

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MICROSOFT CORPORATION and AFFIRMED NETWORKS, INC.,
Petitioners,

v.

LEMKO CORPORATION,
Patent Owner.

Case IPR2023-00570
U.S. Patent No. 9,191,980

DECLARATION OF TODOR COOKLEV, PH.D.

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I. INTRODUCTION

1. My name is Todor V. Cooklev. I am an expert in mobile telecommunications and wireless technology. I have been retained as an expert witness to provide my independent opinion regarding certain matters at issue in *inter partes* review of U.S. Patent No. 9,191,980 (“the ’980 patent”) in IPR2023-00570. I have been retained by Lemko Corporation (“Lemko”), the Patent Owner in the above proceedings. Petitioners are Microsoft Corporation and Affirmed Networks, Inc. (collectively “Petitioners”).

2. For my work on this case, I am being compensated for my time at my typical consulting rate of \$500 per hour. I am also being reimbursed for reasonable expenses that I incur during the course of this work. My compensation does not depend on the substance of my opinions or the outcome of any issues in this case.

3. My analysis of the materials produced in this matter is ongoing and I will continue to review any new material as it is provided. This declaration represents only those opinions I have formed to date. I reserve the right to amend or supplement my opinions based on additional documents or evidence I am presented, including without limitation any arguments or expert declarations advanced by Petitioners in this case.

4. 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. QUALIFICATIONS

5. I am currently Professor of Electrical and Computer Engineering at Purdue University in Fort Wayne, Indiana. At the same institution since 2008 I have served in several faculty and administrative positions, including as the Director of the Wireless Technology Center, ITT Associate Professor of Wireless Communication and Applied Research, and subsequently as Harris Professor of Wireless Communication and Applied Research.

6. I graduated from the Technical University of Sofia, Bulgaria in 1988 with a Diploma of Engineering in the field of Electrical Engineering. I graduated from Tokyo Institute of Technology in Tokyo, Japan in 1995 with a Doctor of Philosophy (Ph.D.) degree in Electrical Engineering.

7. I have contributed to the development of several major standards for communication systems and numerous amendments, including Wi-Fi, cellular, and tactical communication systems. I have participated in many meetings of standards committees and prepared, submitted, and presented documents relating to technical matters considered by these committees. I have also drafted liaison letters among

different standards committees. I have chaired some committee meetings and served in other leadership roles.

8. During 2000-2002 and 2005-2008 I was a Voting Member of the IEEE 802.11 Working Group. Around 2006-2008 I served as Chair of a Study Group within 802.11. For this work I received an award from IEEE Standards Association in 2012.

9. During 2011-2012 I attended 3GPP standards committee meetings. I contributed to and submitted several documents relating to LTE-Advanced.

10. My long record of service to the standards community includes being elected to the Board of Governors of the IEEE Standards Association in 2020 for one term beginning January 2021. The Board of Governors provides overall leadership of the IEEE Standards Association.

11. Also, I am 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) and have held that position since 2017. My responsibilities as an editor include coordinating the review of manuscripts submitted for publication and making publication decisions.

12. Since the 1990s I have reviewed many manuscripts submitted for journal and conference publication, including manuscripts in the field of wireless

networking. In addition, since about 2000 I have reviewed and voted on many IEEE 802.11, 802.15, and 802.16 standards.

13. My current 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. My teaching responsibilities have included courses in communication systems and networks, signals and systems, software-defined radio, and digital signal processing.

14. For example, since about 2003 I have been doing research in the field of software-defined radio (SDR). I have participated in the work of the Software-Defined Radio Forum (later renamed Wireless Innovation Forum).

15. 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, awards, courses I teach in electrical and computer engineering, research grants, and professional activities, etc. appears in my *curriculum vitae* attached as Appendix A.

III. LEGAL STANDARDS

16. I am not a lawyer, and I do not intend to offer any opinions as to the interpretation of the law. When considering the '980 Patent and stating my opinions, I rely on the following legal standards as described to me by the attorneys for Lemko.

A. Priority Date

17. I understand that the analysis of alleged obviousness of the Patent should be performed from the perspective of a person of ordinary skill in the art (POSITA or POSA) as of the priority date of the Patent. The '980 Patent claims priority to April 23, 2008. My opinions in this matter are from the perspective of a POSITA as of that date.

B. Level of Ordinary Skill In The Art

18. 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 person of ordinary skill in the art 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 claim(s) of the '980 patent.

19. I understand that various factors should be considered when determining the person of ordinary skill in the art in connection with a particular patent. I understand that these factors include, without limitation, the type of problems encountered in the art, the prior solutions to those problems found in the

prior art references, the rapidity with which innovations are made, the sophistication of the technology, the level of education of active workers in the field, and my own experience working with those of skill in the art at the time of the invention.

20. I am readily familiar with the level of ordinary skill in the art as of the priority date of the Patent. My qualifications at that time far exceeded that of a POSA, and I had worked with, as well as supervised, many POSA's throughout my work in the field.

21. Mr. Proctor opines that: "Around 2008, a POSA in the field of the '980 Patent's field would have had a bachelor's degree in electrical engineering, computer engineering or an equivalent, as well as two years of industry experience related to telecommunications networks. Such knowledge would encompass the design, architecture, and operations of mobile telecom networks, including gateways, servers, and user devices that were compliant with various standards, and how they interact with other components of a radio access network. Additional graduate education of a POSA could substitute for professional experience, or significant experience in the field could substitute for formal education.." Ex. 1003 (or "Proctor-Decl."), ¶ 55. For the purpose of this declaration, I will apply the same definition of the level of skill of a POSA.

22. Based on my experience, education, and training, I met the definition of a POSA as of the priority date of the Patent. My qualifications at that time far

exceeded that of a POSA. My opinions concerning the '980 Patent claims and the prior art are from the perspective of a POSA, as set forth above.

23. As further discussed below, my opinions as stated in this declaration are valid even if the Board adopts a slightly different level of ordinary skill in the art.

C. Claim Construction

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

D. Obviousness Legal Standard

25. 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.

26. 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.

27. 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.

28. 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.

29. 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.

30. 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.

31. 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.

IV. CLAIM CONSTRUCTION

32. As I mentioned above, I understand that claims in a patent-at-issue in an IPR are generally interpreted according to the district court-type claim construction. I further understand 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.

33. For the purpose of this preliminary proceeding, I have provided a construction for the terms "DMA server" and "DMA gateway."

A. "DMA Servers" Are Connected by Peer-to-Peer Connections

34. I understand that the Challenged Claim requires a distributed mobile architecture (DMA) server. It is my opinion that a DMA server should be construed to mean individual DMA servers are connected with peer-to-peer connections to form a DMA network.

35. The term "distributed network" is well understood in the networking arts to refer to "[a] network in which processing, storage, and other functions are handled by separate units (nodes) rather than by a single main computer." Ex. 2015 at 168 (Microsoft Computing Dictionary, 5th Ed.). In my opinion, this is consistent

with the Merriam-Webster Computing definition of “distributed” as “having at least some of the processing done by the individual workstations and having information shared by and often stored at the workstations.” Ex. 2016 (Merriam-Webster computing definition of “distributed”).

36. I note that rather than managing all calls at a single centralized MSC, like conventional systems, the '980 Patent discloses a “distributed mobile architecture” where call management is distributed among the various DMA servers that make up a DMA network:

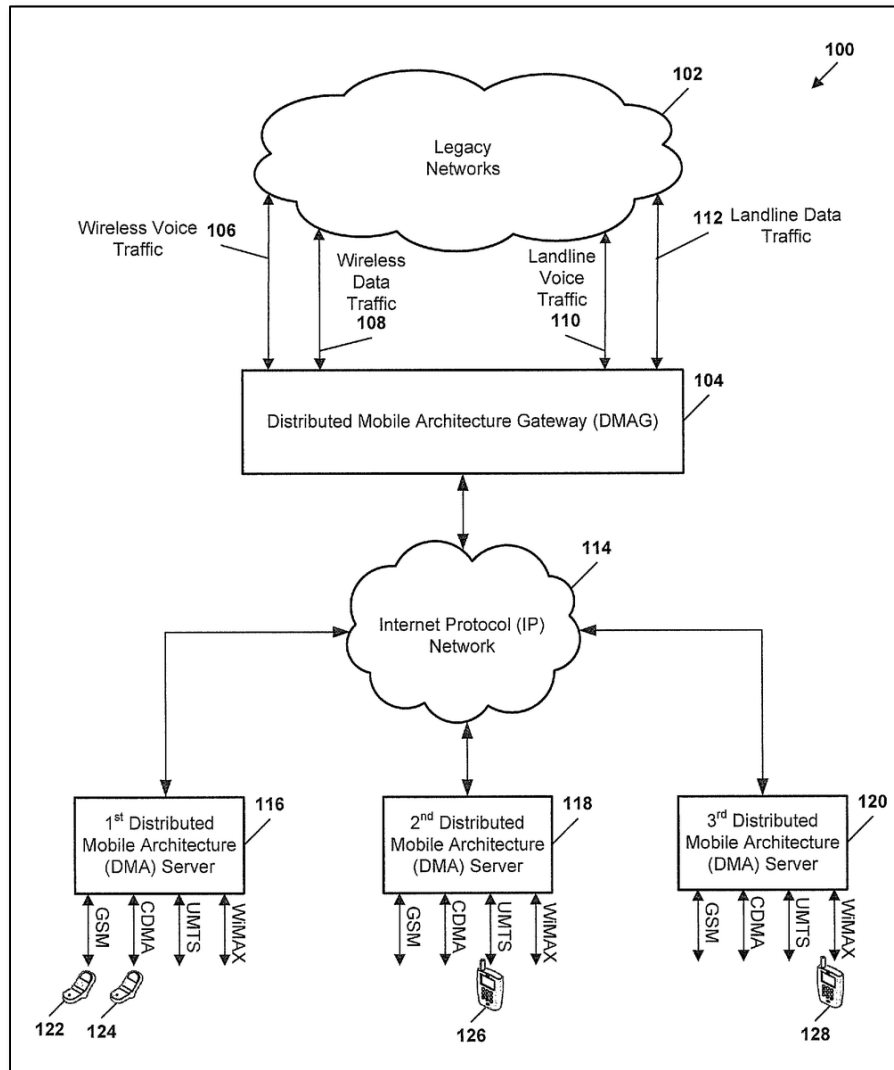
When two DMA servers serve two wireless communications devices, the call may be routed via an IP network or via a DMAG. In one illustrative embodiment, the first DMA server 116 may route a call originating at the first wireless communications device 122 to the fourth wireless communications device 128 via the IP network 114 and via the third DMA server 120. ... **When a call is routed between the DMA servers 116 and 120** and the DMAG 104 is not involved in routing the call, **the routing is known as a peer-to-peer routing**. ...

'980 Patent at 4:25-44; *see also id.* at 16:17-26 (describing the control logic within the DMA server as “distributed” and “associated”). In the '980 Patent's DMA servers, the control logic for routing voice and data traffic is distributed among individual DMA servers, which are connected to the other DMA servers using a peer-to-peer connection. *Id.* at 3:54-4:2.

37. According to the '980 Patent, Figure 1 (which I have reproduced below) illustrates that each DMA server (116, 118, 120) is interconnected with other DMA

servers in a private Internet Protocol (IP) network 140 via peer-to-peer connections.

‘980 Patent at 3:44-53, 4:25-44 (“When a call is routed between the DMA servers 116 and 120 and the DMAG 104 is not involved in routing the call, the routing is known as a *peer-to-peer routing*”) (emphasis added).



Id. at Fig. 1.

38. The use of these peer-to-peer IP network connections between DMA servers in the same network 100 eliminates or reduces the need to route traffic

through a backhaul, as is shown schematically in an expanded and annotated view of Figure 1 below that is based on my understanding of the '980 Patent:

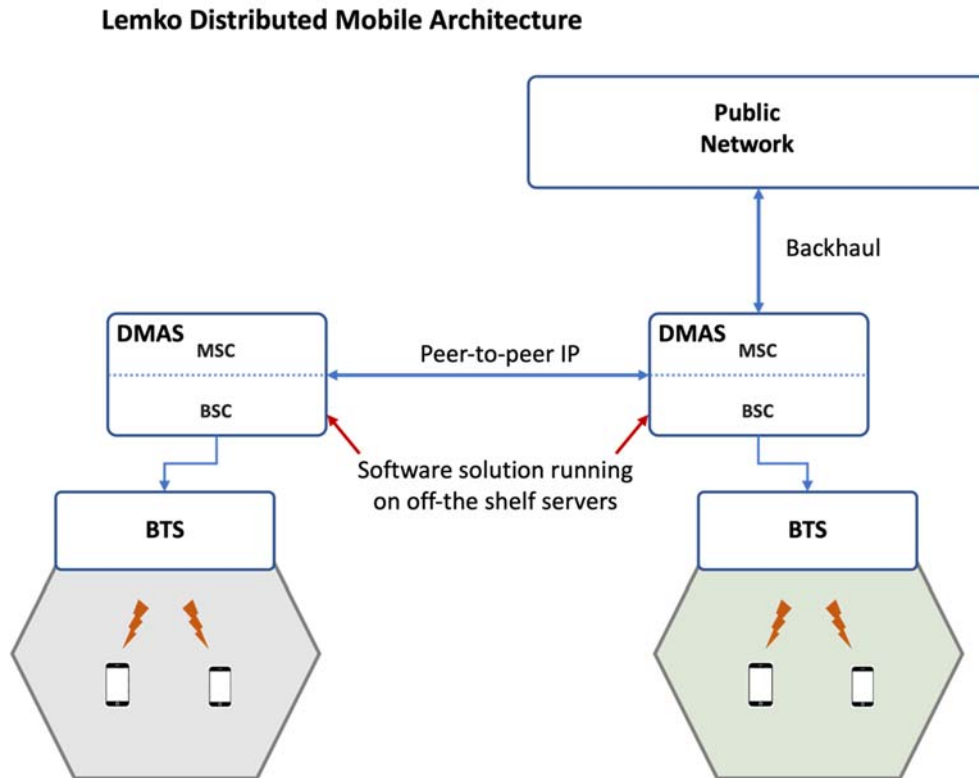


Figure 4-1

39. In Lemko’s DMA network, and in contrast to the conventional network architectures discussed in the previous section, a call from a first UE to a second UE is routed (1) to a BTS, (2) to a DMA, (3) to a second DMA (by a peer-to-peer IP connection), (4) to a BTS, (5) to the receiving UE.

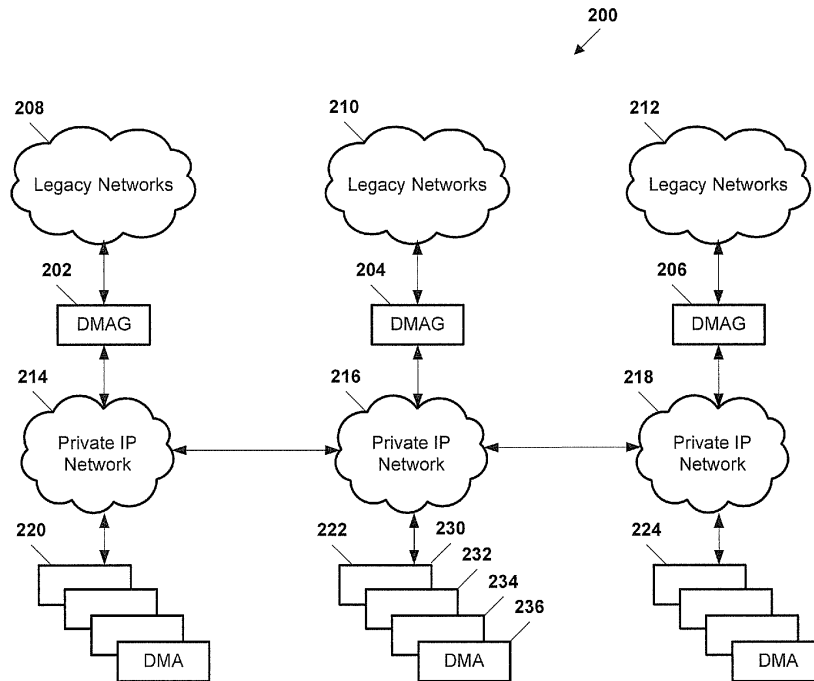
40. Thus, I believe “DMA server” should be construed to be connected to other DMA servers through peer-to-peer connections.

B. “DMA Gateway”

41. It is my understanding that Challenged Claim 1 requires a “distributed mobile architecture gateway (DMAG),” which should be construed to mean a node that controls communications for a plurality of designated DMA servers by enabling communications with one or more legacy networks.

42. This meaning is consistent with the specification of the '980 Patent. For example, the '980 Patent describes: “[e]ach of the DMAGs 202-206 may **control communications related to a respective group of DMA servers** by routing voice traffic, data traffic, signaling, or any combination thereof, **between the one or more legacy networks 208-212** and one or more wireless communication devices communicating with the respective groups of DMA servers 220-224.” '980 Patent at 5:50-64; *see also id.* at 5:66-6:2 (“each DMAG 202-206 may be specified by a communications service provider **as a primary node to control voice traffic, data traffic, signaling, or any combination thereof, for designated DMA servers**”); *id.* at Fig. 2; *id.* at 7:60-62 (“Registration data may identify that a particular DMAG is specified as the primary node **to control communications related to certain DMA servers**”) (emphasis added). This is shown in Figure 2 (reproduced below), where each DMAG (202) connects multiple DMA servers (220) to a legacy network (208, 210, 212). Examples of legacy networks include conventional “a landline voice network, such as a Public Switched Telephone Network (PSTN), an Integrated

Services Digital Network (ISDN)” a “Digital Subscriber Line (DSL) network, a cable television network” and conventional GSM, CDMA or UMTS networks. ‘980 Patent at 9:9-36.



’980 Patent at Fig. 2.

43. I believe this meaning of a DMA gateway is also consistent within the claims of the ’980 Patent, including claim 12 which recites “the registration data indicates that the **DMAG is a node that controls communications** related to the first DMA server.” ’980 Patent at 18:21-25 (emphasis added).

V. TECHNOLOGY BACKGROUND: CONVENTIONAL ARCHITECTURES WERE BASED ON A HIERARCHICAL, HARDWARE PARADIGM

44. Cellular (also referred to as mobile) telephony was developed in response to the enormous market demand for “connectivity anytime anywhere.” Wireless communication networks that divide the service area into relatively small geographic areas are called “cellular.” An individual area within a cellular network is serviced by a single base-station (also called in 3G NodeB or in LTE evolved NodeB, etc.). Devices (also called user equipment (UE) or terminals), such as mobile phones operating within this geographic area, use that base station to communicate.

45. A base station (BS) can be located either at the corner or at the center of a cell. A cell is center-excited if the BS is in the center and corner-excited if it is at the corner. Due to the large density of subscribers several different cell sizes are used, including macro, micro and pico. Macro cells are large cells with ranges from 2 km up to 100 km. Micro cells are smaller and pico cells are even smaller.

46. Generally, a new generation emerges every ten or so years. GSM and IS-95 are major 2G cellular standards. WCDMA and CDMA2000 are 3G standards.

47. When Lemko filed the '980 Patent, then-conventional cellular 2G and 3G networks were based on circuit-switched networks with a centralized, hierarchical paradigm. All calls were carried from cell towers to regional call centers over expensive backhaul connections. The regional call centers relied on large

stacks of servers with custom hardware to manage and route calls for an entire region. In contrast, the cell towers had no functionality for managing and routing calls, since that capacity was located in the regional call centers. There were many drawbacks to this approach, including the need for expensive backhaul to and from regional call centers, even when the two parties to a phone call were in the same area (because the cell towers had no ability to manage or connect calls independent of the regional call centers).

48. Conventional networks were hierarchical because each cell tower (also known as a “base transceiver station” or “BTS”) connects to a single Base Station Controller (“BSC”), which connects to a centralized mobile switching center (“MSC”) that routes calls. See ’980 Patent at 1:30-42. Cell towers did not communicate directly with other cell towers, and BSCs did not communicate directly with other BSCs.

49. These conventional networks were also hardware-based. The MSCs were housed at large Digital Signal Processor (DSP) equipment server centers, shown in the photograph below, where the MSCs relied on stacks of DSP equipment servers and provided the call processing functionality for the networks, including switching functions, call set-up, call termination, and routing. Ex. 2002



Id.; see also Ex. 2003.

50. The BSC (shown in the photograph below) connected a BTS (cell site) to the MSC through a backhaul connection. Ex.2004.



Ex. 2005 at 1; Ex. 2006.

51. The following figure illustrates the hierarchical structure of these conventional networks as a POSITA would have understood these networks at the time of the '980 Patent:

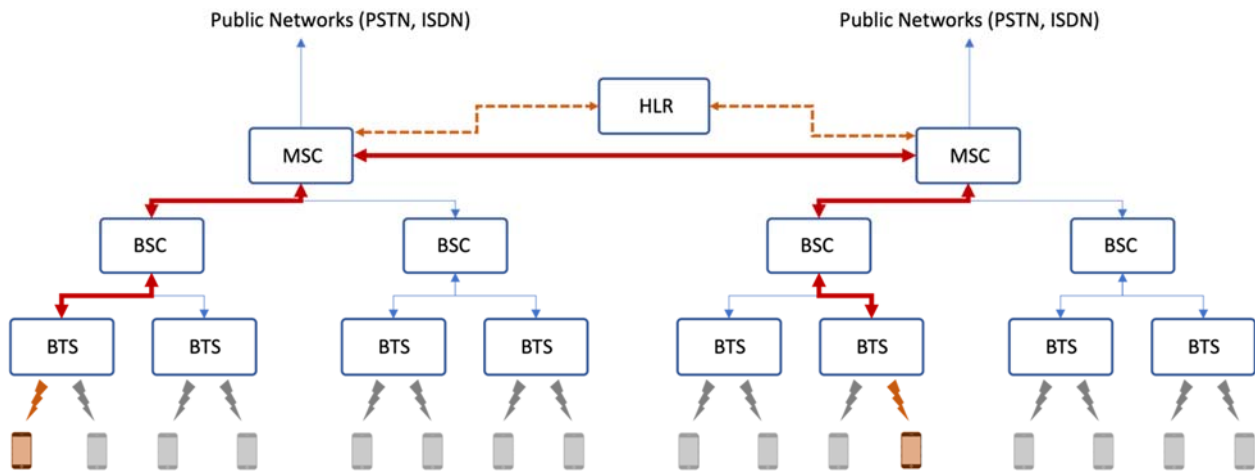


Fig. 5-1

In these conventional networks, the backhaul connections used T1/E1 communication lines. See Ex. 2007 at 2 (explaining that “E1/T1 systems were widely used in telecommunications when 2G technologies including GSM were being rolled out and deployed”). I note that “T1/E1” refers to a telecommunications standard that is either the T1 or E1 digital transmission formats. Both T1 and E1 were developed in the 1960s and provide dedicated connections between two fixed points.

52. To place a call between two cell phones or other mobile devices (conventionally called “user equipment” or “UE”) on two different networks, call data are routed from (1) an originating UE, (2) to a BTS, (3) to a BSC, (4) to an MSC, (5) to the MSC for the second network, (6) to a BSC, (7) to a BTS, (8) to the

receiving UE. This path is shown in red in the schematic diagram above. The BTS to UE connections are wireless radio connections. The other connections in this path are circuit-switched T1/E1 connections. In this context, “circuit switched” connections establish a dedicated communication path between two devices for the duration of a session. In contrast, IP networks transmit data in small packets that travel independently over a network and are dynamically routed. Thus, for two UEs to communicate, the call data are routed to centralized MSCs (stored at centralized server locations) of the public networks using the T1/E1 communication lines.

53. This hierarchical, hardware paradigm had several drawbacks. Such networks were expensive to deploy because they require large amounts of space, power, and hardware resources to accommodate the stacks of servers. The rigid, hardware-based approach made it difficult to integrate and operate the dedicated hardware appliances. *See* Ex. 2008 at 5 (stating the difficulty in “integrat[ing] and operat[ing] increasingly complex hardware-based appliances”). In addition, this centralized, hierarchical network structure required all calls to traverse expensive backhaul connections, even when both UEs were connecting to the same BTS or BTSs in close-proximity.

54. I understand that, in 2012, a broad coalition of network operators published a whitepaper detailing these problems. *See* Ex. 2008. Entitled “Network Functions Virtualization” (the “NFV Paper”), the paper proposed a network

virtualization approach to address these drawbacks, mirroring the solutions Lemko invented years earlier. The NFV Paper's approach is based on the consolidation of hardware network components onto software:

It involves the implementation of network functions in software that can run on a range of industry standard server hardware, and that can be moved to, or instantiated in, various locations in the network as required, without the need for installation of new equipment.

See Ex. 2008 at 5.

55. As shown in the excerpt below, the 2012 NFV Paper contrasted its proposed approach against the "Classical Network Appliance Approach." The NFV Paper noted many drawbacks of the classical approach, including that it (1) depended on "Fragmented non-commodity hardware," (2) required physical installation of appliances at every site, and (3) its hardware requirements made the networks rigid and inflexible, which constrained innovation. *See* Ex. 2008 at 5.

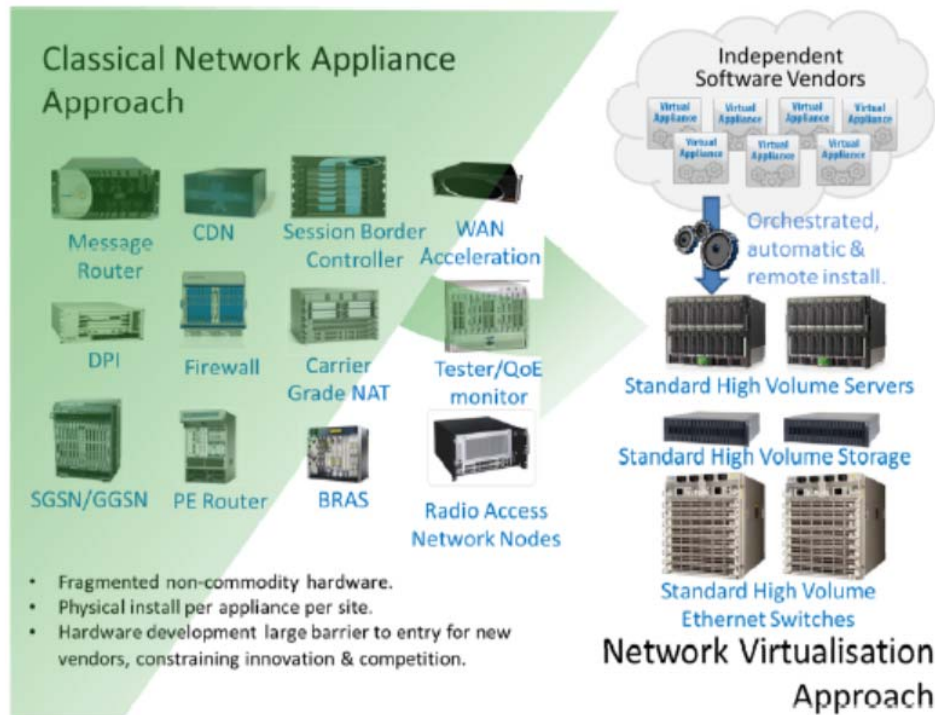


Figure 1: Vision for Network Functions Virtualisation

See Ex. 2008 at 5.

VI. OVERVIEW OF LEMKO'S TECHNOLOGY AND THE '980 PATENT

56. Lemko's approach was fundamentally different, being based on a software-implemented, decentralized, peer-to-peer network paradigm. Instead of cell towers that served only as a conduit to the backhaul leading to and from regional call centers, Lemko's claimed distributed mobile architecture ("DMA") network is based on software-based DMA servers (or DMAS), which are connected to form a peer-to-peer DMA network. Each DMA server has local cellular network management functionality that allows for calls to be connected without the centralized servers of a regional call center.

57. Several years before the industry proposed solutions in the NPV Paper, Lemko filed the application that led to the '980 Patent. Lemko had already solved these needs with its innovative distributed mobile architecture (DMA) infrastructure, which creates a virtualized network. Ex. 2009 at 1 (“to enable distributed networks with a database that enables a customer to create a virtualized network with multiple deployments with its Nodes.”). Lemko “developed Network Functions Virtualization (NFV) before that term was coined” because its “software enables all of core network functions, databases and gateways.” *Id.*

58. Specifically, a POSITA would recognize that Lemko’s DMA implements network functionality, such as MSC, BSC, and home location register (“HLR”) functionality, onto a computer-readable medium running on a standard server. This is illustrated by the below graphic from a Lemko demonstrative that I was made aware of.

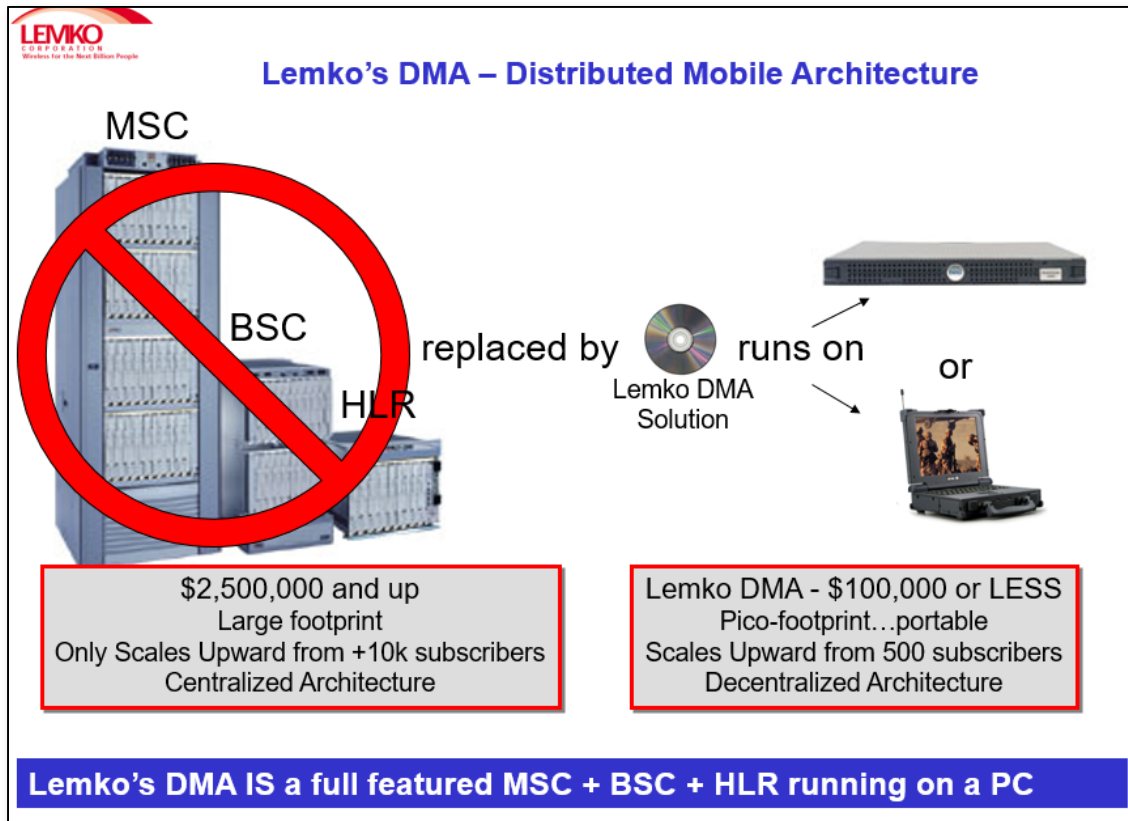


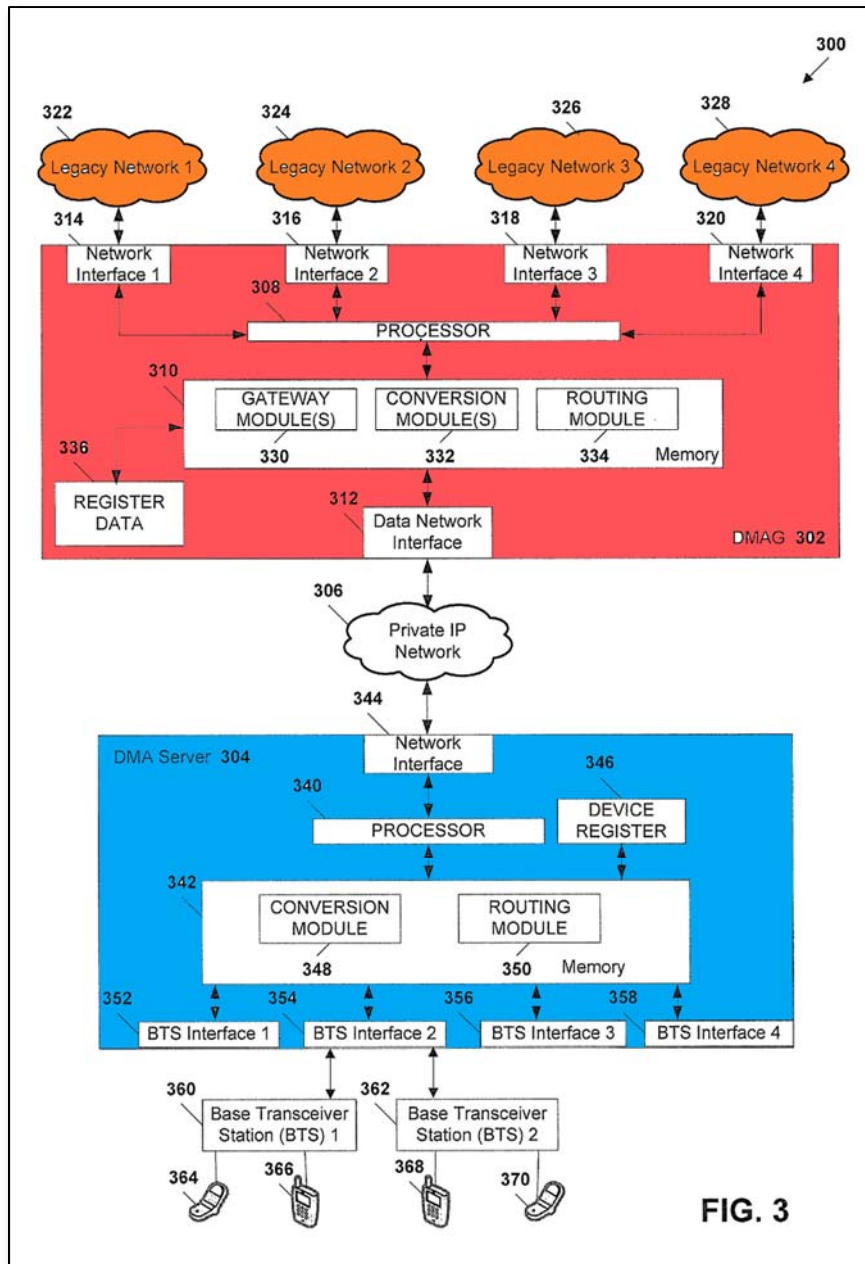
Figure 6-1

See also Ex. 2010 (“[T]he heart of DMA is an all-IP software solution,” including the network functionality of an MSC, BSC, radio network controller (RNC) location registers, and media and data gateways (MSG, GGSN, SGSN); see also ’980 Patent at Figs. 1-3 (depicting the DMA servers).

59. I understand that, unlike the then-conventional hardware-based network architecture, Lemko’s DMA solution implements a virtualized core of network functionality on software running on standard servers to allow “multiple cellular nodes to be linked via IP connections,” as peers, thereby reducing backhaul

via T1/E1 communication lines and eliminating the need for a centralized center or hub. Ex. 2010. Lemko developed multiple product lines based on its inventions. See Ex. 2011.

60. I understand that, in addition to successfully developing these products, Lemko obtained the '980 Patent (and multiple other patents) to protect various aspects of its novel DMA architecture, providing for complete cellular network functionality. See '980 Patent at Abstract, 4:51-5:6. Specifically, the '980 Patent discloses DMA servers (304, highlighted in blue) and DMA gateways (302, highlighted in red), which manages connections to legacy networks (highlighted in orange).



Id. at Figs. 3 (annotated).

61. Each DMA system has its own MSC and BSC functionality, including gateways and a cellular radio network controller (CRNC), to allow for a fully functionally virtualized network. See Figure 6-1 above; Ex.2009; Ex. 2010. Figure 1 (which I have reproduced below) illustrates that each DMA server is

interconnected with other DMA servers in an Internet Protocol (IP) network via peer-to-peer connections. See '980 Patent at 4:31-44 (describing “peer-to-peer routing” via the IP network between DMA servers), Fig. 1 (showing peer-to-peer connections between DMA servers through an IP network). The use of these peer-to-peer IP network connections between DMA servers in the same network eliminates or reduces the need to route traffic through a backhaul.

VII. THE CHALLENGED CLAIMS

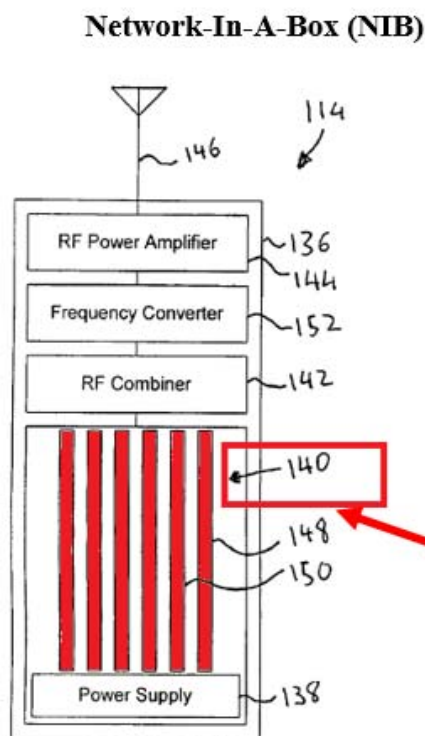
62. I understand that Petitioners present only a single ground, contending that Claim 1 is obvious over Waylett (Ex. 1005) and the knowledge of a POSITA. Pet. at 2.

VIII. OVERVIEW OF THE ASSERTED REFERENCES

A. The Waylett Reference

63. A POSITA would have understood that Waylett is based on the conventional network appliance approach, which depends on a hierarchical network and hardware-based components. Specifically, Waylett is directed to a network-in-a-box (NIB), such as the WaveExpress NIB platform (reproduced below), that located certain hardware-based components in a single enclosure. Ex. 1005 at 8:7-10, *id.* at 9:36-42 (explaining that embodiments are based upon WaveExpress’s NIB platform). I produced the below diagram which illustrates Fig. 2 of Waylett and these hardware-based components which are referenced as cards 140 (I have

highlighted them in red below), and real-life photographs of the NIB that a POSITA would understand as corresponding to the cards 140:



Ex. 2012 at 1; Ex. 1005 at Fig 2 (annotated). This is also consistent with Waylett's disclosure. See also Ex. 1005 at 8:7-36 (disclosing that the NIB includes a number of cards), *id.* at 9:32-46.

64. I understand that Waylett does not disclose connecting NIBs through peer-to-peer connections. Instead, Waylett's NIBs transfer call data using the standard backhaul circuit-switch T1/E1 communication lines. See Ex. 2013 at 1

(disclosing that the NIB communicates “over E1 or T1 timeslot or Ethernet Port.”), Ex. 2014. For example, Waylett discloses the E1 or T1 trunks contained in cards. See Ex. 1005 at 7:9-11 (“Generally, the community WLAN 102 includes a centralized base transceiver station (CBTS 114) coupled the public network via a landline or trunk 116, such as an E1 or T1 trunk.”), 8:33-36 (“In addition, the cards 140 can include a number of cards or module for interfacing with the HLR/AuC 128, and the trunk 116 to connecting to the public network 108. For example, the cards 140 can include an E1 card, T1 card or an ICP card.”).

IX. IN MY OPINION THE CHALLENGED CLAIM IS PATENTABLE OVER WAYLETT

65. In my opinion, and for the reasons described below, Waylett does not teach or suggest at least the following limitations of the Challenged Claim:

- (1) a plurality of DMA servers connected by peer-to-peer connections;
- (2) a DMA gateway (DMAG) communicatively coupled to a plurality of DMA servers; and
- (3) registration data that “indicates that the destination device is not within a wireless coverage area associated with the first DMA server.”

A. Distributed Mobile Architecture Servers

66. It is my understanding that the Challenged Claim requires a distributed mobile architecture (DMA) server. As I discussed earlier, a DMA server is connected to other DMA servers via peer-to-peer connections in order to reduce or eliminate the need to route traffic through a backhaul to a centralized hub. In my opinion, Waylett does not teach such a DMA server with peer-to-peer connections to other DMA servers. In my opinion, the Petition does not show how and why, absent hindsight and use of the '980 Patent as a roadmap, a POSITA would have been motivated to modify Waylett to include peer-to-peer connected DMA servers and have a reasonable expectation of success in doing so.

67. It is my understanding that, in another IPR petition filed by Petitioners challenging another of Lemko's patents, Petitioners appear to admit that Waylett does not disclose transmitting telephony traffic over a peer-to-peer connection. See Ex. 2018 at 24 ("Waylett does not, however, expressly disclose that such a transmission of telephony traffic occurs over a 'peer-to-peer connection.'"). This concession seems logical because Waylett's disclosure of network of hardware-based NIBs fails to teach or render obvious DMA servers interconnected by peer-to-peer connections, for the reasons set forth below.

68. A POSITA would understand that Waylett describes the hardware-based NIBs as "stand-alone" units. Ex. 1005 at 8:8. Like traditional, centralized

MSCs, when multiple NIBs are installed in a private installation the NIBs are connected with conventional T1/E1 communication backhaul links that carry voice and data communications. Waylett also discloses connecting NIBs via a private wide area network (PAN) for non-telephony functions, such as “distributing HLR registration and authentication loads.” Ex. 1005 at 17:10-12, 7:9-11, 9:65-10:6, 17:7-17, Fig. 11; *see also* Ex. 2013 (disclosing the T1/E1 ports for communication). A POSITA would have interpreted this hierarchical setup in Waylett’s Figure 11 as illustrated below in Figure 9-1:

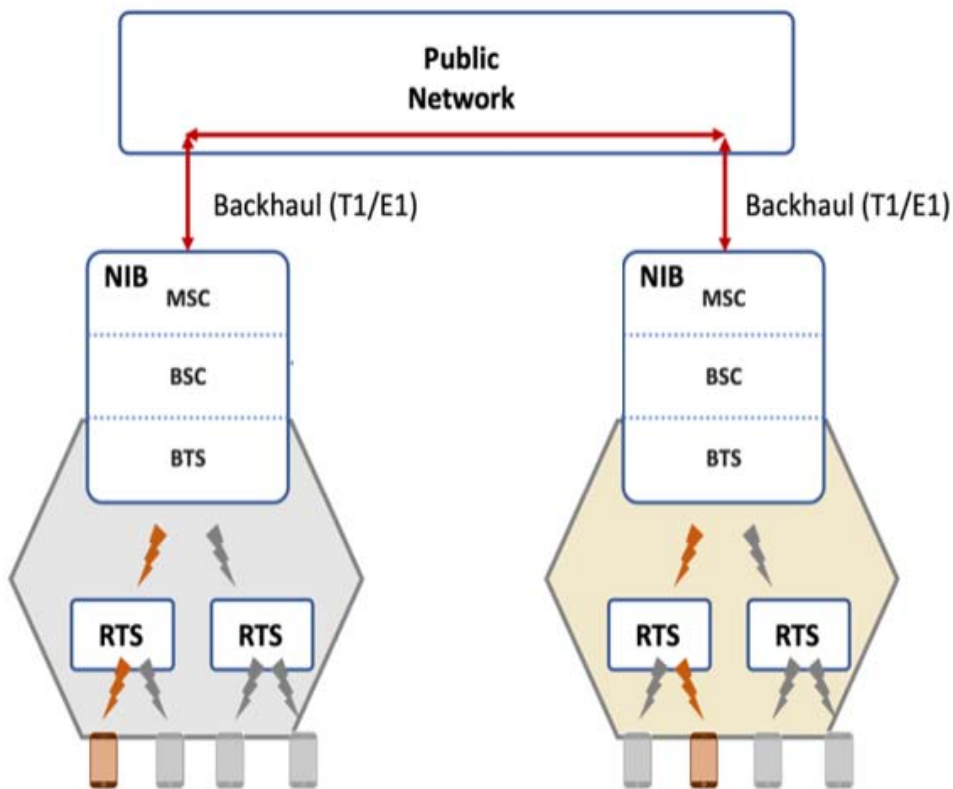


Figure 9-1

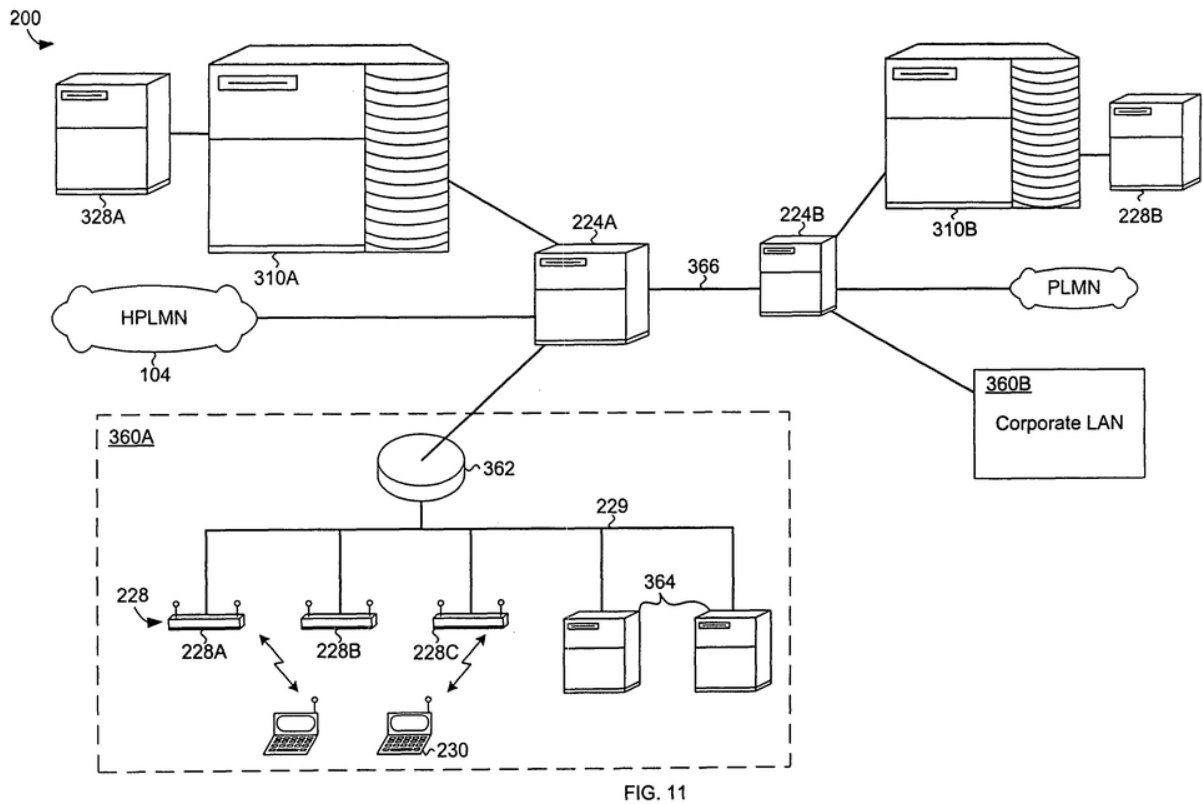


FIG. 11

See Ex. 1005 at Fig. 11; Ex. 2013 (disclosing that the NIB has “all E1 or all T1” ports for voice and data communication); Ex. 1005 at 7:9-11 (“Generally, the community WLAN 102 includes a centralized base transceiver station (CBTS 114) coupled the public network via a landline or trunk 116, such as an E1 or T1 trunk.”), 9:65-10:6 (“It will be understood, that the communication system 200 can include a number of private cellular networks 222, each with an associated WLAN 228, and each linked by a private”), 17:7-17 (describing Figure 11). Since any calls would go through T1/E1 with a public network which is a class 4 switch, a POSITA understands that the call is routed or switched by that public network (class 4 switch),

and therefore cannot be considered as peer-to-peer call. According to Waylett, all calls from a first NIB are connected to the public network and the public network routes the calls to the second NIB through T1/E1 connections. *See* Ex. 2014; Ex. 2013). There are no direct connections between NIBs for carrying calls.

69. As shown in Figure 9-1 above, a POSITA would understand that the call path from one UE to another UE goes from the NIB, over T1/E1 backhaul, to a public network, over T1/E1 backhaul to a second NIB, to the recipient UE. Other than the radio connection between the UE and the NIB, all of these connections are T1/E1. Circuit-switched, dedicated T1/E1 connections were used by industry for such connections because they provided dedicated, reliable, fixed bandwidth connections between known points (such as between an NIB and a public telephone network). Thus, a POSITA would understand that there were no peer-to-peer connections between NIBs of Waylett (which Petitioners contend are DMA servers).

70. Thus, it is my opinion that Waylett does not disclose DMA servers interconnected with peer-to-peer connections. It is my understanding that Petitioner does not assert that it would have been obvious to a POSITA to so modify Waylett's network. Thus, Waylett cannot render obvious the Challenged Claim 1.

B. DMA Gateway Communicatively Coupled to a Plurality of DMA Servers

71. It is my understanding that the Challenged Claim requires a “distributed mobile architecture gateway (DMAG)” that “is communicatively coupled to a

plurality of DMA servers,” including a first DMA server. ’980 Patent at 16:48-50. In my opinion, Waylett’s wireless local area network and its access points (together, “WLAN”) are not a DMA gateway because Waylett’s WLAN (1) does not connect DMA servers to a legacy network, and (2) is not communicatively coupled to a plurality of DMA servers.

72. In my opinion, Waylett’s WLAN cannot be a DMA gateway because it is inconsistent with the hierarchical relationship between DMA servers and DMA gateways. As discussed above, the DMA gateway is a node that controls communications for a plurality of DMA servers by allowing the DMA servers to connect with legacy networks. In Waylett, the WLAN access points (228A, 228B, 228C) do not connect NIBs (which Petitioners allege is a DMA server) to any legacy network. Instead, Waylett discloses various communication flows that go from the UEs 230 to the WLAN access points 228 to the NIB 224 or to the public network 202. Ex. 1005 at 13:41-55 (describing being coupled to different networks “through the NIB 224”), 12:1-5 (“In still another embodiment, the WLAN 228 is further coupled to the Internet 208 through a firewall 240, to enable the private UE 230 to transfer video and audio data, and/or to transfer or download large files or attachments to or from other data processing systems or servers.”), 13:55-62 (“It will be understood that where the WLAN 228 includes multiple separate networks or access points 228A, 228B, 228C, which may or may not use different protocols, each

of the separate access points can be coupled through the NIB 224 to different components in the public network 202.”). Based on this review, Waylett does not describe any communication paths flowing from an NIB to the WLAN access points to a legacy network. Thus, in my opinion, the WLAN is not considered a DMA gateway.

73. In my opinion, a POSITA would not have been motivated to modify Waylett’s teachings to yield a WLAN communicatively coupled to multiple NIBs. Pet. at 16-17. It is my understanding that Petitioners assert that a POSITA would be motivated “(i) to provide wireless or cellular type communication via WLAN over an extended service,” and “(ii) to avoid tolls and maintain ownership and control of information transmitted between different sites of an enterprise linked by the PWAN.” *Id.* But, even if these motivations were valid, at best, these are reasons for including “multiple private cellular networks 222,” but not NIBs (which Petitioners have alleged are DMA servers). A POSITA would not have expected any benefit from reorganizing Waylett’s network hierarchy to communicatively couple a WLAN to plurality of “stand-alone” NIBs, nor is there a reasonable likelihood of success for doing so.

74. Thus, it is my opinion that Waylett does not disclose or render obvious the DMA gateway limitation of Challenged Claim 1.

C. Registration Data Limitation

75. It is my understanding that the Challenged Claim requires “registration data,” and requires that (1) the registration data is “stored at the first DMA server;” (2) the action of determining that a first DMA gateway supports communication with a destination device is performed “based on” the registration data; and (3) the registration data “indicates that the destination device is not within a wireless coverage area associated with the first DMA server.” ’980 Patent at 16:42-50. In my opinion, Waylett fails to teach or render obvious any of these requirements.

76. As discussed above, in my opinion, Waylett does not disclose DMA servers. Thus, by logical extension, Waylett cannot disclose storing registration data at a DMA server.

77. In my opinion, Waylett also does not disclose determining that a DMA gateway “supports communication with the destination device based on registration data,” as required by the Challenged Claim. I understand that Petitioners assert that Waylett’s “Identity Module 238” is “registration data.” Pet. at 13 (citing Ex. 1005 at 10:36-38). However, in my opinion, the Identity Module is not used to support communication with a destination device.

78. A POSITA understands that Waylett’s Identity Module is akin to a SIM card or virtual SIM card that might typically be used with a cellphone. Ex. 1005 at 10:32-52 (describing “identity module 238” as including “SIM cards”, “USIM

cards”); *compare with id.* at 10:8-30 (similarly describing a subscriber identity module 236). From these statements, a POSITA would understand that the purpose of the Identity Module in Waylett is to allow a user equipment (UE) that does not have a GSM radio or a GSM SIM card to join a GSM network. *See* Ex. 1005 at 10:36-37 (“... to enable the private UE to communicate with the public network 102 and/or the private cellular network 222 via the WLAN 228”); *id.* at 11:4-10 (“identity module 238, and programs or software in the private UE 230 that allow it to emulate a communication terminal, are also adapted to enable the private UE to control or access supplementary and/or value added services provided by the private cellular network 222 or public network 202 service provider [sic].”) Thus, a POSITA understands the function of the Identity Module is limited to connecting to a GSM or similar network.

79. In my opinion, Waylett does not disclose that the Identity Module has any role in allowing connections to the WLAN (which Petitioners contend is the DMA gateway). It is my understanding that Petitioners assert that the UE 230 identifiers stored in the Identity Module somehow “identify” that the WLAN supports communication with the UEs 230, but there is no basis for that claim. *Pet.* at 14-15. But, a POSITA would understand that a UE 230 in Waylett can communicate with the WLAN 228 without the use of any identifiers stored in the Identity Module 238. For example, a POSITA understands that the identifiers stored

in the Identity Module have no bearing on the ability of the UE 230 to communicate with the WLAN—these identifiers are to allow the UE 230 to partake in the services of the GPRS/GSM network 204.

80. I disagree with Petitioners’ argument that it was “well known” to use the process of identifiers to “identify” the location of a WLAN in communication with a destination device. In my opinion, there is nothing in Waylett supporting that proposition. I understand that Petitioners rely on an external reference (the Bachmann reference, Ex. 1006). But, the portion of Bachmann cited by Petitioners’ expert (Ex. 1003, ¶ 96-97, citing Ex. 1006) does not explain how its identifiers can be used to determine if a DMA gateway supports communication with a destination device. It is also my understanding that Bachmann is not asserted as a reference in Petitioners’ obviousness challenge, but Petitioners does not appear to provide a reason why a POSITA would have been motivated to redesign Waylett’s network based on Bachmann.

81. Thus, in my opinion, Waylett does not teach or suggest the requirement that registration data is used to determine if a DMA gateway supports communication with a destination device.

82. It is also my opinion that Waylett does not disclose registration data that “indicates that the destination device is not within a wireless coverage area associated with the first DMA server.” See Pet. at 15-16 (citing Ex. 1005 at 11:23-

26, 11:26-29). I note that the cited portion of Waylett merely describes the use of “different protocols,” such as IEEE 802.11 standards and HiperLAN. Ex. 1005 at 11:23-29. But, a POSITA understands that indicating the use of different protocols is not the same as disclosing indicating different wireless coverage areas. There is no support for Petitioners’ assertion that “a POSITA would understand different network protocols have different wireless coverage areas.” Pet. at 15 (citing Ex. 1003 at ¶ 98); Ex. 1003 at ¶ 98 (expert declaration identifying no support for claim that “802.11 wireless networks do not overlap with GPRS network...”).

83. A POSITA would understand that the subscriber information such as that found on a SIM card or the Identity Module lacks any indication that a device is or is not within a wireless coverage area. To the contrary, a POSITA would understand that SIM-type identity data is used to identify static information about a device, such as its identity, but not the device’s current location. It is my understanding that Waylett describes the Identity Module as being “described in greater detail” in another patent application (U.S. App. No. 10/002,551), which published as U.S. Publication No. 2003/0081565 (Ex. 2018), and incorporates its disclosure into Waylett. See Ex. 1005 at 10:38-42 (incorporating Ex. 2018 by reference); see also *id.* at 7:39-44, 15:36-38. A POSITA would understand that Waylett’s Identity Module is used to enable a terminal of a private branch exchange (PBX) coupled to a private wireless network to communicate with a public wireless

network via an A-link, and therefore does not support peer-to-peer calls. Ex. 2018 at [0005], [0013]. McIntosh describes that its Identity Module is used to add additional information from a PBX terminal to an A-Link, which is typically the interface between a BSC and a MSC. *Id.* A POSITA understands that McIntosh's identity module does not support peer-to-peer calling because all UEs in this protocol use IMSI, IMEI, and/or keys which come from a SIM or universal SIM (USIM), and an A-Link interface such as that found in McIntosh is between a BSC and a MSC (and not between different MSCs).

84. Thus, in my opinion, Waylett's Identity Module does not "indicate" any difference in coverage areas, such that it indicates a destination device is not within a certain wireless coverage area.

X. CONCLUSION

85. 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 challenged claims are not shown to be disclosed or obvious.

86. I understand that my opinions discussed above support a legal conclusion that the challenged claims are nonobvious.

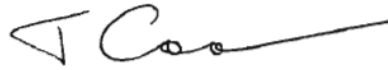
87. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to

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.

88. 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 wilfully 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 wilfully false statements may jeopardize the validity of the application or any patents issued thereon.

June 28, 2023

Respectfully Submitted,

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

Todor V. Cooklev, Ph.D.

Appendix A

Todor Cooklev, PhD.

Curriculum Vitae

Personal

1336 Sycamore Hills Parkway, Fort Wayne, IN 46814

Contact e-mail: tcooklev@gmail.com

Cell: 925-984-5283

Citizenship: United States (by naturalization)

Professional experience

2016 –

Professor of Electrical and Computer Engineering

2101 E Coliseum Blvd., ETCS 349

Purdue University Fort Wayne, Indiana 46805

- Research on most aspects of wireless systems, including hardware, signal processing, and software techniques, in particular for software-defined radios.
- Courses:
ECE 428 Communication Systems
ECE 549 Software-Defined Radio
ECE 543 Wireless Communications and Networks

2013 – 2017

Co-founder and CEO, Adaptive RF, Fort Wayne, IN

- Developed innovative RF technology and served as co-founder of a company that received funding from the Department of Defense

2018 – 2019

Chief Technology Officer, Stryke Industries LLC

- CTO of a company receiving a grant from the Air Force Research Laboratory, Rome, NY

2010 – 2016

ITT Associate Professor of Wireless Communication and Applied Research, Purdue University Fort Wayne

2008 – 2022

Director, Wireless Technology Center *Purdue University Fort Wayne*

2005 – 2008

Consultant, Hitachi America Ltd., San Jose, California

- Voting Member, IEEE 802.11 WG; participated in the work on several 802.11 amendments
- Chair, IEEE 802.11 VTS Study Group; responsible for the proposal and approval to create a Task Group that lead to the IEEE 802.11aa standard

- 2011 – 2012 Consultant, Hitachi America Ltd., San Jose, California**
- Attended meetings of the 3GPP RAN1 standardization committee in Dresden, Germany, Jeju Island, Korea, Prague, Czech Republic, and Qindao, China, 2012.
 - Contributed to several documents submitted to 3GPP
- 2006 – 2008 Consultant, Datamars, Lugano, Switzerland**
- Evaluated and produced reports on certain wireless technologies and standards
 - Participated in the IEEE 802.15.4f committee
- 2004 – 2006 Consultant, Leica Geosystems, Switzerland**
- IEEE 802.16 (WiMAX) and related technologies
- 2005 – 2007 Technical Advisory Board Member, Doceotech, San Ramon, CA**
- 2002 – 2008 Assistant Professor with tenure (2008), San Francisco State University.**
- 2000 – 2002 Member of the Technical Staff, Aware, Inc., Bedford, MA and Lafayette, CA**
- Worked on DSL standards. Participated in the International Telecommunications Union, Study Group 15, Question 4. Chaired the session on coding for DSL at the session in Antwerp, Belgium, June 2000. Participated in the Telecommunications Industry Association T1E1 Committee on DSL
 - Developed advanced coding and decoding methods for DSL
 - Worked on the design of an IEEE 802.11a chipset.
 - Voting member, IEEE 802.15; Co-Founder and First Vice-Chair of IEEE 802.15.3 (High-data rate wireless personal area networking)
- 1998-1999 Consultant, Quantronix, Framingham, Utah**
- Image processing; developed software for edge detection and wrote a report
- 1996-1997 Consultant, Communications Research Center, Government of Canada.**
- Designed digital filter banks for communication systems and wrote two technical reports
- 1997-1999 Senior Engineer, 3Com Corporation**
- Worked on V.90 voice-band modems
 - Implemented data compression and other signal processing algorithms V.42 and V.42bis
 - Worked on the Bluetooth Standard, one of the first contributors to the Host Controller Interface of Bluetooth.
 - Participated in the Bluetooth/IEEE group, which drafted the license agreement between Bluetooth and the IEEE 802, which in turn led to the establishment of the IEEE 802.15 Working Group.

Grants Awarded

1. Office of Naval Research Summer Fellow 2020, Naval Surface Warfare Center Crane
2. National Science Foundation S²ERC I/UCRC, “FPGA implementation of shared-memory middleware”, 2017-2019, PI
3. National Science Foundation S²ERC I/UCRC, “Shared-memory middleware”, 2016-2017, PI
4. City of Fort Wayne, Economic Development Fund, 2013-15, co-PI.
5. Allen County Capital Improvement Board (CIB), 2013-15, co-PI
6. U.S. Defense Advanced Research Projects Agency (DARPA) Small Business Technology Transfer (STTR) Phase I “A flexible and extensible solution to incorporating new RF devices and capabilities into EW/ISR networks, co-PI, August 2013 – February 2014.
7. National Science Foundation S²ERC I/UCRC, “The performance of middleware solutions for SDR”, 2013-2014, PI
8. National Science Foundation S²ERC I/UCRC, “Cognitive decision applications for embedded use,” 2011-2012, PI
9. Visiting Fellowship, National Institute of Communication Technology (Japan), 2011
10. National Science Foundation S²ERC I/UCRC, “Signal processing techniques for multicarrier modulation,” 2009-2011, PI
11. NMDG, Belgium, laboratory grant 2010, PI
12. National Science Foundation, Professional Science Master’s Program, MS in engineering, with concentration in wireless and systems engineering, 2010-2013, Co-PI.
13. Emona Instruments, Sydney, Australia, Laboratory exercises in communications, Principal Investigator, 2008.
14. Lilly Endowment, wireless laboratory grant, 2010, PI.
15. ITT (now Harris) Communications Systems, 2007-2011, PI.
16. State of Indiana, workforce development, 2008-2010, PI
17. National Science Foundation DUE-0442313, “Standards in Education for Product, Process, and Service Design and Development: A Proof-of-Concept Project,” 2005-2008, PI.

18. France Telecom, Paris, France, “New methods for multicarrier modulation for high data-rate wireless systems,” Principal Investigator, 2006.
19. Agilent Technologies/Sun Microsystems, Palo Alto, CA, “Distributed wireless sensor network for environmental monitoring,” Co-principal Investigator, 2005.
20. CSU summer research grant, 2004.
21. U.S. Air-Force Research Laboratory, Wright-Patterson AFB, “Data over voice communications,” Principal Investigator, 2004.

Honors and Awards

- | | |
|------------------|--|
| <i>2012</i> | IEEE Standards Association, “for outstanding contributions to the development of IEEE 802.11aa” |
| <i>2006</i> | Wireless Educator of the Year Award with the citation “In recognition of the pivotal role of educators in preparing tomorrow’s wireless technology leaders”. |
| <i>2005</i> | Duke’s Choice Award, Sun Microsystems, (group award) |
| <i>2003</i> | IEEE Communications Society Oakland/East Bay Chapter Achievement Award, (group award) |
| <i>1999</i> | 3Com Inventor Award |
| <i>1995-1997</i> | NATO Science Fellowship |
| <i>1994</i> | IEEE Asia - Pacific Conference on Circuits and Systems Best Paper Award for the paper “Theory of filter banks over finite fields” |

Education

- | | |
|---------------|---|
| <i>1995</i> | <i>Tokyo Institute of Technology, Tokyo, Japan,</i>
Doctor of Philosophy in Electrical Engineering |
| Dissertation: | Regular Perfect-Reconstruction Filter Banks and Wavelet Bases |
| <i>1988</i> | <i>Technical University of Sofia, Bulgaria,</i> Dipl. Eng. in Electrical Engineering |

Professional Activities

Board Membership:

Board of Governors, IEEE Standards Association, 2021-2022

Committee/Editorial Board Membership:

IEEE Communications Standards Magazine, Series Editor, Wireless and Radio Communications, 2017-

Committee Membership:

- IEEE 802.11 Working Group Voting Member, 2001-2003, 2006-present

- IEEE 802.15 Working Group Voting Member 1999-2001
- Chairman, IEEE Standards in Education Committee, 2006 – present
- Member of the Editorial Board, Journal of Networks.
- 2004-2005 Chairman and 2003-2004 Secretary of the Oakland/East Bay Chapter of the IEEE Communication Society.

Program Committee Membership:

- General Chair, Tactical Communications and Interoperability Conference, 2011
- General Chair, Fort Wayne Wireless Summer School 2009 and 2010
- Program Committee Member, Int. Conf. on Wireless Applications and Computing, 2007.
- Program Committee Member, Int. Conference on WLAN, WPAN, and WMAN, Hawaii, Aug. 2007.
- Program Committee Member, Int. Joint Conf. e-Business and Telecommunications, Barcelona, Spain, 2007.
- Program Committee Member, Int. Conf. Wireless Information Networks and Systems, Lisbon, Portugal, 2006.
- Technical Program Committee Member, Int. Conf. Networking and Services, ICNS 2006, Santa Clara, CA.
- Technical Program Committee Member, Advanced Int. Conference on Telecommunications, AICT, Guadeloupe, French Caribbean 2006.
- Program Committee Member, Int. Joint Conf. e-Business and Telecommunications, Reading, UK, 2005.
- Technical Program Committee Member, Int. Conf. Convergent Services and Next-Generation Networks, June 2005, Chicago, IL.
- Technical Program Committee Member, Int. Conference on Service Assurance with Partial and Intermittent Resources, Lisbon, Portugal, July 2005.
- Technical Program Committee Member, Int. Conf. Telecommunications, 2004, Brazil.
- 3rd Int. Workshop on Signal and Image Processing, Manchester, UK, Special session on wavelets in communication systems, signal and image processing, special session co-organizer, Nov. 1996.

Tutorials at International Conferences

- 1) T. Cooklev, “The analog RF-digital interface: the VITA 49 standard and evolution roadmap,” First IEEE Next G Summit, Johns Hopkins University, June 14, 2022.
- 2) T. Cooklev, “Open RF-digital interfaces and wireless ontologies,” IEEE BlackSeaCom, 4th International Black Sea Conference on Communications and Networking, Varna, Bulgaria, June 2016.
- 3) M. Cummings, T. Cooklev, “Software Defined Radio Technology”, Tutorial at the 2008 Symposium System on Chip, Tampere, Finland, Nov. 2008.
- 4) M. Cummings, T. Cooklev, “Software Defined Radio Technology”, Tutorial at the IASTED Int. Conference Computer Communications, Palma de Mallorca, Spain, Sept. 2008.
- 5) M. Cummings, T. Cooklev, “Software Defined Radio Technology”, Tutorial at the 2007 International Conference on Computer Design, Squaw Creek, CA 2007.
- 6) T. Cooklev, “Wireless communication standards: 802.11, 802.15, and 802.16,” Int. Conference Telecommunications, Fortaleza, Brazil, Aug. 2004, tutorial.
- 7) T. Cooklev, “Wireless data communication standards, IEEE Globecom 2003, Dec. 2003, San Francisco, CA, tutorial.

Short Courses and Invited Talks excluding conferences:

- 1) T. Cooklev, "Open RAN", Technical University of Sofia, Bulgaria, November 2019.
- 2) T. Cooklev, "Software-defined radio technology," Oulu University, Finland, Oct. 2017.
- 3) T. Cooklev, "Software-defined radio technology," Aarhus University, Denmark, Oct. 2017.
- 4) T. Cooklev, "Modern wireless systems," Technical University of Sofia, Bulgaria, 2014.
- 5) T. Cooklev, "Modern Wireless Systems," Featured faculty presentation, Feb. 2012, IPFW.
- 6) T. Cooklev, "Software-defined radio technology," Tokyo Institute of Technology, Dec. 2011.
- 7) T. Cooklev, "Software-defined radio technology," University of Akron, OH, 2010.
- 8) T. Cooklev, "Modern wireless systems," Catholic University of Leuven, Leuven, Belgium, 2010
- 9) T. Cooklev, "Modern wireless systems," University of Qatar, Doha, Qatar, 2009.
- 10) T. Cooklev, "Modern wireless systems," Technical University of Sofia, Bulgaria, 2009.
- 11) T. Cooklev, "Modern wireless systems: from Marconi's radio to cognitive radio," Sigma Xi presentation, February 2009, IPFW.
- 12) T. Cooklev "Software-Defined Radio Technology," Talk at IPFW, Oct. 2008.
- 13) M. Cummings, T. Cooklev, "Software Defined Radio Technology", IEEE Communication Society, Oakland/East Bay Chapter, presentation, Oct. 2007, San Ramon, CA.
- 14) T. Cooklev, "Engineering Standards in Engineering Education," presentation and a panel participant, Standards Engineering Society Annual Conference, San Francisco, CA, August. 2007. (panelist and presenter)
- 15) T. Cooklev, "Vector transform for multicarrier modulation", France Telecom, June 2007, Rennes, France.
- 16) T. Cooklev, "Wireless Communication Standards," Distinguished Lecture, IEEE Communication Society, Oct. 2006, University of Maine.
- 17) T. Cooklev, "The IEEE 802.11, 802.15, and 802.16 Families of Standards," Short Course, April 2006, Lietuvos Telekomas, Vilnius, Lithuania,
- 18) T. Cooklev, "The IEEE 802.11, 802.15, and 802.16 Families of Standards," Short Course, Feb. 2006, Austin, TX.
- 19) T. Cooklev, "The IEEE 802.11, 802.15, and 802.16 Families of Standards," Invited Talk, Dec. 2005, Cisco Systems, San Jose, CA.
- 20) Wireless local area networks, Hitachi Ltd., Brisbane, CA, June 2005.
- 21) T. Cooklev, "The IEEE 802.11, 802.15, and 802.16 Families of Standards," Invited Talk, May 2005, Texas Instruments, Dallas, TX.
- 22) T. Cooklev, "Standards for the Wireless Internet", IEEE Communication Society, Oakland/East Bay Chapter, presentation, January 2005. Freemont, CA.
- 23) T. Cooklev, "Wireless data communication standards, IEEE Wescon, Aug. 2003, San Francisco, CA, tutorial.
- 24) Short Course on 802.11, 802.15, 802.16, West Long Branch, NJ, August 2003
- 25) Wireless data communication standards, Lockheed Palo Alto Research Center, June 5, 2003.
- 26) Short Course on IEEE 802.11, 802.15, and 802.16, San Francisco, CA, Dec. 2002.
- 27) Standards for wireless data communications, University of Utah, Salt Lake City, UT, 1999
- 28) OFDM for wireless communications, 3Com Technology Forum, Boston, MA, Nov. 1998.
- 29) Filter banks and wavelets: a modern applied mathematics tool, Invited Lecture at the Analysis Day, Department of Mathematics and Statistics, Carleton University, Ottawa, Canada, 1997
- 30) Filter banks and wavelets for video signal processing, Genesis Microchip Inc, Markham, Ontario, Canada, July 1996.

- 31) Advanced topics in filter banks, wavelets, and their applications in modern communications systems, CRC, Ottawa, March and August 1996.
- 32) Digital filter banks and wavelets, Dept. Elect. Eng., University of Ottawa, March 1996.
- 33) Digital filter banks and wavelets, Dept. Elect. Eng., Queen's University, Kingston, March 1996.
- 34) Perfect-reconstruction filter banks and wavelet bases and their applications in digital communications, Fujitsu Laboratories, Kawasaki, Japan, July 1994.
- 35) Fast algorithms for signal processing, Istanbul University, Istanbul, Turkey, Jan. 1994.

Publications

Books and Monographs

- 1) T. Cooklev, *Modern Communication Systems: A first course*, University of Michigan Press, 2022 (in preparation).
- 2) T. Cooklev, *Wireless communications standards: A Study of IEEE 802.11, 802.15, 802.16*, IEEE Press, New York, NY. 2004.

Chapters in Books

- 1) A. Vlahov, D. Elkova, V. Poulkov, T. Cooklev, Virtualized, open, and intelligent: the evolution of the Radio Access Network,” River Publishers, 2021.
- 2) Subbu Ponnuswamy, Todor Cooklev, Yang Xiao, and Krishna Sumanth Velidi, “Security in fixed and mobile IEEE 802.16 networks,” Chapter 4, *WiMAX/MobileFi: Advanced Research and Technology*, edited by Yang Xiao, Taylor and Francis, January 2008.
- 3) T. Cooklev and A. Hristozov, “The Software Communications Architecture,” in *Resource Management in Future Internet*, edited by Ramjee Prasad, River Publishers, Denmark, 2015.

Journal Papers

- 1) V. Kolev, T. Cooklev, F. Keinert, *Design of a Simple Orthogonal Multiwavelet Filter by Matrix Spectral Factorization*, Circuits, Systems, and Signal Processing, 2019.
- 2) Y. Acar and T. Cooklev, “High performance OFDM with index modulation”, *Physical Communication*, vol. 32, pp. 192-199, 2019.
- 3) M. Sherman and T. Cooklev, “Abstract descriptions of spectrum: VITA 49 and IEEE 1900.5.2”, *IEEE Communications Standards Magazine*, vol. 2, no. 4, pp. 43-48, December 2018.
- 4) T. Cooklev, V. Poulkov, D. Bennett, K. Tonchev, “Enabling RF data analytics services and applications via cloudification,” *IEEE Aerospace Electronic Systems Magazine*, vol. 33, no. 5-6, pp. 44-55, May-June 2018.
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Contributions to ITU-T SG15 Q4 on DSL technology

- 15) T. Cooklev, A. Freedman, and M. Tzannes, "Low-density parity check codes (LDPC) for ADSL," ITU-T SG15 Q4 BI-068, Bangalore, India, Nov. 2000. (on behalf of Aware, Inc.)
- 16) T. Cooklev, M. Tzannes, A. Freedman, "Low-density parity check coded modulation for ADSL," ITU-T SG15 Q4 BI-081, Bangalore, India, 2000. (on behalf of Aware, Inc.)
- 17) T. Cooklev, "Error-correcting codes for ADSL," ITU-T SG15 Q4, BA-108, Antwerp, Belgium, June 2000. (on behalf of Aware, Inc.)

Other non-referred publications and technical reports

- 18) T. Cooklev, "Standards, regulation, and compliance," IEEE Standards University, [online] <https://www.standardsuniversity.org/e-magazine/september-2017/standards-regulation-compliance/>
- 19) T. Cooklev A wavelet transform approach to the design of sequences for communications, Communications Research Centre, Ottawa, Tech. Report U6800-6-2438, 1997.
- 20) I. Rabinovitch, A. N. Venetsanopoulos, and T. Cooklev, "Perceptually lossless still image compression using the wavelet transform, considering the properties of the Human Visual System," ITRC, Kingston, Ontario, 1996.
- 21) T. Cooklev, On the design and implementation of filter banks and filter bank trees with finite wordlength, Communications Research Centre, Ottawa, Tech. Report 67CRC-5-3315, 1996.
- 22) T. Cooklev, M. Kato, A. Nishihara, M. Sablatash "Multifilter banks and multiwavelets," IEICE Tech. Report, Tokyo, Japan, May 1995.
- 23) T. Cooklev, A. Nishihara, "Regular biorthogonal filter banks and wavelet bases: new design and implementation," IEICE Tech. Report, presented at KDD Research Institute, Kamifukuoka, Saitama, Japan, April 1995.
- 24) V. Dimitrov and T. Cooklev, "Two algorithms for modular exponentiation using non-standard arithmetics," IEICE Tech. Report, ISEC93-98, 1994. (in Japanese), presented at the IEICE meeting on information security and cryptography, Osaka, Japan, March 1994.
- 25) T. Cooklev and A. Nishihara, "Pruning the real-valued FFT algorithms for efficient time-domain interpolation and linear convolution," IEICE Tech. Report, CAS93-14, VLD93-14, DSP93-24, May 1993.
- 26) T. Cooklev and A. Nishihara, "Band pass maximally flat FIR filters and Hilbert transformers," IEICE Tech. Report, CS92-88, DSP92-88, Jan. 1993.

Expert witness experience

- 2020 – Expert for Smart Mobile Technologies LLC
- Law firm: Hagens Berman Sobol Shapiro, Pasadena, CA (2020-2022); Graves and Shaw LLP (2022 – present).
 - Case names: *Smart Mobile Technologies LLC v. Apple Inc.*, and *Smart Mobile Technologies LLC v. Samsung Electronics Co. Ltd. and Samsung Electronics America, Inc.*
 - Case Nos: 6:21-cv-00603, 6:21-cv-00701 (W.D. Tex.)
 - PTAB case Nos. IPR2022-00766, IPR2022-00807, IPR2022-00808, IPR2022-01002, IPR2022-01003, IPR2022-01004, IPR2022-01005, IPR2022-00979, IPR2022-00980, IPR2022-00981, IPR2022-00982, IPR2022-01222, IPR2022-01223, IPR2022-01248, IPR2022-01249
 - Submitted multiple declarations
 - Testified at multiple depositions
- 2023 – Expert for WSOU Investments, LLC d/b/a Brazos Licensing and Development
- Law firm: Folio Law Group
 - Case name: *WSOU Investments, LLC d/b/a Brazos Licensing and Development v. Google, LLC.*,
 - Case Nos. 6:20-cv-00585-ADA (W.D. Tex.)
 - Submitted a validity report
 - Testified at a deposition
 - Technology at issue: determining a location of a mobile device and location-based services
- 2021 – 2023 Expert for TQ Delta, Austin, TX
- Law firm: Davis Law Firm, P.C., Longview TX, and McAndrews, Chicago, IL
 - Case name: TQ Delta, LLC, v. Commscope Holding Company, Inc., Commscope Inc., Arris International Limited, Arris Global Ltd, Arris US Holdings, Inc., Arris Solutions, Inc., Arris Technology, Inc., and Arris Enterprises, LLC
 - Civil Action No: 2:21-cv-310-JRG, 2:21-cv-309-JRG (E.D. Tex.)
 - Submitted a declaration in connection with claim construction, infringement report, validity report, and reports on testing and simulation
 - Testified at two depositions and at trial
- 2021 – 2022 Expert for WSOU Investments, LLC d/b/a Brazos Licensing and Development
- Law firm: Kasowitz Benson Torres LLP
 - Case name: *WSOU Investments, LLC d/b/a Brazos Licensing and Development v. Canon, Inc.*,
 - Case Nos. 6:20-cv-00980-ADA, 6:20-cv-00981-ADA (W.D. Tex.)
 - Submitted a declaration in connection with claim construction, infringement and validity reports.
 - Testified at a deposition

- Technologies at issue: frequency-hopping wireless communication; image processing and compression

2021 – 2022 Expert for NXP

- Law firm: Jones Day, Washington, DC
- Case name: Certain Integrated Circuits, Chipsets, and Electronic Devices, and Products Containing the Same, ITC 337-TA-1287
- Technology at issue: IEEE 802.11
- Submitted a validity report
- Testified at a deposition

2019 – 2022 Expert for Evolved Wireless LLC, Austin, TX

- Law firm: Nelson Bumgardner Albritton P.C., Fort Worth, TX (2019–22); Bruster PLLC, Southlake, TX (2022–present)
- PTAB Case No. IPR2021-00943
- Submitted a declaration
- Testified at a deposition
- Technology at issue: 4G cellular communications

2021 – Expert for Flexiworld Technologies

- Law firm: Nelson Bumgardner Conroy, Dallas, TX
- Case name: *Roku, Inc. v. Flexiworld Technologies*
- PTAB Case Nos. IPR2021-00713, IPR2021-00714, IPR2021-00715, PGR2021-00112, IPR2022-00775
- Submitted multiple declarations
- Testified at multiple depositions

2021 – 2022 Expert for 3G Licensing

- Law firm: Devlin Law Firm LLC
- Case name: *Cradlepoint, Inc., Dell Inc., Honeywell International, Inc., Sierra Wireless, Inc., TCL Communication Technology Holdings Limited, TCT Mobile International Limited, TCT Mobile, Inc., TCT Mobile (US) Inc., TCT Mobile (US) Holdings Inc., Thales DIS AIS Deutschland Gmbh, ZTE Corporation, and ZTE (USA) Inc. v. 3G Licensing, S.A.*
- PTAB Case Nos. IPR2021-00640, IPR2021-01141
- Technology at issue: cellular communications
- Submitted declarations
- Testified at a deposition

2021 – 2021 Expert for Barkan Wireless IP Holdings, L.P.

- Law firm: Heim, Payne & Chorush, LLP, Houston, TX
- Case name: *Barkan Wireless v. T-Mobile, Inc. and Nokia of America Corp.*
- Civil Action No. 2:21-CV-00034-JRG (E. D. Tex.)
- Submitted a validity report
- Testified at a deposition

- Technology at issue: cellular network architecture involving home base stations

2020 – 2021

Expert for General Access Solutions, Dallas, TX

- Law firm: Bartlit Beck, Denver, CO
- Case name: *General Access Solutions, LTD. v. Virgin Mobile USA, L.P., Boost Mobile, LLC, and Sprint Spectrum L.P.*
- Civil Action No. 2:20-cv-00007-RWS (E. D. Tex.)
- Submitted a report on standards essentiality
- Testified at a deposition
- Technology at issue: beamforming in 4G and 5G cellular standards

2014 –

Expert for TQ Delta, Austin, TX

- Law firm: McAndrews, Chicago, IL
- Case name: TQ Delta, LLC v. Adtran
Civil Action No. 14-cv-00954-RGA (D-Del.), Civil Action No. 15-cv-00121-RGA (D-Del.)
- Case name: TQ Delta, LLC v. 2Wire
Civil Action No. 13-cv-1835-RGA (D-Del.)
- Case name: TQ Delta, LLC v. Zhone Technologies, Inc.
Civil Action No. 13-cv-1836-RGA (D-Del.)
- Case name: TQ Delta, LLC v. Zyxel Communications, Inc. and Zyxel Communications Corporation
Civil Action No. 13-cv-2013-RGA (D-Del.)
- Submitted product testing reports, computer simulation reports, a report on the terms of a license agreement, a report on standards essentiality, infringement reports, validity reports
- Testified at depositions and trials
- Technology at issue: Digital signal processing in Digital Subscriber Line communication systems

2015 – 2019

Expert for Evolved Wireless, Austin, TX

- Law firm: Robins Kaplan, Minneapolis, MN
- Civil Actions No. 15-cv-542-SLR-SRF, No. 15-cv-543-SLR-SRF, No. 15-cv-544-SLR-SRF, No. 15-cv-545-SLR-SRF, No. 15-cv-546-SLR-SRF, and No. 15-cv-547-SLR-SRF (D-Del.) brought against Apple, HTC, Lenovo, Samsung, ZTE, and Microsoft.
- Submitted infringement and validity reports
- Testified at deposition and trial
- Technologies at issue:
 - Random-access procedure in the LTE cellular standard
 - Generation and format of the random-access preamble in LTE
 - Handover and contention-free random access in LTE
 - Constant-amplitude zero-autocorrelation sequences in LTE