

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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ERICSSON INC.  
NOKIA OF AMERICA CORPORATION  
Petitioner,

v.

XR COMMUNICATIONS LLC,  
Patent Owner.

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Case IPR2024-00868  
Patent 8,737,511

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**DECLARATION OF TODOR V. COOKLEV, PH.D.**

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## **I. INTRODUCTION**

1. My name is Todor V. Cooklev, Ph.D. I have been retained as an expert witness to provide my independent opinion in regard to the matters at issue in *inter partes* review of U.S. Patent No. 8,737,511 (“the ’511 patent”) in IPR2024-00868. I have been retained by XR Communications LLC, the “Patent Owner” in the above proceedings. Petitioners are Ericsson, Inc., and Nokia of America Corporation (“Petitioners”).

2. I am being compensated at my standard hourly rate of \$700 for my time spent working in connection with this case. My compensation does not depend on my opinions or on the outcome of this litigation. If called as a witness, I would testify to the statements and opinions contained in this report.

3. I am not a legal expert and offer no opinions on the law. However, I have been informed by counsel of the various legal standards that apply, and I have applied those standards in arriving at my conclusions.

## **II. BACKGROUND AND QUALIFICATIONS**

4. Below is a summary of my background and qualifications. A detailed record of my professional qualifications is set forth in Exhibit 200, which is my *curriculum vitae*, including a list of publications, awards, courses I teach in electrical and computer engineering subjects, research grants, and professional activities. In addition, I am attaching my Curriculum Vitae, which includes

additional information about my qualifications and publications, as Appendix A to this declaration.

5. I am currently professor of electrical and computer engineering at Purdue University in Fort Wayne, Indiana, where I have had several administrative and faculty appointments.

6. I have taught courses in communication systems and networks, signals and systems, software-defined radio, and digital signal processing. My research interests include most aspects of modern wireless systems, including hardware and software architectures. A significant part of my research is specifically focused on standards-related issues. I have received a number of research grants in these areas.

7. I am a named inventor on more than thirty U.S. patents, most of which relate to the hardware or software aspects of communication systems. In 2019, I was inducted into the Purdue Inventors Hall of Fame. I have also authored and co-authored more than one hundred peer-reviewed articles. A list of my publications and patents appears in my *curriculum vitae* attached as Exhibit 2002. Among my publications is the textbook “Modern Communications Systems: A First Course”, published by the University of Michigan in 2024. Since publication, according to the publisher, my textbook has been used at over 200 universities in the United States and 100 abroad.

8. I graduated from Tokyo Institute of Technology in Tokyo, Japan in 1995 with a Doctor of Philosophy (Ph.D.) degree in Electrical Engineering.

9. In addition to my academic experience, I have worked in the computer and data communications industries. I worked in research and development, but also contributed to product firmware and software development, including digital signal processing algorithms for communication systems.

10. I have contributed to the development of several major standards for communication systems and numerous amendments, including Bluetooth, T1.413 and ITU G.993 standards for DSL, IEEE 802.11 (Wi-Fi), LTE Advanced, and standards related to signal intelligence and tactical radio systems. I have participated in many meetings of standards committees and I have chaired some committee meetings and served in other leadership roles.

11. Around 1998 - 1999 I was among the authors of the Bluetooth 1.0 specification, contributing to the Host Controller Interface (HCI). In 1999 I participated in the group that established the license agreement between the Bluetooth SIG and the IEEE 802. Subsequently I joined IEEE 802.

12. From 2000 to 2002, and from 2005 to 2008 I was a Voting Member of the IEEE 802.11 Working Group, serving at times in leadership roles. From 2005-2006 to around 2007-2008 I was Chair of a Study Group. For my work I received an IEEE Standards Association award in 2012.

13. I have participated in other organizations and contributed to other standards, generally related to wireless communication systems. For example, I have contributed to the IEEE 1588 Precision-Time Protocol (PTP) and the VITA 49 standard. Around 2007-2011 I participated in the Software-Defined Radio Forum (now called the Wireless Innovation Forum) contributing to the Cognitive Radio Ontology 1.0.

14. One aspect of my research since about 2007 has been interfaces between the analog RF and digital section of a radio. The OBSAI/CPRI interfaces described by the prior art identified by the Petitioner, are examples of such interfaces.

15. In the 2011-2012 timeframe I made contributions related to the development of LTE-Advanced and attended several meetings of the 3<sup>rd</sup> Generation Partnership Project (3GPP).

16. I have received research funding from the National Science Foundation (NSF) and a number of technology companies. During 2009-2019 I participated in the NSF Industry/University Cooperative Research Center on Software and Security. Further, since 2013 I have received a series of grants, beginning with a grant from the Defense Advanced Research Projects Agency (DARPA) under the Small Business Technology Transfer program, followed by funding from the U.S. Air Force Research Laboratory, Rome NY, for my work

generally related to electronic warfare. In 2020 I was a Navy Fellow further continuing that work.

17. In 2020 I was elected to serve on the Board of Governors of the IEEE Standards Association as a Member-at-Large. I participated in several committees of the Board. The Board of Governors provides overall leadership of the IEEE Standards Association and interacts with other standards organizations worldwide.

18. Since 2017 I have been the Series Editor for Wireless and Radio Communications for the IEEE Communications Standards Magazine (which is the premier journal in the field of communication standards). As member of the Editorial Board I coordinate the review of scholarly manuscripts that relate to the most recent communications standards.

19. I am qualified by education and experience to testify as an expert with respect to subject matter in the fields of standards for wireless communications such as cellular, Wi-Fi, and Bluetooth, wireless communications protocols, wireless data transmission, wireless device hardware, data and signal processing hardware and software, and wireless device interoperability.

### **III. MATERIALS CONSIDERED**

20. In the course of conducting my analysis and forming my opinions, I have reviewed materials including those listed below:

- i. U.S. Patent No. 8,737,511 (Ex. 1001) (“the ’511 patent”);

- ii. The prosecution history of the '511 patent (Ex. 1002);
- iii. The Declaration signed by Dr. Negus in IPR2024-00868 (Ex. 1003) (the “Negus Declaration” or “Negus Decl.”);
- iv. Petition for *inter partes* review of U.S. Patent No. 8,737,511 (the “Petition” or “Pet.”) and exhibits thereto, including US Patent Application 2011/0150050 (Ex. 1004 or “Trigui”)
- v. Patent Owner’s Preliminary Response for IPR2024-00868 (“POPR”)
- vi. Institution Decision for IPR2024-00868 (“ID”)
- vii. “Wireless Communications”, Cambridge University Press, 2005. (Ex. 2005)
- viii. “Fundamentals of Wireless Communication,” Cambridge University Press, 2005. (Ex. 2006)
- ix. The exhibits and other documents cited herein.

#### **IV. LEVEL OF ORDINARY SKILL**

21. My opinions in this declaration are based on the understandings of a person of ordinary skill in the art, as of the time of the invention. I understand that the POSITA is a hypothetical person who is presumed to have known the relevant art at the time of the invention. By “relevant,” I mean relevant to the challenged claims of the '511 patent.

22. Dr. Negus opines that a POSITA “[w]ould 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. 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.” [Ex. 1003 at ¶ 24-25].

23. For the purpose of this declaration, I apply the same definition of the level of skill of a POSITA. I understand that an analysis of alleged invalidity of a patent be performed from the perspective of a POSITA. The ’511 Patent was filed in April 2012. My opinions in this matter are from the perspective of a POSITA as of that date; however, my opinions would not change if the priority date is slightly changed or if the level of POSITA slightly changed.

24. Based on my experience, education, and training, I met the definition of a POSITA as of the priority date of the Patent. My qualifications at that time far exceeded that of a POSITA, and I had worked with, as well as supervised, many

POSITA's throughout my work in the field. My opinions concerning the '511 patent claims and the prior art are from the perspective of a POSITA, as set forth above.

## **V. APPLICABLE LEGAL STANDARDS**

25. I am not a lawyer, and I do not intend to offer any opinions as to the interpretation of the law. When considering the '511 patent and stating my opinions, I rely on the following legal standards as described to me by Patent Owner's counsel.

### **A. Claim Construction**

26. I understand that claims in a patent-at-issue in an IPR are generally interpreted according to the district court-type claim construction.

27. I further understand that this means that claim terms are interpreted as they would have been interpreted by a person of ordinary skill in the art at the time of the invention, in light of the specification and the patent's prosecution history in the patent office.

### **B. Obviousness**

28. I understand that a patent claim is unpatentable if the claimed invention would have been obvious to a person of ordinary skill in the art at the time of the invention.

29. I understand that an obviousness analysis involves comparing a claim to the prior art to determine whether the claimed invention would have been obvious

to a person of ordinary skill in the art at the time of the invention in view of the prior art and in light of the general knowledge in the art as a whole. I also understand that obviousness is ultimately a legal conclusion based on underlying facts of four general types, all of which must be considered: (1) the scope and content of the prior art; (2) the level of ordinary skill in the art; (3) the differences between the claimed invention and the prior art; and (4) any objective indicia of non-obviousness, including any praise of the invention. Objective indicia of non-obviousness may include, for example, commercial success of an embodiment, a long-felt need, skepticism, failure by others to find the solution provided by the claimed invention, copying by others of the subject matter of the claim invention, unexpected results of the claimed invention, acceptance of others and industry praise, and licensing of the patents.

30. I also understand that obviousness may be established under certain circumstances by combining or modifying the teachings of the prior art. However, I have been informed that a claim is not proved obvious merely by demonstrating that each of the elements was independently known in the prior art. I have been informed that many, if not all, inventions rely on building blocks already previously known, and claimed discoveries almost of necessity will likely be combinations of what is already known. I have been informed that it is important to identify whether a reason existed at the time of the invention that would have motivated a person of

ordinary skill in the art in the relevant field to combine the known elements in the way the claimed invention does. Specific teachings, suggestions, or motivations to combine any first prior art reference with a second prior art reference can be explicit or implicit, but must have existed before the date of purported invention. I understand that prior art references themselves may be one source of a specific teaching or suggestion to combine features of the prior art, but that such suggestions or motivations to combine art may come from the knowledge that a person of ordinary skill in the art would have had.

31. I understand that a reference may be relied upon for all that it teaches, including uses beyond its primary purpose, but also including teachings that lead away from the invention. I understand that a reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, although the mere disclosure of alternative designs does not teach away.

32. I further understand that whether there is a reasonable expectation of success in combining references in a particular way is also relevant to the analysis.

33. I understand that it is improper to use hindsight to combine references or elements of references to reconstruct the invention using the claims as a guide. My analysis of the prior art is made from the perspective of a person of ordinary skill in the art at the time of the invention.

34. I am not offering any legal opinions in this declaration nor am I qualified to do so. I only consider such legal standards in framing my opinions and conclusions as well as placing assertions made by Petitioners in the Petition into the proper context. Additionally, from a subject matter perspective, I understand that the petitioner always has the burden of persuasion regarding a challenge of patentability of an invention under an *inter partes* review.

## **VI. RELEVANT TECHNOLOGY BACKGROUND**

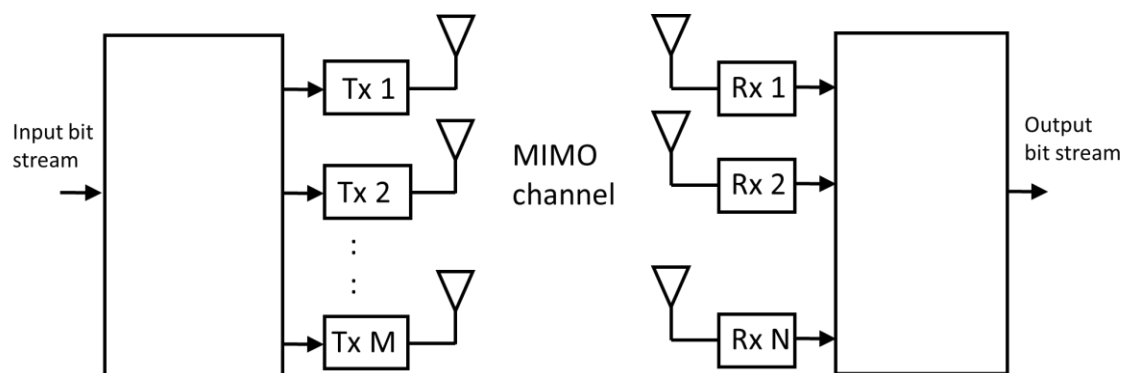
35. Multiple-Input Multiple-Output (MIMO) is a technique involving generally multiple antennas at both ends of a connection<sup>1</sup>. Strictly speaking, the component that is MIMO is the channel.

36. This is recognized by the '511 patent: "MIMO systems often have multiple transmitters (e.g., one associated with each transmit antenna) and multiple receivers (e.g., one associated with each receive antenna)." [Ex. 1001 at 1:13-16].

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<sup>1</sup> There are cases when one of the devices has a single antenna, either on the transmitter, making the channel single-input multiple-output (SIMO) or on the receiver, making the channel multiple-input single-output (MISO). These cases can be considered special cases of MIMO.

Such a MIMO connection between two devices is illustrated below:



37. At the time of the invention (and today) a person of skill would have referred to a multiple-antenna device as a MIMO device or MIMO system. Typically, every MIMO device is capable of both transmitting and receiving.

38. Further, a person of skill would have understood that for a device to be a MIMO device there must be some coordination between these multiple transmitters and receivers, even if this coordination is not explicitly shown. For example, generally the signals transmitted on the multiple antennas have the same carrier frequency, the same symbol period, and are aligned in time. This coordination is generally easy to achieve when the transmitters associated with every antenna are part of the same device or system.

39. One advantage of MIMO is that by transmitting or receiving independent signals on every antenna simultaneously<sup>2</sup> the spectrum efficiency of

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<sup>2</sup> This simultaneous transmission is an example of the synchronization mentioned above.

wireless transmission is increased. [*See generally* “Wireless Communications”, Cambridge University Press, 2005.] The number of data streams that can be transmitted can be at most equal to the number of antennas, assuming the transmitter and receiver have equal numbers of antennas. *See Id.*

40. A POSITA would have also understood that the transmission of multiple uncoordinated transmitters is not MIMO. Without coordination, the result is multiple separate transmissions.

41. The Petition describes MIMO as: “So, for example, in a 2x2 MIMO system, there are 2 transmit antennas (or sets of antennas if beamforming is done) and 2 receive antennas (or sets of receive antennas if beamforming is done).” [Petition at p. 28]<sup>3</sup>. However, the Petition omits that there must be coordination between the 2 transmit antennas (and separately between the 2 receive antennas). Another fact omitted by the Petition is that MIMO systems are capable of beamforming *without* sets of antennas. A MIMO device with 2 antennas can perform beamforming, for example by precoding at the transmitter and some processing (which can be referred to as post-coding) at the receiver. [*See* “Wireless Communications”, Cambridge University Press, 2005, Chapter 10.] Further, this

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<sup>3</sup> I note that this statement in the Petition does not seem to be present in the Declaration by Dr. Negus.

type of beamforming would be optimal for a given wireless channel. Therefore, two *sets* of antennas are not needed at either end of the connection.

42. Wireless communication devices consist of a digital hardware section and an analog RF section. The analog front-end performs the tasks of down-conversion and up-conversion from RF to baseband, or baseband to RF, and also does filtering for frequency band selection, and amplification. Digital signal processing (DSP) operations – modulation, coding, etc. – are implemented on baseband signals (that are centered at zero frequency). [See “Fundamentals of Wireless Communications, Cambridge University Press, 2005, Section 2.2.2.]

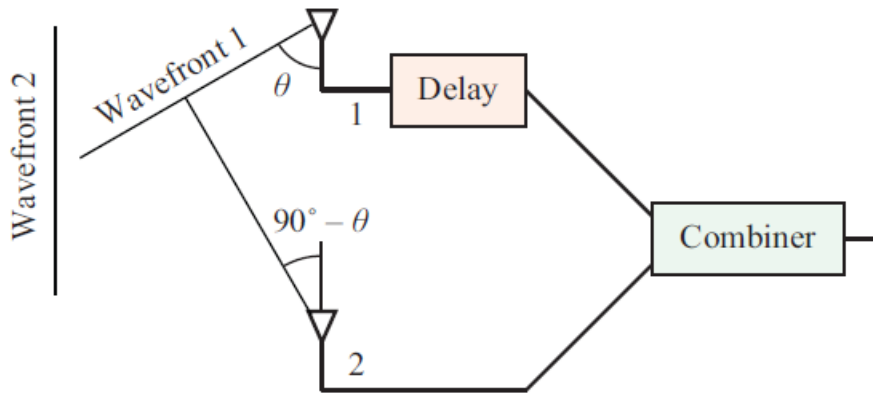
43. The interface between the analog RF and the digital sections can be standardized. This interface includes IQ samples and additional control signals. The Open Base Station Architecture Initiative (OBSAI) and the Common Public Radio Interface (CPRI) are examples of such interface standards, applicable to base stations. At the time of the invention, the two components separated by this interface were called Baseband Unit (BBU) and a Remote Radio Head (RRH).

44. A device with multiple antennas (alternatively antenna elements) can beamform. A beam is the main lobe of the radiation pattern of an antenna array. Beamforming is a method to focus the radio signal in a given direction similar to a flashlight. While the flashlight analogy is appropriate, there is a difference. Beamforming can also be a receive function, because antennas are reciprocal devices.

45. The higher the number of antenna elements, the narrower the beam and the higher the antenna gain. With beamforming, the power is transmitted mainly in the direction of the intended receiver, which reduces interference and leads to higher achievable bitrates. Because the radio signal is focused in a certain direction, beamforming leads to a higher Signal-to-Interference and Noise Ratio (SINR). In turn, a higher SINR allows higher-order modulation and/or higher-rate coding to be used, which, in turn, lead to higher throughput.

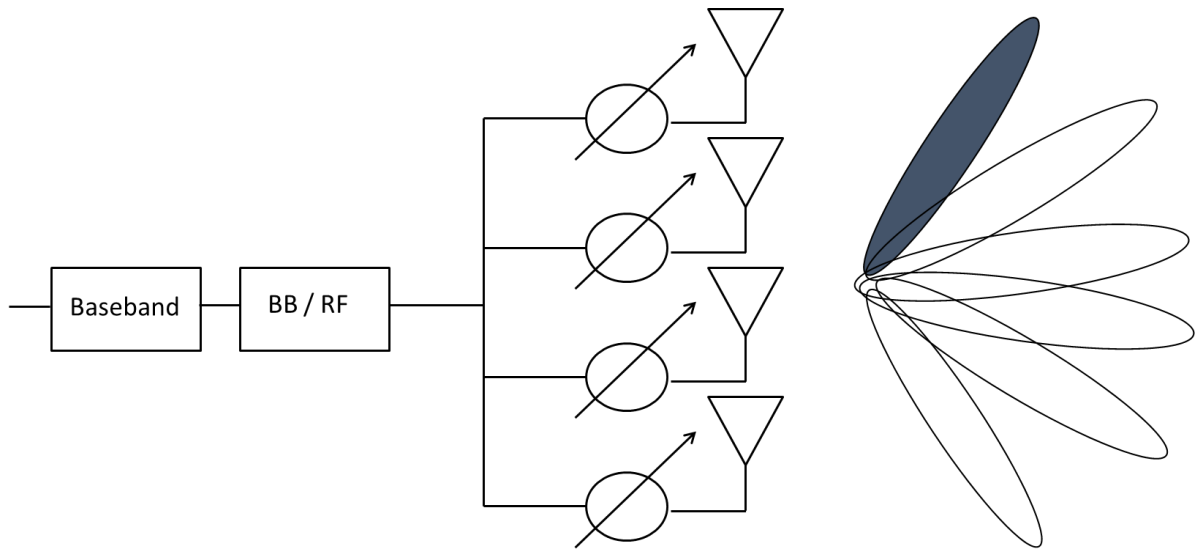
46. Beamforming involves multiple antennas and the ability to adjust the amplitudes and phases of the signals transmitted or received by the multiple antennas. While each antenna element in a linear array has its own radiation pattern, the RF effect of the entire array depends on the spacing, phase shifts and/or amplitude variation between its elements.

47. The figure below provides a simple illustration of two waves impinging on two antenna elements from two different directions. Wave 1 will strike the second antenna element sometime after it strikes the first antenna element because it travels additional distance. If there is a time delay in the receive path after the first antenna element (as shown in the figure) the two signals will arrive in phase at the combiner; and there will be antenna gain in that direction.



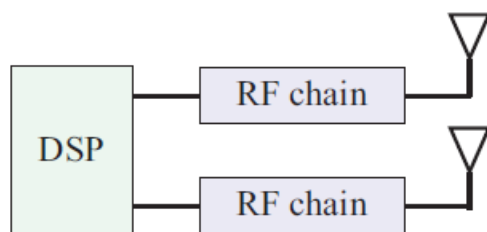
48. On the other hand, wave 2 arrives at the same time at the antenna elements. After the same delay is applied, the phases of the two signals become misaligned. The receiver is able to receive wave 1, but not wave 2.

49. This time delay is equivalent to and can be implemented with a phase shift. [See Fundamentals of Wireless Communication, Cambridge University Press, 2005] This is the traditional approach to beamforming illustrated in the figure below that I prepared. This figure shows 4 antenna elements and 4 phase shifters. Before the phase shifting is the RF to Baseband (in receive mode) and BB to RF (in transmit mode) conversion. In other words, phase shifting is implemented in the RF domain.



50. Because the phases are adjusted using an analog technique, this type of beamforming is analog and is generally cost-effective.

51. If the phases (and possibly the amplitudes) are adjusted in the digital domain, beamforming is digital. The accuracy of digital beamforming is superior. However, digital beamforming requires a separate RF chain for every antenna element. Each RF chain includes, *inter alia*, down- and up-converters, and high-performance analog-to-digital and digital-to-analog converters (ADCs). The required digital signal processing (DSP) is also complex. This increases the number of components and cost, especially when the number of antenna elements is large.



52. A MIMO device can perform a different type of digital beamforming which allows to transmit multiple data streams as long as the number of data streams is less than the number of transmit antennas. To perform multi-stream beamforming, the transmitter multiplies the first columns of the matrix  $V$  (also called steering vectors, obtained after singular-value decomposition (SVD)) with the vector of symbols to be transmitted. This operation at the transmitter can be called precoding. The receiver performs post-coding by multiplication with the first columns of the matrix  $U^H$  (which is also obtained from the SVD). This type of beamforming is optimal when the wireless channel is known. [See Fundamentals of Wireless Communication, Cambridge University Press, 2005].

## VII. THE '511 PATENT

### C. Overview

53. The '511 patent is directed at system that includes a plurality of  $m$  antenna arrays. The components of an antenna array are antennas themselves and can be referred to as antenna elements:

“Each antenna array includes a plurality of antenna elements and a beam former configured to produce  $n$  different bi-directional beams using the plurality of antenna elements.” [See Ex. 1001 at 1:30-33.]

“For example, 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 Ex. 1001 at 4:5-8.]

54. The '511 patent describes and claims a specific beamforming architecture involving  $m$  antenna arrays. For example, as the specification describes: “The  $m$  antenna arrays can be separated by a distance more than one wavelength apart at the carrier frequency. The antenna elements can be less than or equal to one half wave length apart at the carrier frequency.” Ex. 1001 at 1:54-57. The close separation of antenna elements within one array and the comparatively large distance among the antenna arrays is an exemplary feature that illustrates and can be important for the benefits of the '511 patent.

“For example, 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**. 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.” [See Ex. 1001 at 5:47-54.]

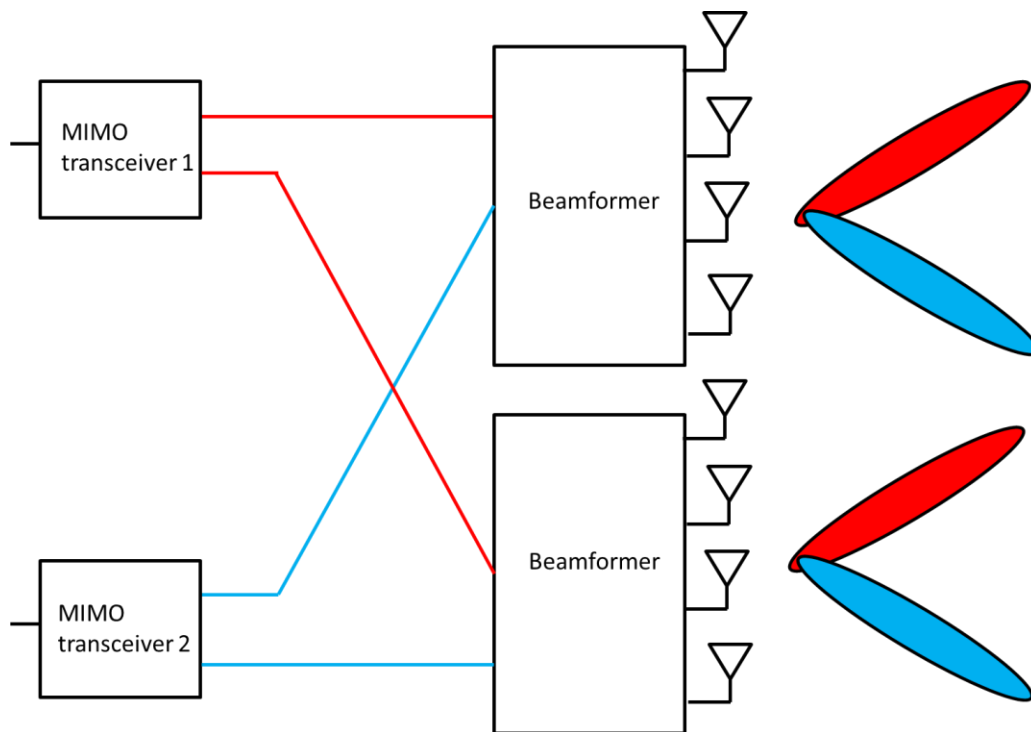
55. The antenna arrays use “beamformers”, which adjust the phases and possibly the amplitudes of the signals on the different antenna elements:

The antenna array **130**, **140** may be configured with a beamformer that provides fixed beams or steerable beams.” [See Ex. 1001 at 4:9-10.]

56. The '511 patent describes a specific architecture that combines  $n$  MIMO transceivers, where each MIMO transceiver is configured to provide  $m$  output signals:

“The system includes a plurality of  $n$  multiple-input multiple output transceivers (MIMO). Each MIMO transceiver includes 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. Each MIMO transceiver also includes 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.” [See Ex. 1001 at Abstract. See also at 1:33-42.]

57. The system that is claimed by the '511 patent can be illustrated for the case  $n=2$  and  $m=2$  as follows



58. The '511 patent system combines MIMO and beamforming operations. According to the specific architecture that is claimed by the patent:

“In some configurations, there are as many MIMO transceivers **160** as beams supported by any one antenna. In this configuration, the

number of antenna arrays is equal to the number of receive input and transmit output ports on each MIMO transceiver.” [See Ex. 1001 at 4:32-36.]

#### **D. Priority Date**

59. The ’511 patent was filed on April 13, 2012, and the challenged claims are entitled to a priority date no later than April 13, 2012. ’511 patent at (22). Petition does not challenge the April 13, 2012, priority date of the challenged claims. Pet. 14. Thus, the parties are adopting that date for purposes of this IPR.

#### **E. Prosecution History**

60. I understand the following regarding the prosecution history of the ’511 patent. The application leading to the ’511 patent, Application No. 13/447,139, was filed on April 13, 2012. ’511 Pros. Hist. (Ex. 1002) at 1. On, June 29, 2012, the PTO issued a first office action, rejecting claim 1 and certain other claims as obvious over U.S. Patent Pub. 2009/0322608 (Adams) and U.S. Patent Pub. 2002/1032600 (Rudrapatna). *Id.* at 64-73. On September 21, 2012, the Applicant amended claim 1 and other claims “to more clearly define the features of those claims and improve form.” *Id.* at 87. Regarding obviousness, the Applicant distinguished Adams and noted that Rudrapatna fails to cure the deficiencies of Adams. *Id.* at 89-92.

61. On January 25, 2013, the Examiner issued a final obviousness rejection and an Examiner-Initiated Interview Summary. *Id.* at 96-99. The

interview summary notes: “claim 1 was discussed with regard to the amendment made” and suggestions “were provided as to how the claim be improve[d] in order to further prosecution and potentially put the case in condition for allowance.” *Id.* at 98.

62. On March 23, 2013, the Applicant amended the claims again. *Id.* at 115. The Applicant also made arguments distinguishing Adams to overcome the obviousness rejection. *Id.* at 121-126. In notable part, the Applicant argued that:

- “Thus, nowhere does Adams describe an implementation where the number of beams per antenna array is equal to the number of MIMO transceivers.”
- “Thus, nowhere does Adams describe an implementation where the number of inputs/outputs per MIMO transceiver is equal to the number of antenna arrays.”

*Id.* at 124.

63. The Applicant did not substantively discuss Rudrapatna. This is because, as the Applicant stated: “Rudrapatna fails to cure the above-noted deficiencies of Adams. Nor does the Office allege that Rudrapatna does.” *Id.* at 125. Thus, as the Applicant argued, Adams and Rudrapatna, whether taken alone or in combination fail to disclose or suggest the features of claim 1 and the obviousness rejection for all pending claims should be withdrawn. *Id.* at 125-126.

64. On January 16, 2014, the Examiner issued a Notice of Allowance accompanied by the Detailed Action. *Id.* at 193-206. The Examiner found that Adams alone, as well as 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” and it would have been obvious to one having ordinary skill in the art.” *Id.* at 206. Therefore, “the office found the claimed invention to be allowable over the cited prior art.” *Id.*

65. On April 14, 2014, the Applicant submitted a comment on the Examiner’s reasons for allowance. *Id.* at 222. The Applicant Clarified that entry of the reasons for allowance “should not be construed as any agreement with or acquiescence in the reasoning stated by the Examiner” (as the only reasons for allowance). The Applicant noted that “Each of the claims stands on its own permits and is patentable because of the combination it recites and not because of the presence or absence of any particular element.” *Id.*

## **VIII. CLAIMS-AT-ISSUE AND CLAIM CONSTRUCTION**

66. I understand that Petitioners have challenged Claims 1-2, 4-6, 9-11, 13-15, and 18-20. Under Ground I the Petitioners are challenging Claims 1-2, 4-6, 9-11, 13-15, and 18-20 as allegedly obvious over Trigui. Claims 1, 10, and 19 are

independent claims, and claims 2, 4-6, 9, 11, 13-15, 18, and 20 are dependent claims. Claim 1 contains limitations that appear in other challenged claims.

67. In this Declaration I address independent Claim 1 which recites:

[1 pre]<sup>4</sup> A system comprising:

[1a] 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

[1b] 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,

[1c] 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  $i=1, \dots, m$ ,  $j=1, \dots, n$ , and  $v=1, \dots, m$ ,  
wherein  $n \geq 2$  and  $m \geq 2$ ,  
wherein  $z=1, \dots, w$ , and  
wherein  $n \geq w \geq 2$ .

68. The Petition contends that no formal claim constructions are necessary and that each term carries its plain and ordinary meaning. Pet. at 13-14. I

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<sup>4</sup> I adopt the numbering used by Dr. Negus and the Petition.

understand that Patent Owner did not propose any constructions in its POPR but informed the Board about claim construction proceedings in the parallel district court action.

69. The parallel district court action (“Related Actions”) are:

- *XR Communications LLC v. Verizon Communications, Inc. et al.*, Case 2:23-cv-00203-JRG-RSP (E.D. Tex.);
- *XR Communications LLC v. T-Mobile USA, Inc.*, Case 2:23-cv-00204-JRG-RSP (E.D. Tex.);
- *XR Communications LLC v. AT&T Services Inc.*, AT&T Mobility LLC, and AT&T Corp., Case 2:23-cv-00202-JRG-RSP (E.D. Tex.);
- *XR Communications LLC v. Verizon Communications, Inc. et al.*, Case 2:23-cv-00470-JRG-RSP (E.D. Tex.);
- *XR Communications LLC v. T-Mobile USA, Inc.*, Case 2:23-cv-00469-JRG-RSP (E.D. Tex.); and
- *XR Communications LLC v. AT&T Services Inc.*, AT&T Mobility LLC, and AT&T Corp., Case 2:23-cv-00468-JRG-RSP.

70. In the Related Actions, the parties have proposed the following constructions for the ’511 patent, as shown the parties’ Joint Claim Construction Chart filed on August 28, 2024:

| '511 Patent Claim Term                                                                                                                                                                                    | Patent Owner / Plaintiff XR's Proposed Construction   | Petitioners / Intervenor Ericsson & Nokia's Proposed Construction                                           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| "n multiple-input multiple-output Transceivers (MIMO)"<br><br>( '511 Patent claims 1, 10)                                                                                                                 | No construction necessary; plain and ordinary meaning | "a single unit comprising a MIMO transmitter and a MIMO receiver, with common circuit components"           |
| "MIMO transmitter configured to process . . .<br>"Z-th MIMO transmitter"<br>"in multiple-input multiple-output transmitters (MIMO)"<br>/ "a Z-th MIMO transmitter"<br><br>( '511 Patent claims 1, 10, 20) | No construction necessary; plain and ordinary meaning | "transmitter that processes MIMO signals for transmission"                                                  |
| "MIMO receiver configured to process . . ." / "j-th MIMO receiver" / "n multiple-input multiple-output receivers (MIMO)"<br><br>( '511 Patent claims 1, 10, 19)                                           | No construction necessary; plain and ordinary meaning | "receiver that processes received MIMO signals"                                                             |
| "2nd Generation Partnership Project (3GPP) Long Term Evolution (LTE), 3GPP LTE-Advanced, 3GPP LTE-TDD, 3GPP LTE-FDD"<br><br>( '511 Patent claims 2, 11)                                                   | No construction necessary; plain and ordinary meaning | "one of the 3GPP LTE, LTE-Advanced, LTE-TDD or LTE-FDD standards that existed at the time of the invention" |

71. I understand that Notably, Petitioners / Intervenor proposed four constructions for terms of the '511 patent in the Related Actions that they have not

proposed in this IPR. I further understand that the District Court has not adopted Petitioners' narrower constructions for independent claim 1.

72. I understand that claim construction is an issue of law and I do not propose any express constructions in this declaration. However, I would like to clarify that the plain and ordinary meaning of claim 1, including the term “ $n$  MIMO transceivers” in the context of the '511 patent would include some coordination among the MIMO transceivers. This coordination would be a result of these  $n$  MIMO transceivers being part of the same claimed system that comprises the claim elements. That is how a POSITA would understand the claim. To the extent that Petitioners / Dr. Negus advance a different understanding without any concept or requirement of coordination, that would be incorrect, either to a POSITA's understanding or as a matter of claim construction.

73. I note that Dr. Negus and the Petition appear not to pay a consideration to this aspect of the claimed  $n$  MIMO transceivers. The meaning that Dr. Negus seems to have applied includes any set of MIMO transceivers, without any concept or requirement of coordination.

## **IX. GENERAL COMMENTS REGRADING TRIGUI**

74. US Patent Application 2011/0150050 (hereinafter Trigui) is prior art identified by Dr. Negus and Petitioners. Trigui is devoted to the problem “... 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” [See Ex. 1004 at [0020].]

75. In particular, Trigui seeks to “share antenna elements and active electronics between multiple operators servicing the same geographic area”. [See Ex. 1004 at [0002].]

76. Trigui advances a “digital integrated antenna array (DIAA)”.

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, while FIG. 2B shows a more detailed implementation of the DIAA of FIG. 2A. [See Ex. 1004 at [0036].]

77. The Petition and the Declaration cite to Figure 6, which is an “[e]xemplary implementation of a 2xN MIMO DIAA, essentially including multiples of the hardware of FIGS. 2A and 2B”. [See Ex. 1004 at [0036].] Also, “...FIG. 6 illustrates two MIMO branches configured to provide a 2xN MIMO DIAA system.” [See Ex. 1004 at [0081].]

78. While Trigui refers to “2xN MIMO”, Trigui clarifies that “N is the number of transceivers at the subscriber station, a detailed discussion of which is outside the scope of the present application.” [See Ex. 1004 at [0036].] Dr. Negus opines that a POSITA would understand from Figure 6 of Trigui that it “[d]escribes at least the case where “ $N = 2$ ”. [See Ex. 1003 at ¶ 191.] I disagree. Trigui leaves the number of transceivers at the subscriber station “outside the

scope'. At the time of the invention virtually all subscriber stations had a single transceiver.

79. Similarly, I disagree with Dr. Negus that “*4×N MIMO DIAAs*” depicted in FIGS. 7-11 of Trigui ... describes at least the case where “*N = 4*” [See Ex. 1003 at ¶ 195 (emphasis in original).] Reference to 4 x N makes no assumption about N.

80. Trigui relates to base station architectures where the analog RF and digital sections of a radio are separated by interfaces such as OBSAI or CPRI. On one side of this interface is a “modem” or “baseband module”:

In FIG. 2A, 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. The one or more digital interface cores 208, 210 are used to handle signals as specified by Open Base Station Architecture Initiative (“OBSAI), Common Protocol Radio Interface (“CPRI), or other propriety digital interfaces. Each digital interface core is able to multiplex the multi-antenna signals, if applicable, and extract messages to control and monitor specific hardware components or registers which are then relayed to an operation and maintenance (“OAM) module 212.” [See Ex. 1004 at [0037].]

81. Trigui’s solution connects each modem using a separate “interface core” that implements the interface.

“In FIG. 2B, six OBSAI/CPRI cores 210 are used to correspond to 6 distinct modem signals. Each core is able to handle one or more signals as specified in the OBSAI, CPRI, or base station vendor standards. The cores will de-multiplex the multi-antenna signals, if applicable, and extract specific messages to control and monitor

specific hardware components and/or registers.” [See Ex. 1004 at [0052].]

82. The beamforming weights in Trigui are calculated by software:

“The server based software is used to control the DIAA 200 allowing a user to define any shape of radiation pattern for the passive antenna array 202 via a graphical user interface or entering key parameters such as azimuth pointing direction, azimuth beamwidth, side-lobes level, electrical tilt, RF frequency, and antenna type. The server based software calculates the ideal beam forming weights 214 that best approximate the desired radiation pattern and the weights are passed to the DIAA 200.” [See Ex. 1004 at [0038].]

“Further, the server based software can be equipped with a real-time optimization module that dynamically adjusts the radiation patterns to improve coverage and capacity without need for human intervention or a fixed schedule.” [See Ex. 1004 at [0039].]

83. In the architecture of Trigui beamforming is performed in the “beamforming and frequency translation module”:

“After processing by the digital interface cores 208, 210, each of the modem signals are transmitted to the beam forming 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. FIG. 2A illustrates a system having four digital interface cores 208,210 and four transceiver paths; however, it should be apparent to one of ordinary skill in the art that alternative numbers of each may be used. Each set of the modem signals, after split, is multiplied by the beam forming 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 Ex. 1004 at [0044].]

84. A POSITA would have understood that the modem signals are at baseband and the beamforming and frequency translation in Trigui is also at baseband level. Beamforming in Trigui is implemented by multiplying each branch with a complex number:

“Each modem signal is then frequency shifted before being fed into a beam forming core 218 where the modem signal is split into a number of signals equal to the number of transceivers in the DIAA (FIG. 2B shows 4 transceivers). Additionally, in the beam forming 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 Ex. 1004 at [0052].]

85. Trigui envisions that the DIAA can be “... [u]sed as a substitute for the prior art remote radio heads (“RRH”)” [See Ex. 1004 at [0058].] Further, Trigui proposes that several cellular operators use the invention:

“Operator 1 **314** and Operator 2 **316** could operate different radio access technologies (RAT) in the case the operators coexist within the frequency bandwidth as the present invention is RAT agnostic.” [See Ex. 1004 at [0059].]

86. The advantages that Trigui seeks are

“Additionally, the DIAA, when controlled by the server-based software, is capable of providing new business opportunities for tower owners who currently rent space and, at best, provide the service of basic infrastructure to service providers. In this manner, the DIAA could function as a key enabling system element for the tower company to provide high value services to the service provider simply by investing in DIAA equipment, server-based control software, and low to medium skilled operational personnel.” [See Ex. 1004 at [0069].]

## X. REBUTTAL OPINIONS

87. In my opinion, Petitioners and Dr. Negus have not shown invalidity under any obviousness ground asserted in the petition for any challenged claim of the '511 patent. My decision to not rebut a particular opinion is declaration is not, and should not be interpreted as, agreement with that opinion. Rather, I have set forth my opinions below sufficient to support my conclusion that invalidity has not been shown for any of the challenged claims.

### A. Trigui does not render obvious limitation [1a]

88. It is my opinion that Petitioner and Dr. Negus have not shown that Trigui renders obvious limitation [1a].

89. Limitation [1a] requires  $m$  antenna arrays, where each array comprises a beamformer configured to produce  $n$  different bi-directional beams<sup>5</sup>.

90. Trigui's antenna arrays are not configured to produce  $n$  different bidirectional beams. Trigui's passage on which the Petition and Dr. Negus rely on recites "...[u]ser-specified radiation pattern may have one or more subsector radiation patterns (*bi-directional beams*).” [Ex-1003 ¶¶182-183 citing Ex-1004, [0044]] [Petition at p. 25]. A POSITA would have understood that a “user-specified radiation pattern is different from the claim element “ $n$  different

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<sup>5</sup> The meaning of the integers  $m$  and  $n$  is further clarified in limitation [1b].

bidirectional beams”. Claim element [1b] clarifies that  $n$  is the number of MIMO transceivers.

91. The Petition’s and Dr. Negus rely on Trigui’s Figures 4A and 4B as as allegedly teaching this limitation. They state: “Each of Trigui’s arrays can produce multiple beams ( *$n$  different bi-directional beams*). For example, Figures 4A and 4B, annotated by Dr. Negus below, each shows a configuration of 3 beams being generated by a single array.” [See Petition at p. 26 (emphasis in original)]. I agree that “each of Trigui’s arrays can produce multiple beams”. But this does not disclose the claim element and it is particularly telling that even Dr. Negus does not assert that it does.

92. According to Trigui these three beam patterns are based on the frequency allocations given in Fig. 3A for the cellular operators.

“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.” [Ex. 1004 at 0062].

93. The Petition and the Declaration of Dr. Negus try to show by annotation the “right” number of beams, arrays, and MIMO transceivers, as in the claims of the ‘511 patent. However, the beams on which Dr. Negus relies for his analysis have nothing to do with the number of transceivers as the challenged claim 1 requires. There is nothing in Trigui that even suggests “ $n$  different bidirectional beams”, where  $n$  is the number of MIMO transceivers. I conclude that

Trigui does not disclose “a beamformer configured to produce n different bi-directional beams using the plurality of antenna elements”.

94. In his analysis Dr. Negus annotates Figure 6 [*See* Ex-1003 ¶¶ 192-193], but his annotation of Fig. 6 is incorrect. Figure 6 shows two sub-arrays and at most one MIMO transceiver, identified as modem A, connected via the OBSAI/CPRI interface. Further Figure 6 shows “two MIMO branches” [*See* Ex-1004 at [0081]].

95. As I state above, I disagree that a reference to 2xN or 4xN makes any assumption about N (the number of transceiver branches on the subscriber station). It seems like Dr. Negus tries to construct a 2x2 and a 4x4 MIMO system between the base station and the subscriber station. [*See* Ex-1003 at ¶195]. Even if the subscriber station has two or four transceiver branches (so that it is able to support a 2x2 or 4x4 MIMO transmission), this does not disclose Claim 1.

96. The Petition alleges that Figure 6 shows “a single antenna array with two beams”. [*See* Petition at p. 28]. In my opinion, the Petition’s argument is incorrect and unsupported, and a POSITA would not understand this.. The Petition tries to combine arbitrarily the two sub-arrays shown in Figure 6, into one array. A POSITA would not understand the arbitrary combination as an antenna array. For example, the purported array is inconsistent with the teachings of Trigui about the antenna arrays.

97. I provide an example to illustrate my point. Trigui teaches that “[t]he antenna elements of each sub-array are combined passively to achieve a predefined pattern. Ideally, the antenna array elements are closely spaced to avoid grating lobes when steering a beam off boresight direction.” [See Ex. 1004 at [0050]] and that [e]ach sub array is allocated to one operator”. [See *Id.* at [0063]]. A POSITA would have understood that Trigui’s subarrays are not intended to be combined as Petitioners suggest.

98. The Petition is similarly wrong about Figure 10, relying on Dr. Negus’s annotation. For the same reasons that I discuss above, Figure 10 shows four subarrays, not “two antennas” [See Petition at p. 28].

99. Trigui does not teach any relationship between the number of beams and the number of MIMO transceivers. Therefore, the annotations of Dr. Negus are not supported by the Trigui reference itself.

**B. Trigui does not render obvious [1b]**

100. Claim element [1b] requires, in short,  $n$  MIMO transceivers, where each is 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.

101. The Petition cites paragraph 77 of Trigui as allegedly describing that “each MIMO transceiver branch has one beam”. [See Petition at p. 37]. However, par. 77 recites:

“In a case where the DIAA supports only two sectors with a similar number of carriers, a possible configuration would be to use a MIMO transceiver branch to transmit to a specific sector and two MIMO transceiver branches to receive from both sectors. In other words, each MIMO transceiver branch has one beam for transmit and receive, and a second beam for receive only.” [Ex. 1004 at [0077]].

102. At least because having “one beam for transmit and receive” and “a second beam for receive only” is different from the claim language, claim element [1b] is not disclosed.

103. An additional reason the challenged claim element is not disclosed is that a “MIMO transceiver branch” of Trigui is different from the claimed MIMO transceiver. Trigui’s MIMO transceiver branch includes essentially only the analog RF functionality. It does not include DSP functions such as modulation/demodulation, coding/decoding, etc.

104. The Petition supports its argument by describing MIMO as: “So, for example, in a 2x2 MIMO system, there are 2 transmit antennas (or sets of antennas if beamforming is done) and 2 receive antennas (or sets of receive antennas if beamforming is done).” [Petition at p. 28]. However, as I describe above this is inaccurate. A MIMO transceiver in the context of the claim is a system that in addition to the analog RF functionality performs baseband DSP.

105. Dr. Negus and the Petition point to both the MIMO transceiver branch and the modem of Trigui as the claimed MIMO transceiver. I disagree. As

explained above, Trigui's MIMO transceiver branch is not the claimed MIMO transceiver. But neither is Trigui's modem. I note that Trigui's modem is not necessarily MIMO. It could be single-input single-output (SISO). Even if it is MIMO, Trigui does not teach any relationship between the number of MIMO transceivers and the number of beams. Therefore, claim element [1b] is not disclosed or made obvious.

106. The second argument of Dr. Negus is that "Trigui's Figure 10 discloses two MIMO transceivers with two inputs that correspond to a beam from each of the two antenna arrays (*i.e.*,  $m=2$  for both)" [Ex-1003, ¶¶251-253]. But this is wrong.

107. First, Figure 10 does not show two MIMO transceivers, it shows only modem A, which is, at most, one MIMO transceiver. There is no "modem B" on Figure 10, it is added by Dr. Negus. But even if a second modem is added, it would be for a different operator. A POSITA would have known that there is no relationship between the modems of two operators. Every operator would be transmitting independently, in a different frequency band, and without coordination<sup>6</sup> with the other operator. A POSITA would have understood that the number of MIMO branches that one operator uses has no impact on the number of

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<sup>6</sup> There might be coordination between the operators to resolve interference issues, but such coordination is an entirely separate issue.

MIMO branches that another operator uses. By way of an example, while one modem might support 2x2 MIMO, the other modem might support 4x2 MIMO. (The modems in Trigui are connected via an OBSAI/CPRI interface which is generally independent from the rank of the supported MIMO transmission). Further, even if the modems were identical (which they cannot be assumed to be), due to the lack of coordination, such a system would not be producing  $n$  beams. As discussed above, Trigui does not teach any relationship between the number of beams and the number of MIMO transceivers.

108. Assuming *arguendo* that a second modem is added to the Figure, this modem will be connected via a separate OBSAI/CPRI interface. The interface connects two systems – Trigui’s DIAA on one side and the modems on the other. Each modem is independent and there cannot be coordination between them. The modems are not part of the DIAA. This is why according to Trigui there is no relationship between the number of beams and the number of MIMO transceivers. This is another reason claim element [1b] is not rendered obvious.

109. The argument about “two inputs and outputs (one input/output to/from each array)” also fails. I disagree with the annotation regarding modem B. Dr. Negus ignores that Figure 10 illustrates that “... each MIMO branch having an OBSAI/CPRI core”. [See Ex. 1004 at [0085]]. The four MIMO branches shown in Figure 10 are bidirectional and there aren’t “two inputs and outputs (one

input/output to/from each array)”. There is no support for “two inputs and outputs (one input/output to/from each array)”, this argument is entirely made-up and contradicted by the Trigui reference.

110. Based on the foregoing, Trigui does not disclose that the number of MIMO transceivers matches the number of beams per array. Even using Claim 1 as a roadmap, Dr. Negus has not shown that Trigui can be made to disclose Claim 1.

111. Dr. Negus opines that “A POSA would thus understand from this disclosure that each modem can be connected to one beam in each array (transmitted/received by one MIMO branch). Ex-1003, ¶¶220-221. I disagree.

112. The fact that each operator has a modem that is a “MIMO transceiver” is irrelevant because it is not a “MIMO receiver configured to process  $m$  different received signals” (the  $m$  different received signals being the reception paths received from each array).” as asserted by Dr. Negus. [See Ex-1003, ¶221].

113. Dr. Negus repeatedly relies on the argument that “Each modem has a pair of bi-directional I/Q signals that correspond to a pair of transmission/reception paths for a 2x2 MIMO system and is thus a MIMO transceiver as explained above.” [See Ex-1003, ¶¶220-221]. I disagree.

114. There is no support that each modem has “a pair” of bi-directional IQ signals; it is a mere possibility. The modems in Trigui are connected via a

OBSAI/CPRI interface which is generally independent from the number of IQ signals<sup>7</sup>. But putting this aside, Trigui does not teach a relationship between the I/Q signal streams and the number of transmission/reception paths. Fig. 2A is described by Trigui as "a single MIMO branch". Fig. 6 is  $2 \times N$  and has two MIMO branches. Further, a POSITA would have understood that the number of MIMO branches that one operator uses has no impact on the number of MIMO branches that another operator uses.

115. I disagree with Dr. Negus' opinions that a " **$4 \times N$  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 " **$2 \times 2$  MIMO system**" [Ex-1003, ¶ 226 (emphasis in original)]. It is unclear what system is Dr. Negus trying to construct.

116. A  $4 \times N$  MIMO DIAA if  $N = 4$  would support  $4 \times 4$  MIMO. However, as an initial matter, a  $4 \times 4$  MIMO system is different from and does not suggest two "independent"  $2 \times 2$  MIMO systems. Further, if  $N=4$ , which Dr. Negus seems to assume, none of the two-operator systems would be  $2 \times 2$ . According to Trigui's

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<sup>7</sup> The interface will impose a limit on the data rate.

teachings, and in contrast with the '511 patent, N is equal to the number of antennas on the subscriber terminal, thus they would be 2x4, not 2x2. Dr. Negus is incorrect.

117. The Petition relies on Negus's opinion that "Figure 2A discloses two independent modems, each processing a pair of bi-directional I/Q signals corresponding to a pair of transmission/reception paths for a 2x2 MIMO system. [Ex-1003, ¶¶ 226-227]." [Petition at p. 38]. I disagree.

118. First, Figure 2A does not disclose "two independent modems". Figure 2A shows three modems A, B, and C. There is nothing in Trigui about "a pair" of bidirectional IQ signals. Each modem is connected via an OBSAI/CPRI interface. Generally, these interfaces are independent of the number of IQ signals, with the maximum data rate on the interface providing a constraint. In fact, the figure shows several transmission paths and from Figure 2A a POSITA would have concluded the opposite - the number of IQ signals does not depend on the number of transmission/reception paths.

119. Dr. Negus devotes considerable attention to interconnecting the arrays in Trigui's Figure 10 in a way that would allegedly render obvious the challenged claims of the '511 patent. The significant exercise in doing so shows that he is using the '511 patent as a roadmap. In any case, Dr. Negus is incorrect.

120. Dr. Negus asserts that “there would be only two possible ways to interconnect the two arrays in Figure 10 with the two disclosed independent “modems” for the two-operator system where the operators share the passive antenna, transceivers, and total power of the DIAA. [See Ex-1003, ¶ 235]. He continues on to assert that “the first possible way is the “direct” connect approach”, where each modem connects with only a single one of the two arrays. Each modem uses both transmit/receive paths from a single array. [See Ex-1003, ¶ 236].

121. For several reasons, each of which is sufficient, I disagree with Dr. Negus.

122. Dr. Negus continues on to opine that the second possible way to connect the antenna arrays with the modems is that the antenna arrays are “cross” connected to the two “transmission/reception paths” for each modem, *i.e.*, one to each array (shown in his annotated Figure 10). [See Ex-1003, ¶ 237]. But in Fig. 10, there is only one modem, connected to all four sub-arrays. Consequently, Figure 10 directly contradicts both “ways” that Dr. Negus describes.

123. These two “ways” that the Petitioners are trying to create are inflexible and incompatible with the teachings of Trigui. Trigui teaches flexibility, which is achieved by connecting the modem in Figure 10 to all four subarrays of the DIAA. Further, these two ways are incompatible with Figure 10 because the figure shows four identical MIMO branches and a separate OBSAI/CPRI interface

to every branch. The IQ samples received on that interface are aimed for that branch. Because there is separate, dedicated interface to each branch, none of these “direct-connect” and “cross-connect” techniques, is correct. Again, modem A (the only modem shown in Figure 10) is connected to all four branches. Consequently, the “two ways” that Dr. Negus has created are not shown in Figure 10, and, more significantly, cannot be made to be shown because they contradict the Trigui reference. The annotation of Dr. Negus is unsupported.

124. Dr. Negus seems to argue that, if there is sharing with a second operator, the 1st and the 3rd branches would be exclusively devoted to the first operator, and the 2<sup>nd</sup> and the 4<sup>th</sup> to the second operator. I disagree. This type of sharing would reduce the number of branches to which an operator can connect, based on the presence of other operators. A POSITA would have understood that that type of sharing is not attractive and even not viable given the OBSAI/CPRI interface to every branch.

125. The opinion of Dr. Negus is based on the argument that the “cross” connect approach minimizes the “correlation of the signals” among the two “transmission/reception paths” for each modem in the “4xN MIMO DIAAs” when applied to the two-operator system of Trigui, and would thus provide the best performance for the “MIMO system” for each operator. [See Ex-1003, ¶¶ 239-240]. I disagree. This argument is without any support and is in fact wrong

specifically in the context of Trigui's disclosure. This argument appears to assume that the first and the second sub-array would be close (and therefore the correlation among them would be high). The reason the argument is wrong is a POSITA would have understood that there is minimal correlation among any two sub-arrays in the specific apparatus disclosed by Trigui. This is the reason why four sub-arrays are identified in the Figure. There is no support for the argument that the correlation between the first and the third sub-arrays would be lower than the correlation between the first and the second sub-arrays. Fig. 10 shows four identical branches and doesn't show the actual layout of the antenna elements. In any case, a POSITA would have understood that in an apparatus constructed according to Trigui's teachings there is minimal correlation between any two antenna sub-arrays. Thus, the opinions of Dr. Negus about maximal separation fail. [See Ex-1003, ¶ 244].

126. Based on the foregoing, the annotation of Trigui's Figure 10 is wrong."

**C. Trigui does not render obvious [1c]**

127. For the same reasons as above Trigui does not render obvious claim element [1c].

## **XI. CONCLUSION**

128. Although my complete opinions are set forth above, for convenience I summarize several points of my opinions in conclusion. For the foregoing reasons, based on my expertise and experience and the record of this case that I have reviewed, it is my opinion that the independent claims of the '511 patent are not obvious over the identified prior art.

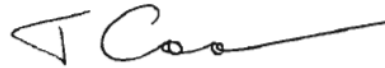
129. I understand that my opinions discussed above support a legal conclusion that the challenged claims are not obvious.

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

I hereby declare that all statements made herein of my own knowledge are true and all statements made herein on information and belief were and are believed by me to be true, and that all statements herein were and are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code and that any such willful false statements may jeopardize the validity of the application or any patents issued thereon.

Respectfully submitted,

Dated: April 21, 2025

A handwritten signature in black ink, appearing to read 'T Cooklev', with a long horizontal stroke extending to the right.

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Todor V. Cooklev, Ph.D.