above).

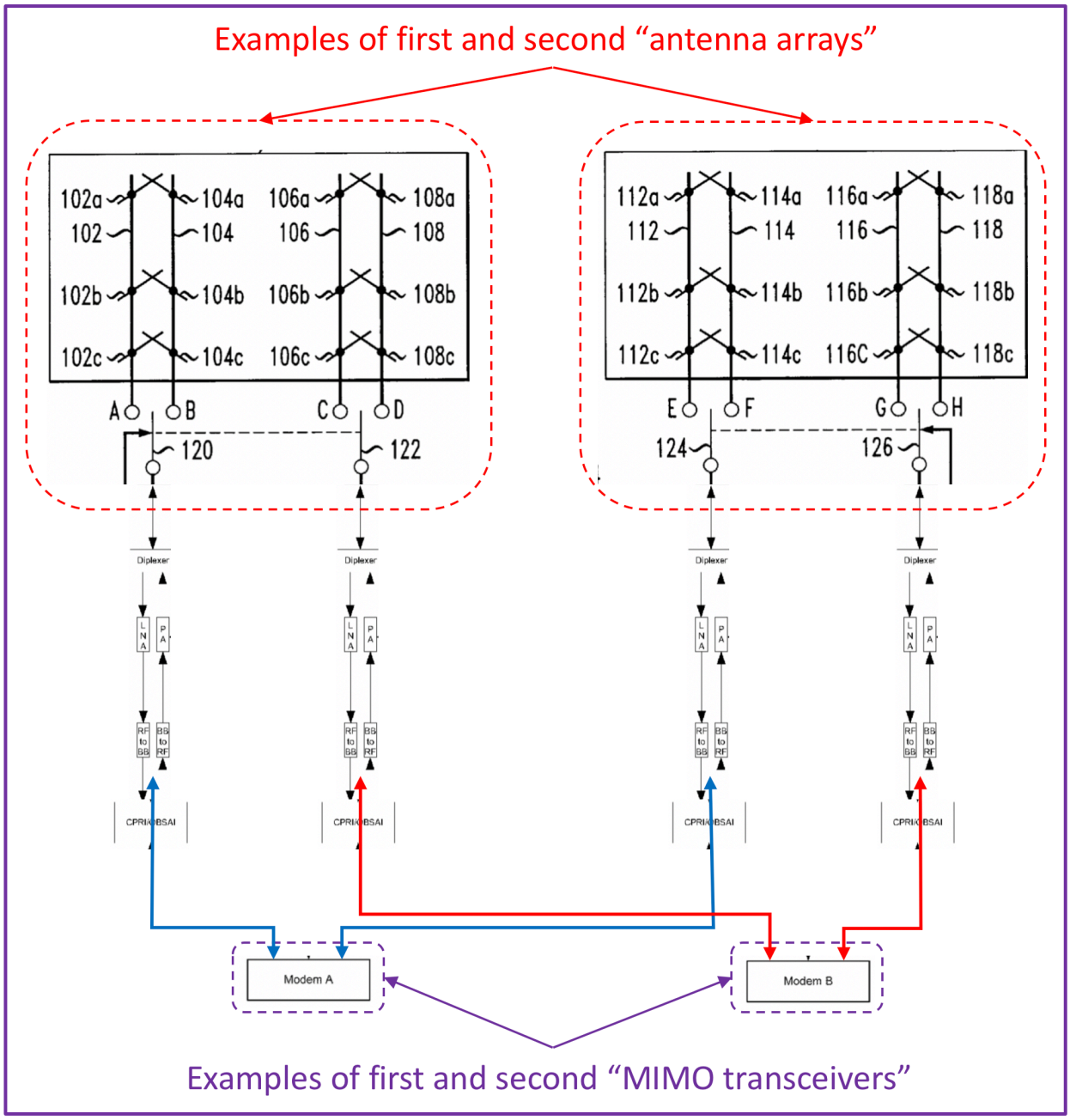
257. However, Trigui observes that "A *key factor* in network design is the *cost per bit of transmitted data*" and further informs that at least because "*per user beamforming* requires the development of *more expensive base stations* that provide meaningful business only in specific cases" that "*Sub-sectorization*" using an "*antenna array* to create sub-sectors with *specified radiation patterns* to serve a desired number of subscribers" is a "*more economical hotspot solution* addressing the unbalanced traffic demand across the network" (see, for example, ¶¶ 97 and 101 above).

258. Accordingly, a POSITA would have been highly motivated for those "***base stations***" that would benefit from such "***multiple operator sharing***" as described above for the "***two operator system***" of Trigui but do not need all of the described "***flexibility***" when "***splitting resources***" to instead limit the possible "***specified radiation patterns***" for the "***antenna arrays***"

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such that the "***cost per bit of transmitted data***" is decreased for a "***more economical hotspot solution***" that still provides MIMO operation.

259. Accordingly, a POSITA would understand that the antenna system of Rudrapatna as I described above for claim element 1(a) is one approach to implementing a "***more economical hotspot solution***" with "***specified radiation patterns***" for the "***antenna arrays***" in the "***two operator system***" of Trigui because multiple components described for Trigui would be removed as unnecessary when adapting the antenna system of Rudrapatna to the otherwise same "***two operator system***" with "***two independent 2×N MIMO***" of Trigui as shown in the modified and annotated composite of FIG. 10 of Trigui and FIG. 1 of Rudrapatna below:



260. As shown in the annotated figure above, such a combination of Trigui in view of Rudrapatna would meet not only all of the limitations of claim element 1(a) as described above for my analysis of Rudrapatna but also all of the limitations of claim element 1(b) as described herein for my analysis of Trigui, including the interconnection limitation that would be met as

shown by the interconnection lines above that are substantially identical to that of my analysis for Trigui and the knowledge of a POSITA.

261. Alternatively, such a combination of Trigui in view of Rudrapatna would also meet all of the limitations of claim element 1(b) even if the term "**MIMO transceiver**" were construed to require performing the "*Tx/Rx RF signal conditioning*" functionality of the '511 Patent as "*shown separately*" which "*may be combined* into a *single component or element*" (see ¶ 214 above). Under such a narrower construction for the plain and ordinary meaning of the term "**MIMO transceiver**", the combination of Trigui in view of Rudrapatna as described in the modified and annotated FIG. 10 shown above would disclose a first such "**MIMO transceiver**" by the combination of "***Modem A***", the left-most group of "***CPRI/OBSAI***", "***RF to BB***", "***BB to RF***", "***LNA***", "***PA***", and/or "***Diplexer***" blocks, and the second-from-the-right group of "***CPRI/OBSAI***", "***RF to BB***", "***BB to RF***", "***LNA***", "***PA***", and/or "***Diplexer***" blocks, and similarly, would disclose a second such "**MIMO transceiver**" by the combination of "***Modem B***", the second-from-the-left group of "***CPRI/OBSAI***", "***RF to BB***", "***BB to RF***", "***LNA***", "***PA***", and/or "***Diplexer***" blocks, and the right-most group of "***CPRI/OBSAI***", "***RF to BB***", "***BB to RF***", "***LNA***", "***PA***", and/or "***Diplexer***" blocks (see, for example, ¶ 259 above).

262. Similarly, if the term "**antenna array**" or its constituent "**beamformer**" for claim element 1(a) were construed to require excluding the "*Tx/Rx RF signal conditioning*" functionality of the '511 Patent as corresponding in my analysis of claim element 1(a) for Trigui to at least the "***RF to BB***", "***BB to RF***", "***LNA***", "***PA***", and/or "***Diplexer***" blocks in the "***4×N MIMO DIAAs***" that are "***illustrated by FIGS. 7-11***" of Trigui (see, for example, ¶ 192 above), the combination of Trigui in view of Rudrapatna as described in the modified and annotated FIG.

10 shown above would still disclose such "**antenna array**" and/or "**beamformer**" for claim element 1(a) under such narrower construction (see, for example, ¶ 259 above).

263. With any above-described constructions for the terms "**MIMO transceiver**", "**antenna array**" and/or "**beamformer**", a POSITA would have had a high expectation of success for combining Trigui in view of Rudrapatna as described above for at least the following reasons.

264. First, the antenna system of Rudrapatna is described as providing 4 bi-directional "***beams***" at RF as I have noted in my analysis of Rudrapatna for claim element 1(a) as described above and a POSITA would understand that this would match precisely with the 4 "***transmission/reception paths***" of the exemplary "***4×N MIMO DIAAs***" when applied to the described "***two operator system***" of Trigui.

265. Second, Rudrapatna describes that "*Each antenna pair in each group* has *orthogonally polarized antennas*" that are "*uncorrelated to each other*" (see, for example, ¶ 139 above), which a POSITA would understand to match precisely with the requirements for the exemplary "***4×N MIMO DIAAs***" when applied to the described "***two operator system***" of Trigui as described above.

266. Third, Rudrapatna teaches that "The *second group* (**103**) is *positioned with respect to the first group*" such that "*signals from any antenna in the second group is uncorrelated with any signals from any antenna in the first group*" and thus "*both groups can perform MIMO operations*" whereby "the *second group of antennas is preferably located a distance of at least* 10λ *from the first group*" such that "*any antenna in the first group* is positioned at a *distance of at least* 10λ f*rom any antenna in the second group*" (see, for example, ¶¶ 145-146 above), which a POSITA would understand to match precisely with the requirements

for the exemplary "***4×N MIMO DIAAs***" when applied to the described "***two operator system***" of Trigui as described above.

267. Fourth, at least because the described combination of Trigui in view of Rudrapatna would remove the 4 "***Beamforming and Frequency Translation***" modules along with all of the required control elements and remove at least another 12 combinations of "***RF to BB***", "***BB to RF***", "***LNA***", "***PA***", and "***Diplexer***" blocks, while adding only the 4 simple "***switches***" and substituting 4 similar-complexity passive antenna element arrays, then a POSITA would have known that this combination of Trigui in view of Rudrapatna would be simpler overall and thus a "***more economical hotspot solution***" with a lower "***cost per bit of transmitted data***" for those "***base stations***" that do not need all of the described "***flexibility***" for Trigui alone.

268. Thus, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious "**n multiple-input multiple-output transceivers (MIMO)**" (for example, by the two independent modems of a two operator system for the exemplary 4×N MIMO DIAA system of Trigui, or alternatively when each of these two independent modems is combined with the applicable "CPRI/OBSAI", "RF to BB", "BB to RF", "LNA", "PA", and/or "Diplexer" blocks as described above), each "**MIMO transceiver**" comprising: "**a MIMO receiver configured to process m different received signals, wherein an i-th received signal to a j-th MIMO receiver corresponds to a j-th beam of an i-th antenna array**" (for example, by the two receive path MIMO processing for each of the two modems of Trigui when connected to the two independent 2×N MIMO DIAAs as shown above in modified and annotated FIG. 10 of Trigui in view of Rudrapatna) and "**a MIMO transmitter configured to process m different transmit signals, wherein a v-th transmit signal from a z-th MIMO transmitter corresponds to a z-th beam of a v-th antenna array**" (for example, by the two transmit path MIMO processing for

each of the two modems of Trigui when connected to the two independent 2×N MIMO DIAAs as shown above in modified and annotated FIG. 10 of Trigui in view of Rudrapatna).

269. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

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1(c) wherein m, n, v, and z are integer number values,
wherein i=1, . . . , m, j=1, . . . , n, and v=1, . . . m,
wherein n≥2 and m≥2,
wherein z=1, . . . , w, and
wherein n≥w≥2.

270. Based on my analysis of claim elements 1(a) and 1(b) above, Trigui in view of the knowledge of a POSITA for the described implementation two "***independent 2×N MIMO DIAAs***" with the two independent "***modems***" for the "***two operator system***" of Trigui discloses "**m=2**" (i.e. "**wherein m … integer number values**" and "**wherein … m≥2**") (see, for example, ¶¶ 196, 217, 219 and 251 above), "**n=2**" (i.e. "**wherein n … integer number values**" and "**wherein … n≥2**") (see, for example, ¶¶ 192, 196-197, 226-232 and 251 above), "**i=1,2**" (i.e. "**wherein i=1, . . . , m**") (see, for example, ¶¶ 196, 219 and 251-252 above), "**j=1,2**" (i.e. "**wherein … j=1, . . . , n**") (see, for example, ¶¶ 196, 219 and 251-252 above), "**v=1,2**" (i.e. "**wherein v=1, . . . , m**" and "**wherein v … integer number values**") (see, for example, ¶¶ 196, 219, 251 and 253 above), and "**z=1,2**" and "**w=2**" (i.e. "**wherein z=1, . . . , w**", "**wherein z … integer number values**" and "**wherein n≥w≥2**") (see, for example, ¶¶ 196, 219, 251 and 253 above).

271. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

272. Similarly, based on my analysis of claim elements 1(a) and 1(b) above, Trigui in view of Rudrapatna and the knowledge of a POSITA for the described implementation two "***independent 2×N MIMO DIAAs***" with the two independent "***modems***" for the "***two operator system***" of Trigui in combination with the antenna system of Rudrapatna discloses "**m=2**" (i.e. "**wherein m … integer number values**" and "**wherein … m≥2**") (see, for example, ¶¶ 207, 217, 219, 251 and 259 above), "**n=2**" (i.e. "**wherein n … integer number values**" and

"**wherein … n≥2**") (see, for example, ¶¶ 207, 226-232, 251 and 259 above), "**i=1,2**" (i.e. "**wherein i=1, . . . , m**") (see, for example, ¶¶ 207, 219, 251-252 and 259 above), "**j=1,2**" (i.e. "**wherein … j=1, . . . , n**") (see, for example, ¶¶ 207, 219, 251-252 and 259 above), "**v=1,2**" (i.e. "**wherein v=1, . . . , m**" and "**wherein v … integer number values**") (see, for example, ¶¶ 207, 219, 251, 253 and 259 above), and "**z=1,2**" and "**w=2**" (i.e. "**wherein z=1, . . . , w**", "**wherein z … integer number values**" and "**wherein n≥w≥2**") (see, for example, ¶¶ 207, 219, 251, 253 and 259 above).

273. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

‘511 Patent: Claim 2

> 2. The system of claim 1, configured to substantially comply with one or more of Electrical and Electronic Engineers (IEEE) 802.11a/b/g/n/ac (WiFi), IEEE 802.16 (WiMAX), 2nd Generation Partnership Project (3GPP) Long Term Evolution (LTE), 3GPP LTE-Advanced, 3GPP LTE-TDD, 3GPP LTE-FDD, High Speed Packet Access (HSPA), and HSPA+.

2. The system of claim 1, configured to substantially comply with one or more of Electrical and Electronic Engineers (IEEE) 802.11a/b/g/n/ac (WiFi), IEEE 802.16 (WiMAX), 2nd Generation Partnership Project (3GPP) Long Term Evolution (LTE), 3GPP LTE-Advanced, 3GPP LTE-TDD, 3GPP LTE-FDD, High Speed Packet Access (HSPA), and HSPA+.

274. Trigui recommends “adopting the most *spectrally efficient air interface* (for example, *orthogonal frequency-division multiplexing (OFDM)*), and *multiple input multiple output (MIMO) antenna techniques* by an advanced wireless system such as *WiMAX or 3rd Generation Partnership Project Long Term Evolution (3GPP LTE)*” (see, for example, ¶ 97 above).

275. More specifically, Trigui informs that “the *DIAA is designed to comply with* mobile *WiMAX (IEEE802.16e), UMTS, and LTE base stations* supporting space time transmit diversity (“STTD”) and *spatial multiplexing* (“SM”)” (see, for example, ¶ 119 above).

276. Accordingly, it would have been obvious to a POSITA that the described implementation of “***base stations***” using two “***independent 2×N MIMO DIAAs***” with the two independent “***modems***” for the “***two operator system***” of Trigui in my analysis of Claim 1 herein is “***designed to comply with***” (i.e. “**configured to substantially comply with**”) at least one or more of “***WiMAX (IEEE802.16e)***” (i.e. “**IEEE 802.16 (WiMAX)**”) or “***3rd Generation Partnership Project Long Term Evolution (3GPP LTE)***” (i.e. at least one of “**2nd Generation Partnership Project (3GPP) Long Term Evolution (LTE), 3GPP LTE-Advanced, 3GPP LTE-TDD, 3GPP LTE-FDD**”).

277. Thus, Trigui in view of the knowledge of a POSITA renders obvious “**The system of claim 1**” (for example, by my analysis herein for Claim 1), “**configured to**

substantially comply with one or more of Electrical and Electronic Engineers (IEEE) 802.11a/b/g/n/ac (WiFi), IEEE 802.16 (WiMAX), 2nd Generation Partnership Project (3GPP) Long Term Evolution (LTE), 3GPP LTE-Advanced, 3GPP LTE-TDD, 3GPP LTE-FDD, High Speed Packet Access (HSPA), and HSPA+" (for example, when the described implementation for Claim 1 is designed to comply with either WiMAX or 3rd Generation Partnership Project Long Term Evolution (3GPP LTE)).

278. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

279. At least because Trigui renders obvious the limitations of this claim element, then Trigui in view of Rudrapatna and the knowledge of a POSITA also renders obvious the limitations of this claim element.

‘511 Patent: Claim 4

> 4. The system of claim 1, wherein the m antenna arrays are separated by a distance more than one wavelength apart at the carrier frequency.

4. The system of claim 1, wherein the m antenna arrays are separated by a distance more than one wavelength apart at the carrier frequency.

280. I note that during the prosecution of the ‘511 Patent that applicant did not dispute the patent examiner’s finding that the additional limitations of this claim are met by effectively Rudrapatna (see ¶¶ 68 and 129 above) because “Rudrapatna teaches a *beamforming MIMO system* wherein the *antenna groups* are *separated by more the one wavelength* (*Rudrapatna [0031]*)” (see, for example, ¶¶ 69 and 74 above).

281. As I also noted in my analysis of Claim 1 herein, a POSITA would have known from the prior art that “*Correlation of the signals at different antenna elements* can *significantly reduce the capacity* of a *MIMO system*” wherein such “*Correlation* is *influenced by the angular spectrum* of the channel as well as the *arrangement and spacing of antenna elements*” (see, for example, ¶ 159 above).

282. More specifically, a POSITA would have known from the prior art that with regard to “*Spatial diversity*” that “*irrespective of the processing method*, *performance* is *influenced by correlation* of the signals *between the antenna elements*” and “This relationship is *different for BS antennas and MS antennas*” (where “BS” means “***Base Stations***” and “MS” means “***Mobile Stations***”) such that for “*BSs in cellular systems*” the “Interacting *Objects* (IOs) are *typically concentrated around the MS*” and thus “the *antenna spacing* required to obtain *sufficient decorrelation increases*” such that “antenna spacing *has to be on the order of 2–20 wavelengths* for angular spreads between 1º and 5º in order to *achieve decorrelation*” (see, for example, ¶¶ 154-155 above).

283. For example, a POSITA would have also known from the prior art that particular "*first*" and "*second*" "*groups of antennas*" used for MIMO signal processing have the "*second group*" being "*positioned with respect to the first group*" such that "*signals from any antenna in the second group is uncorrelated with any signals from any antenna in the first group*" when "the *second group of antennas is preferably located a distance of at least* 10λ *from the first group*" where "λ" is "the *corresponding wavelength of the signal* to be transmitted (or being received) by the antenna" (see, for example, ¶¶ 141 and 145-146 above).

284. Accordingly, it would have been obvious to a POSITA that for the described implementation two "***independent 2×N MIMO DIAAs***" with the two independent "***modems***" for the "***two operator system***" of Trigui as I described in my analysis of Claim 1 herein that each "***independent 2×N MIMO DIAA***" (i.e. an "**antenna array**") would have a "***spacing***" on the "***order of 2–20 wavelengths***" such as "***a distance of at least* 10λ**" (i.e. "**the m antenna arrays are separated by a distance more than one wavelength apart at the carrier frequency**").

285. Thus, Trigui in view of the knowledge of a POSITA renders obvious "**The system of claim 1**" (for example, by my analysis herein for Claim 1), "**wherein the m antenna arrays are separated by a distance more than one wavelength apart at the carrier frequency**" (for example, when the described implementation for Claim 1 has pairs of antenna element sub-arrays for each independent 2×N MIMO DIAA spaced at a distance of 2-20 wavelengths apart from each other).

286. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

287. Note that applicants of the '511 Patent admit that Rudrapatna discloses the additional limitations of this claim (see ¶ 280 above).

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288. For example, Rudrapatna describes "an *antenna array comprising at least two antenna groups* where *each group comprises at least two pairs of antennas*" and "A *first group of antennas* is *positioned* with *respect to a second group* of antennas such that there is *relatively low correlation or no correlation* between signals to be transmitted (or being received) by any one of the *antennas from different groups*" (see, for example, ¶ 137 above).

289. More specifically, Rudrapatna teaches that the "*second group*" is "*positioned with respect to the first group*" such that "*signals from any antenna in the second group is uncorrelated with any signals from any antenna in the first group*" when "the *second group of antennas is preferably located a distance of at least* 10λ *from the first group*" where "*λ*" is "the *corresponding wavelength of the signal* to be transmitted (or being received) by the antenna" although "*other distances* (e.g., 5λ, 6λ, 15λ) may be used to *achieve de-correlation between signals from the different groups* based on propagation environment" (see, for example, ¶¶ 141 and 145-146 above).

290. Thus, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious "**The system of claim 1**" (for example, by my analysis herein for Claim 1), "**wherein the m antenna arrays are separated by a distance more than one wavelength apart at the carrier frequency**" (for example, when the described implementation for Claim 1 has groups of antennas for each independent 2×N MIMO DIAA spaced at a distance such as at least 5 wavelengths apart from each other).

291. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

‘511 Patent: Claim 5

> 5. The system of claim 1, wherein the antenna elements are less than or equal to one half wavelength apart at the carrier frequency.

5. The system of claim 1, wherein the antenna elements are less than or equal to one half wavelength apart at the carrier frequency.

292. I note that during the prosecution of the ‘511 Patent that applicant did not dispute the patent examiner’s finding that the additional limitations of this claim are met by prior art that discloses “*antenna elements are less than or equal to one half wavelength apart at the carrier frequency*” (see, for example, ¶¶ 70 and 74 above).

293. Trigui explains that the depicted “*antenna arrays*” consist of “*sub-arrays where the antenna elements* of each sub-array are *combined passively* to achieve a *predefined pattern*” and accordingly, “the *antenna array elements* are *closely spaced to avoid grating lobes*” (see, for example, ¶ 114 above).

294. A POSITA would have known from the prior art that “*Array antennas* are *often used for BS antennas*” (where “BS” refers to “***base stations***”) because “They result in an *antenna pattern that can be more easily shaped*” where “d_a is the *distance between the antenna elements*” and such “*Distance is usually chosen* as $d_a = \lambda/2$” because “$d_a \leq \lambda/2$ is *necessary to avoid spatial aliasing* – i.e., periodicities in the antenna pattern” where “λ is the *wavelength*” (see, for example, ¶¶ 151-153 above).

295. Accordingly, it would have been obvious to a POSITA that Trigui’s teaching that “***the antenna array elements are closely spaced to avoid grating lobes***” means that such “***antenna array elements***” would be “***spaced***” with a separation “***distance between the antenna elements***” of “$d_a \leq \lambda/2$” to avoid such “***grating lobes***” (aka “***spatial aliasing***”) where “λ ***is the wavelength***” (i.e. “**wherein the antenna elements are less than or equal to one half wavelength apart at the carrier frequency**”).

296. Thus, Trigui in view of the knowledge of a POSITA renders obvious "**The system of claim 1**" (for example, by my analysis herein for Claim 1), "**wherein the antenna elements are less than or equal to one half wavelength apart at the carrier frequency**" (for example, when the described implementation for Claim 1 has antenna elements within a particular sub-array spaced at a distance of $d_a \leq \lambda/2$ to avoid grating lobes in the antenna pattern).

297. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

298. Rudrapatna teaches that "The *antenna array of the present invention* is further configured such that *similarly polarized antennas within a group are positioned with respect to each other* such that they are able to *transmit (or receive) signals* which are relatively *highly correlated*" and thus "Preferably, the *distance separating similarly polarized antennas* is $\frac{\lambda}{2}$ or less" where "λ" is "the *corresponding wavelength of the signal* to be transmitted (or being received) by the antenna" (see, for example, ¶¶ 140-141 above).

299. Accordingly, a POSITA would understand that the described implementation two "***independent 2×N MIMO DIAAs***" with the two independent "***modems***" for the "***two operator system***" of Trigui in combination with the antenna system of Rudrapatna discloses that within any particular antenna/beam combination that such "***antenna elements***" as shown, for example, in annotated FIG. 1 of Rudrapatna (see, for example, ¶¶ 207 or 259 above) would be "***spaced***" with a "***distance separating similarly polarized antennas***" of "$\frac{\lambda}{2}$ ***or less***" where "λ" is "***the corresponding wavelength of the signal to be transmitted (or being received) by the antenna***", as also would have been obvious to a POSITA per my analysis above for Trigui.

300. Thus, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious "**The system of claim 1**" (for example, by my analysis herein for Claim 1), "**wherein the antenna elements are less than or equal to one half wavelength apart at the carrier frequency**" (for example, when the described implementation for Claim 1 has antenna elements within a particular polarized antenna spaced at a distance of $d_a \leq \lambda/2$ to avoid grating lobes in the antenna pattern).

301. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

‘511 Patent: Claim 6

6. The system of claim 1, wherein the beamformer is an electronic beamformer.

6. The system of claim 1, wherein the beamformer is an electronic beamformer.

302. I note that during the prosecution of the ‘511 Patent that applicant did not dispute the patent examiner’s finding that the additional limitations of this claim are met by effectively Rudrapatna (see ¶¶ 68 and 129 above) because “Adams in view of Rudrapatna teaches wherein the *beamformer is an electronic beamformer* (*Adams [0008], fig. 4; Rudrapatna [0024]*)” (see, for example, ¶¶ 71 and 74 above).

303. Trigui discloses that “*Beamforming* is a general signal processing technique *used to control the directionality of the reception or transmission of a signal on a transducer array*” such that “the *majority of signal energy* can be *transmitted* from a group of transducers (such as radio antenna) in a *chosen angular direction*” (see, for example, ¶ 100 above).

304. For example, Trigui teaches that for a “*digital integrated antenna array (“DIAA”)*” suitable for “*sharing antenna elements and active electronics between multiple operators* servicing the same geographic area” that “*the ideal beamforming weights*” for the “*desired radiation pattern*” are “*passed to the DIAA*” wherein “Each set of the modem signals, after split, is *multiplied by the beamforming and calibration weights* such that when applied to the passive antenna array **202**, a *user-specified radiation pattern is formed*” (see, for example, ¶¶ 96, 104, 106 and 108 above).

305. Additionally, Trigui discloses “in the *beamforming core* **218**, *each branch of the modem signal* is *multiplied by a complex-valued number* such that *when applied to the antenna array*, along with the other branches of the modem signal, a *specified radiation pattern is formed*” wherein “*transmit and receive beamforming weights for each modem are the same*” (see, for example, ¶ 111 above).

306. Similarly, Trigui describes that "In the *receive direction*, *signals from the passive antenna array* **202** are passed through the *diplexer* **228** before entering a *low-noise amplifier* **224**" and then subsequently being "*converted from RF to baseband by a circuit* **220** before being fed to the *beamforming and frequency translation module* **218** where *beamforming* and calibration *weights are applied* to the received signals to *form modem signals*" (see, for example, ¶ 110 above).

307. Accordingly, it would have been obvious to a POSITA that Trigui's teaching that a "***digital integrated antenna array***" composed of "***active electronics***" includes a "***beamforming core***" in which "***beamforming weights***" for the "***desired radiation pattern***" are "***applied to the antenna array***" when "***each branch of the modem signal is multiplied by a complex-valued number***" for both "***transmit and receive beamforming***" would mean that such "***beamforming core***", as well as, alternatively, other active components such as "***RF to BB***", "***BB to RF***", "***LNA***" and "***PA***" blocks, would be part of one or more "***digital integrated***" and "***electronic***" circuits (i.e. "**wherein the beamformer is an electronic beamformer**").

308. Thus, Trigui in view of the knowledge of a POSITA renders obvious "**The system of claim 1**" (for example, by my analysis herein for Claim 1), "**wherein the beamformer is an electronic beamformer**" (for example, when the described implementation for Claim 1 uses a beamforming core within each MIMO branch to multiply a complex-valued beamforming weight with a modem signal using one or more digital integrated and electronic circuits).

309. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

310. Note that applicants of the '511 Patent admit that Rudrapatna discloses the additional limitations of this claim (see ¶ 302 above).

311. For example, Rudrapatna describes that each "*group of antennas* has *switches*" that are "positioned to *select either antennas in each of the antenna pairs*", or hence disclosing "***beamforming***" per my analysis in Claim 1 herein, wherein such "*switches are operated* either *electronically, electrically or electromechanically* through means *well known to those skilled in the art*" (see, for example, ¶ 142 above).

312. Accordingly, a POSITA would understand that the described implementation two "***independent 2×N MIMO DIAAs***" with the two independent "***modems***" for the "***two operator system***" of Trigui in combination with the antenna system of Rudrapatna discloses that "***beamforming***" is realized using "***switches***" that are "***operated either electronically, electrically or electromechanically through means well known to those skilled in the art***" (i.e. "**wherein the beamformer is an electronic beamformer**").

313. Thus, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious "**The system of claim 1**" (for example, by my analysis herein for Claim 1), "**wherein the beamformer is an electronic beamformer**" (for example, when the described implementation for Claim 1 has beamforming switches that are operated electronically).

314. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

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‘511 Patent: Claim 9

> 9. The system of claim 1, wherein the system simultaneously provides MIMO and beamforming.

9. The system of claim 1, wherein the system simultaneously provides MIMO and beamforming.

315. I note that during the prosecution of the ‘511 Patent that applicant did not dispute the patent examiner’s finding that the additional limitations of this claim are met by effectively Rudrapatna (see ¶¶ 68 and 129 above) because “Adams in view of Rudrapatna teaches wherein the system *simultaneously provides MIMO and beam forming* (*Rudrapatna [0031]*)” (see, for example, ¶¶ 72 and 74 above).

316. Trigui discloses in reference to a “*single MIMO branch of a DIAA system*” among “*multiple MIMO branches*” that “*I/Q signals* **215** *from any of the modems*, as well as the *beamforming weights* **214**, can be *sent to other MIMO branches*” such that “in the *beamforming core* **218**, *each branch of the modem signal* is *multiplied by a complex-valued number* such that *when applied to the antenna array*, along with the other branches of the modem signal, a *specified radiation pattern is formed*” (see, for example, ¶¶ 104, 107 and 111 above).

317. Accordingly, a POSITA would understand that the described implementation two “***independent 2×N MIMO DIAAs***” with the two independent “***modems***” for the “***two operator system***” of Trigui provides both “***MIMO***” operation at each “***modem***” and “***beamforming***” on each “***sub-array***” at each “***MIMO branch***” for each “***operator***” at the same time (i.e. “**the system simultaneously provides MIMO and beamforming**”).

318. Thus, Trigui in view of the knowledge of a POSITA renders obvious “**The system of claim 1**” (for example, by my analysis herein for Claim 1), “**wherein the system simultaneously provides MIMO and beamforming**” (for example, when the described implementation for Claim 1 uses a beamforming core within each MIMO branch to multiply a

complex-valued beamforming weight with a modem signal among multiple such MIMO signals at the same time).

319. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

320. Note that applicants of the '511 Patent admit that Rudrapatna discloses the additional limitations of this claim (see ¶ 315 above).

321. Rudrapatna discloses "an *antenna array*, which *simultaneously performs beam forming/steering, MIMO, diversity operations or any combination thereof*" (see, for example, ¶ 135 above).

322. Accordingly, a POSITA would understand that the described implementation two "***independent 2×N MIMO DIAAs***" with the two independent "***modems***" for the "***two operator system***" of Trigui in combination with the antenna system of Rudrapatna discloses that "***beamforming***" and "***MIMO***" are performed "***simultaneously***" (i.e. "**the system simultaneously provides MIMO and beamforming**").

323. Thus, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious "**The system of claim 1**" (for example, by my analysis herein for Claim 1), "**wherein the system simultaneously provides MIMO and beamforming**" (for example, when the described implementation for Claim 1 has beamforming and MIMO performed simultaneously).

324. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

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‘511 Patent: Claim 10

10. An apparatus comprising:

a) m antenna arrays configured to receive a propagating radio frequency signal and configured to transmit a propagating radio frequency signal, each of the antenna arrays comprising:

a plurality of antenna elements; and

a beamformer configured to produce n different bi-directional beams using the plurality of antenna elements; and

b) n multiple-input multiple-output transceivers (MIMO), each MIMO transceiver comprising:

a MIMO receiver configured to process m different received signals, wherein an i-th received signal to a j-th MIMO receiver corresponds to a j-th beam of an i-th antenna array; and

a MIMO transmitter configured to process m different transmit signals,

wherein a v-th transmit signal from a z-th MIMO transmitter corresponds to a z-th beam of a v-th antenna array,

c) wherein m, n, v, and z are integer number values, and

wherein i=1, . . . , m, j=1, . . . , n, and v=1, . . . m,

wherein n≥2 and m≥2,

wherein z=1, . . . , w, and

wherein n≥w≥2.

10. An apparatus comprising:

325. In my opinion, this preamble claim element expresses no limitations.

326. However, I have considered that this preamble claim element may be limiting.

327. For example, Trigui discloses exemplary embodiments of a “*4×N MIMO DIAA system*” for “*cellular base stations*” (see, for example, ¶¶ 105 and 122-127 above).

328. In my opinion, a POSITA would understand that Trigui’s disclosure of this “***MIMO DIAA system***” as summarized herein would at least constitute an “**apparatus**”.

329. Thus, Trigui discloses an “**apparatus**” (for example, the exemplary embodiments of a 4×N MIMO DIAA system directed to cellular base stations in Trigui).

330. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element, if any.

331. At least because Trigui renders obvious the limitations of this claim element, if any, then Trigui in view of Rudrapatna and the knowledge of a POSITA also renders obvious the limitations of this claim element, if any.

10(a) m antenna arrays configured to receive a propagating radio frequency signal and configured to transmit a propagating radio frequency signal, each of the antenna arrays comprising:

a plurality of antenna elements; and

a beamformer configured to produce n different bi-directional beams using the plurality of antenna elements;

332. The limitations of this claim element 10(a) are identical to that of claim element 1(a).

333. Accordingly, my analysis of claim element 1(a) herein that shows both that Trigui and the knowledge of a POSITA renders obvious such limitations and that Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious such limitations also applies to this claim element 10(a).

334. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

335. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

10(b) n multiple-input multiple-output transceivers (MIMO), each MIMO transceiver comprising:

a MIMO receiver configured to process m different received signals, wherein an i-th received signal to a j-th MIMO receiver corresponds to a j-th beam of an i-th antenna array; and

a MIMO transmitter configured to process m different transmit signals,

wherein a v-th transmit signal from a z-th MIMO transmitter corresponds to a z-th beam of a v-th antenna array,

336. The limitations of this claim element 10(b) are identical to that of claim element 1(b), subject to a non-substantive format change.

337. Accordingly, my analysis of claim element 1(b) herein that shows both that Trigui and the knowledge of a POSITA renders obvious such limitations and that Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious such limitations also applies to this claim element 10(b).

338. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

339. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

10(c) wherein m, n, v, and z are integer number values, and
wherein i=1, . . . , m, j=1, . . . , n, and v=1, . . . m,
wherein n≥2 and m≥2,
wherein z=1, . . . , w, and
wherein n≥w≥2.

340. The limitations of this claim element 10(c) are identical to that of claim element 1(c), subject to a non-substantive format change.

341. Accordingly, my analysis of claim element 1(c) herein that shows both that Trigui and the knowledge of a POSITA renders obvious such limitations and that Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious such limitations also applies to this claim element 10(c).

342. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

343. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

‘511 Patent: Claim 11

> 11. The apparatus of claim 10, configured to substantially comply with one or more of Electrical and Electronic Engineers (IEEE) 802.11a/b/g/n/ac (WiFi), IEEE 802.16 (WiMAX), 2nd Generation Partnership Project (3GPP) Long Term Evolution (LTE), 3GPP LTE-Advanced, 3GPP LTE-TDD, 3GPP LTE-FDD, High Speed Packet Access (HSPA), and HSPA+.

11. The apparatus of claim 10, configured to substantially comply with one or more of Electrical and Electronic Engineers (IEEE) 802.11a/b/g/n/ac (WiFi), IEEE 802.16 (WiMAX), 2nd Generation Partnership Project (3GPP) Long Term Evolution (LTE), 3GPP LTE-Advanced, 3GPP LTE-TDD, 3GPP LTE-FDD, High Speed Packet Access (HSPA), and HSPA+.

344. The additional limitations of this dependent Claim 11 are identical to that of dependent Claim 2.

345. Accordingly, my analysis of dependent Claim 2 herein that shows both that Trigui and the knowledge of a POSITA renders obvious such additional limitations and that Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious such additional limitations also applies to this dependent Claim 11.

346. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

347. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

‘511 Patent: Claim 13

> 13. The apparatus of claim 10, wherein the m antenna arrays are separated by a distance more than one wavelength apart at the carrier frequency.

13. The system of claim 1, wherein the m antenna arrays are separated by a distance more than one wavelength apart at the carrier frequency.

348. The additional limitations of this dependent Claim 13 are identical to that of dependent Claim 4.

349. Accordingly, my analysis of dependent Claim 4 herein that shows both that Trigui and the knowledge of a POSITA renders obvious such additional limitations and that Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious such additional limitations also applies to this dependent Claim 13.

350. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

351. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

‘511 Patent: Claim 14

> 14. The apparatus of claim 10, wherein the antenna elements are less than one half wavelength apart at the carrier frequency.

14. The apparatus of claim 10, wherein the antenna elements are less than one half wavelength apart at the carrier frequency.

352. The additional limitations of this dependent Claim 14 are substantially similar to that of dependent Claim 5, subject to the change that the scope of this Claim 14 does not include "**or equal to**" in addition to "**less than**".

353. However, my analysis of dependent Claim 5 herein shows both that Trigui and the knowledge of a POSITA renders obvious such additional limitations and that Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious such additional limitations, wherein for either case the exclusion of "**equal to**" does not change that my analysis already shows "**less than**".

354. Accordingly, my analysis of dependent Claim 5 herein that shows both that Trigui and the knowledge of a POSITA renders obvious such additional limitations and that Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious such additional limitations also applies to this dependent Claim 14.

355. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

356. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

‘511 Patent: Claim 15

15. The apparatus of claim 10, wherein the beamformer is an electronic beamformer.

15. The apparatus of claim 10, wherein the beamformer is an electronic beamformer.

357. The additional limitations of this dependent Claim 15 are identical to that of dependent Claim 6.

358. Accordingly, my analysis of dependent Claim 6 herein that shows both that Trigui and the knowledge of a POSITA renders obvious such additional limitations and that Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious such additional limitations also applies to this dependent Claim 15.

359. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

360. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

‘511 Patent: Claim 18

> 18. The apparatus of claim 10, wherein the apparatus simultaneously provides MIMO and beamforming.

18. The apparatus of claim 10, wherein the apparatus simultaneously provides MIMO and beamforming.

361. The additional limitations of this dependent Claim 18 are substantially similar to that of dependent Claim 9, subject to the non-substantive change that “**system**” in the additional limitations is replaced by “**apparatus**”.

362. Accordingly, my analysis of dependent Claim 9 herein that shows both that Trigui and the knowledge of a POSITA renders obvious such additional limitations and that Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious such additional limitations also applies to this dependent Claim 18.

363. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

364. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

‘511 Patent: Claim 19

> 19. An apparatus comprising:
> a) m antenna arrays configured to receive a propagating radio frequency signal, each of the antenna arrays comprising:
> a plurality of antenna elements; and
> a beamformer configured to produce n different receive beams using the plurality of antenna elements; and
> b) n multiple-input multiple-output receivers (MIMO), each MIMO receiver configured to process m different received signals, wherein an i-th received signal to a j-th MIMO receiver corresponds to a j-th beam of an i-th antenna array,
> c) wherein m and n are integer number values, and
> wherein i=1, . . . , m, j=1, . . . , n, and
> wherein n≥2 and m≥2.

19. An apparatus comprising:

365. In my opinion, this preamble claim element expresses no limitations.

366. However, I have considered that this preamble claim element may be limiting.

367. For example, Trigui discloses exemplary embodiments of a “*4×N MIMO DIAA system*” for “*cellular base stations*” (see, for example, ¶¶ 105 and 122-127 above).

368. In my opinion, a POSITA would understand that Trigui’s disclosure of this “***MIMO DIAA system***” as summarized herein would at least constitute an “**apparatus**”.

369. Thus, Trigui discloses an “**apparatus**” (for example, the exemplary embodiments of a 4×N MIMO DIAA system directed to cellular base stations in Trigui).

370. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element, if any.

371. At least because Trigui renders obvious the limitations of this claim element, if any, then Trigui in view of Rudrapatna and the knowledge of a POSITA also renders obvious the limitations of this claim element, if any.

19(a) m antenna arrays configured to receive a propagating radio frequency signal, each of the antenna arrays comprising:

a plurality of antenna elements; and

a beamformer configured to produce n different receive beams using the plurality of antenna elements;

372. The limitations of this claim element 19(a) are a subset of those for claim element 1(a). In particular, this claim element 19(a) does not require that the "**m antenna arrays**" also be "**configured to transmit a propagating radio frequency signal**" or that the "**beamformer**" be "**configured to produce n different bi-directional beams**" as opposed to only being "**configured to produce n different receive beams**".

373. Accordingly, my analysis of claim element 1(a) herein that shows both that Trigui and the knowledge of a POSITA renders obvious such limitations and that Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious such limitations also applies to this claim element 19(a).

374. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

375. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

19(b) n multiple-input multiple-output receivers (MIMO), each MIMO receiver configured to process m different received signals, wherein an i-th received signal to a j-th MIMO receiver corresponds to a j-th beam of an i-th antenna array,

376. The limitations of this claim element 19(b) are a subset of those for claim element 1(b). In particular, this claim element 19(b) does not require "**n multiple-input multiple-output transceivers (MIMO)**" as opposed to only "**n multiple-input multiple-output receivers (MIMO)**" and does not require that "**each MIMO transceiver**" also be "**comprising: … a MIMO transmitter configured to process m different transmit signals**".

377. Accordingly, my analysis of claim element 1(b) herein that shows both that Trigui and the knowledge of a POSITA renders obvious such limitations and that Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious such limitations also applies to this claim element 19(b).

378. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

379. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

19(c) wherein m and n are integer number values, and
wherein i=1, . . . , m, j=1, . . . , n, and
wherein n≥2 and m≥2.

380. The limitations of this claim element 19(c) are a subset of those for claim element 1(c). In particular, this claim element 19(c) does not require that "**v and z are integer number values**", that "**v=1, . . . m**", that "**z=1, . . . , w**" or that "**n≥w≥2**".

381. Accordingly, my analysis of claim element 1(c) herein that shows both that Trigui and the knowledge of a POSITA renders obvious such limitations and that Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious such limitations also applies to this claim element 19(c).

382. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

383. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

‘511 Patent: Claim 20

> 20. An apparatus comprising:
> a) m antenna arrays configured to transmit a propagating radio frequency signal, each of the antenna arrays comprising:
> a plurality of antenna elements; and
> a beamformer configured to produce n different transmit beams using the plurality of antenna elements; and
> b) n multiple-input multiple-output transmitters (MIMO), each MIMO transmitter configured to process m different transmit signals, wherein a v-th transmit signal from a z-th MIMO transmitter corresponding to a z-th beam of a v-th antenna array is selected for transmission,
> c) wherein m, n, v and z are integer number values, and
> wherein z=1, . . . , n, v=1, . . . , m, and
> wherein n≥2 and m≥2.

20. An apparatus comprising:

384. In my opinion, this preamble claim element expresses no limitations.

385. However, I have considered that this preamble claim element may be limiting.

386. For example, Trigui discloses exemplary embodiments of a “*4×N MIMO DIAA system*” for “*cellular base stations*” (see, for example, ¶¶ 105 and 122-127 above).

387. In my opinion, a POSITA would understand that Trigui’s disclosure of this “***MIMO DIAA system***” as summarized herein would at least constitute an “**apparatus**”.

388. Thus, Trigui discloses an “**apparatus**” (for example, the exemplary embodiments of a 4×N MIMO DIAA system directed to cellular base stations in Trigui).

389. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element, if any.

390. At least because Trigui renders obvious the limitations of this claim element, if any, then Trigui in view of Rudrapatna and the knowledge of a POSITA also renders obvious the limitations of this claim element, if any.

20(a) m antenna arrays configured to transmit a propagating radio frequency signal, each of the antenna arrays comprising:

a plurality of antenna elements; and

a beamformer configured to produce n different transmit beams using the plurality of antenna elements;

391. The limitations of this claim element 20(a) are a subset of those for claim element 1(a). In particular, this claim element 20(a) does not require that the "**m antenna arrays**" also be "**configured to receive a propagating radio frequency signal**" or that the "**beamformer**" be "**configured to produce n different bi-directional beams**" as opposed to only being "**configured to produce n different transmit beams**".

392. Accordingly, my analysis of claim element 1(a) herein that shows both that Trigui and the knowledge of a POSITA renders obvious such limitations and that Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious such limitations also applies to this claim element 20(a).

393. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

394. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

20(b) n multiple-input multiple-output transmitters (MIMO), each MIMO transmitter configured to process m different transmit signals, wherein a v-th transmit signal from a z-th MIMO transmitter corresponding to a z-th beam of a v-th antenna array is selected for transmission,

395. The limitations of this claim element 20(b) are a subset of those for claim element 1(b), subject also to a non-substantive wording change. In particular, this claim element 20(b) does not require "**n multiple-input multiple-output transceivers (MIMO)**" as opposed to only "**n multiple-input multiple-output transmitters (MIMO)**" and does not require that "**each MIMO transceiver**" also be "**comprising: … a MIMO receiver configured to process m different received signals**". Additionally, this claim element 20(b) recites that "**a v-th transmit signal from a z-th MIMO transmitter corresponding to a z-th beam of a v-th antenna array is selected for transmission**" as opposed to "**a v-th transmit signal from a z-th MIMO transmitter corresponds to a z-th beam of a v-th antenna array**" in claim element 1(b), but a POSITA would not consider this change in wording to convey any additional limitation beyond that already shown in my analysis of claim element 1(b) for both Trigui and the knowledge of a POSITA and Trigui in view of Rudrapatna and the knowledge of a POSITA.

396. Accordingly, my analysis of claim element 1(b) herein that shows both that Trigui and the knowledge of a POSITA renders obvious such limitations and that Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious such limitations also applies to this claim element 20(b).

397. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

398. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

20(c) wherein m, n, v and z are integer number values, and
wherein z=1, . . . , n, v=1, . . . , m, and
wherein n≥2 and m≥2.

399. The limitations of this claim element 20(c) are a subset of those for claim element 1(c). In particular, this claim element 20(c) does not require that "**i=1, . . . , m, j=1, . . . , n**", that "**z=1, . . . , w**" or that "**n≥w≥2**", but does require that "**z=1, . . . , n**". However, in my analysis of claim element 1(c) herein, I showed that both Trigui and the knowledge of a POSITA and Trigui in view of Rudrapatna and the knowledge of a POSITA disclosed "**w=n=2**", and thus the additional limitation for this claim element 20(c) of "**z=1, . . . , n**" was already shown by the claim element 1(c) limitation of "**z=1, . . . , w**" wherein "**w=n=2**".

400. Accordingly, my analysis of claim element 1(c) herein that shows both that Trigui and the knowledge of a POSITA renders obvious such limitations and that Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious such limitations also applies to this claim element 20(c).

401. Therefore, in my opinion, Trigui and the knowledge of a POSITA renders obvious the limitations of this claim element.

402. Therefore, in my opinion, Trigui in view of Rudrapatna and the knowledge of a POSITA renders obvious the limitations of this claim element.

IX. CONCLUSION

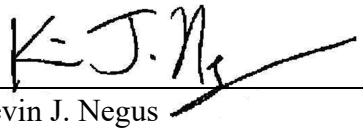
403. In my opinion, the claims of the '511 Patent are invalid for at least the reasons stated above.

404. I reserve the right to supplement my opinions in the future to respond to any arguments raised by Patent Owner or its experts and to take into account new information that becomes available to me.

405. I declare under penalty of perjury that all statements made herein are of my own knowledge and are true and correct and were made with the knowledge that willful false statements are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Respectfully submitted,

Date: May 8, 2024



Kevin J. Negus