

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 IPR2023-00531
U.S. Patent No. 7,855,988

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. 7,855,988 (“the ’988 patent”) in IPR2023-00531. 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, 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 '988 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 '988 Patent claims priority to July 14, 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 of the '988 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 '988 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."), ¶ 56. 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 '988 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.

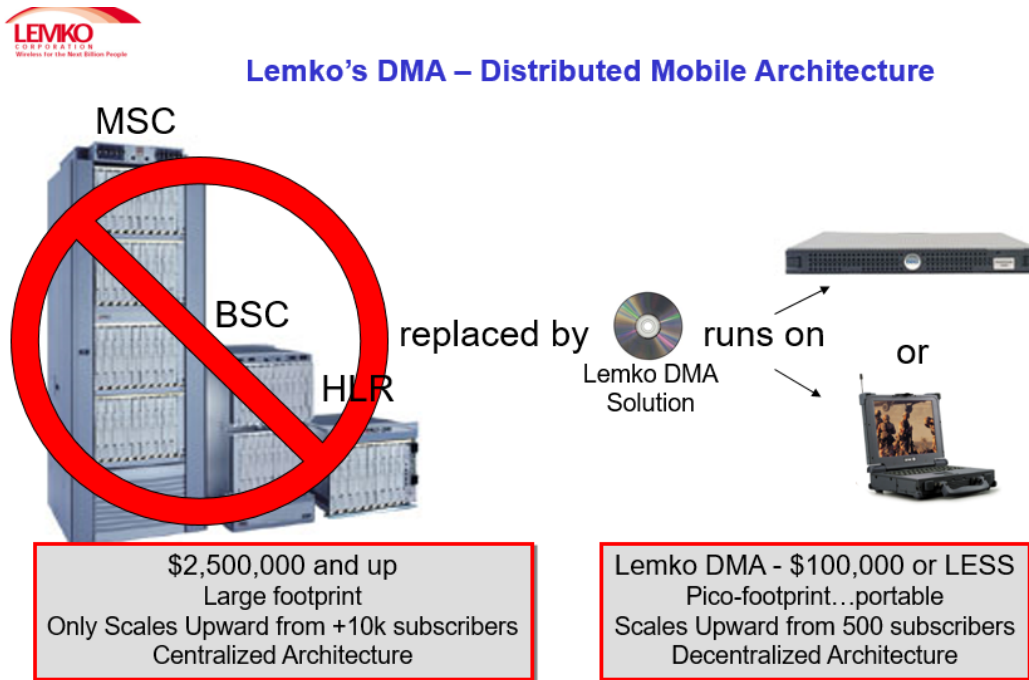
25. For the purpose of this preliminary proceeding, I have provided constructions for the terms "DMA server" and "communications information."

1. In My Opinion, "DMA Servers" Are Connected by Peer-to-Peer Connections

26. I understand that each of the Challenged Claims requires a distributed mobile architecture (DMA), where individual DMA servers are connected with peer-to-peer connections. Accordingly, DMA servers are connected by peer-to-peer connections.

27. According to the '988 Patent, each DMA server has its own MSC and BSC functionality, including gateways and a cellular radio network controller

(CRNC), to allow for a fully functionally virtualized network. '988 Patent at Figs. 1, 5 (annotated); *see id.* at 7:19-21. Lemko's claimed DMA is a full featured MSC and BSC running on a DMA server, as I illustrate below with an excerpted illustration from one of Lemko's presentations:



Lemko's DMA IS a full featured MSC + BSC + HLR running on a PC

28. As such, a POSITA would appreciate that rather than managing all calls at a single centralized MSC, like conventional systems, the '988 Patent discloses a "distributed mobile architecture" where call management is distributed among the various DMAs that make up a DMA network:

Within the distributed and associative communications system 400, the controlling logic can be distributed and de-centralized. Moreover, the wireless coverage provided by the disclosed system 400 is self-healing and

redundant. In other words, due to the interconnectivity via the IP network 410, if one or more of the DMAs 406 loses power, fails, or is otherwise inoperable, telephony traffic handled by the inoperable DMA 406 can re-routed to one of the remaining operable DMAs 406. Additionally, user data stored in a database, e.g., a home locator resource (HLR) or a visitor locator resource (VLR), can be distributed equally and fully among all of the DMAs 406. It can also be appreciated that new cellular coverage sites can be easily added to the system 400 as the demand for users increases. Specifically, a DMA can be deployed, connected to an antenna, connected to the IP network, and activated to provide cellular coverage in a new area.

'988 Patent at 6:63-7:12 (emphasis added). In the '988 Patent's DMA Network, the controlling logic, and the data for routing calls, are distributed among individual DMAs, which are connected to every other DMAs in the DMA Network using a peer-to-peer connection. *Id.* at 7:2-7.

29. Figure 4 (that I have reproduced below) illustrates that each DMA server ("DMAS") is interconnected with other DMAS in an Internet Protocol (IP) network via peer-to-peer connections. '988 Patent at 6:46-37 ("each DMA server 106 is interconnected with the other DMA servers 106 via an Internet protocol network . . . As such, there exists peer-to-peer connection 412 between each DMA server 406 in the system").

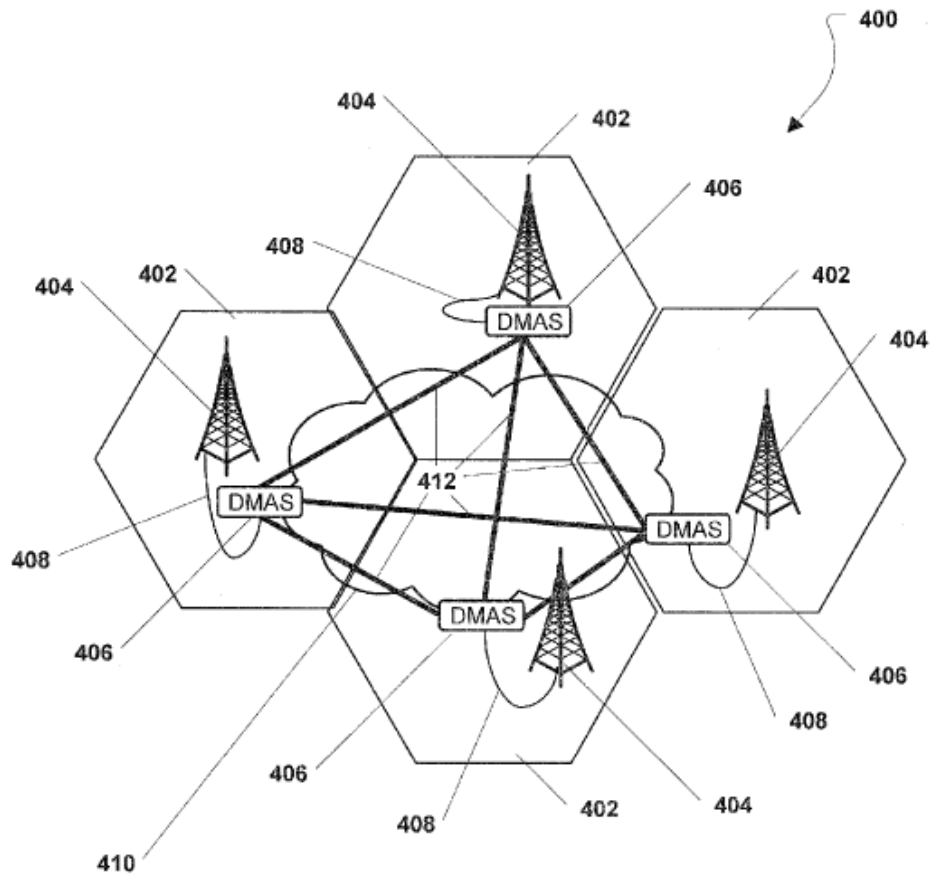
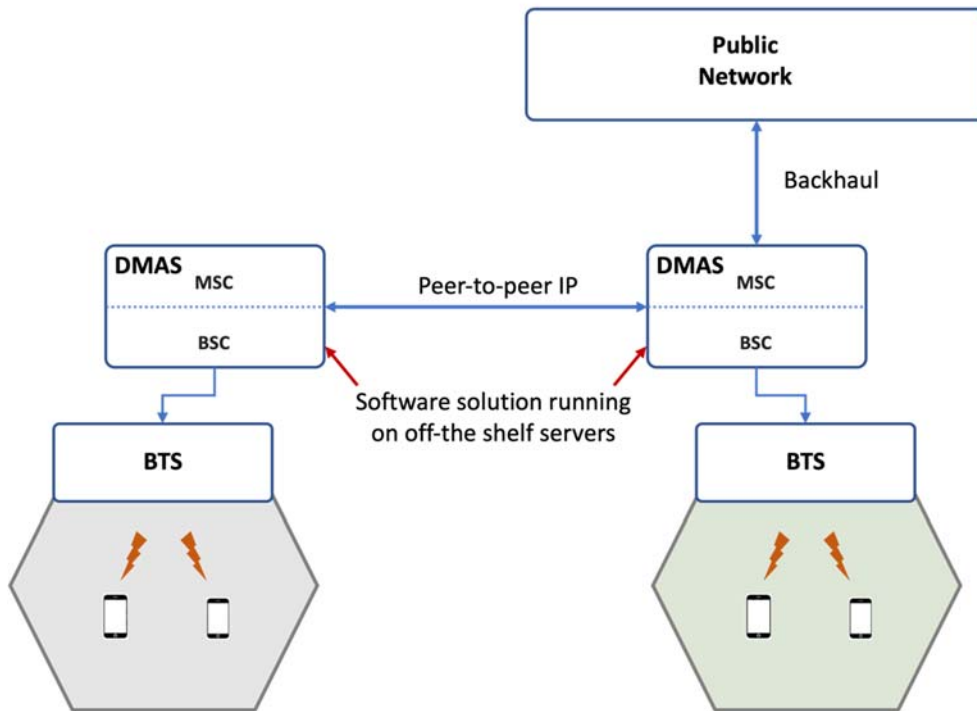


FIG. 4

Id. at Fig. 4. A POSITA would understand that the use of these peer-to-peer IP network connections between DMA servers in the same network 400 eliminates or reduces the need to route traffic through a backhaul, as is shown schematically in an expanded and annotated view of Figure 4 below:

Lemko Distributed Mobile Architecture



30. 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 DMAS, (3) to a second DMAS (by a peer-to-peer IP connection), (4) to a BTS, (5) to the receiving UE.

31. Thus, I understand a DMA server as being to be connected to other DMA servers through peer-to-peer connections.

2. In My Opinion, “Communications Information” Must Include Information Identifying the Home Network for a Target Device

32. It is my opinion that the claimed “communications information” must include information identifying devices serviced by a home network. ’988 Patent at Claim 1.

33. The Challenged Claims expressly state that the claimed “communications information:” (i) “indicat[es] one or more devices accessible by a DMA server and a legacy communications network,” (ii) is stored “in a home DMA register,” and (iii) is “to be served by the second DMA gateway” to indicate a target device. ’988 Patent at Claim 1. In accordance with these requirements, the “communications information” must include information that identifies the target devices serviced by a home network. *Id.* at 11:10-25, 14:5-14;

34. A POSITA would understand that to facilitate communication between devices serviced by different networks, the DMA gateways maintain communications information that identifies devices on the home networks that each DMA gateway services, and which is provided to other DMA gateways through the exchange of register data:

DMA gateways provide information to one another regarding the communications networks they service by exchanging register data describing the networks they service. The register data describes devices for which the networks they service are the home network

'988 Patent at 11:20-25. The register data identifying “devices for which the networks they service are the home network” (*id.* at 11: 23-24) is known as home location register (HLR) information that is stored in a “home DMA register.” *Id.* at Claim 1, 15:14-23, 16:63-17:12. By locating this functionality at the DMA gateway, the DMA gateway is able to identify the specific DMA gateway it needs to contact in order to connect a call to a UE located in a different home network.

35. The HLR information includes subscriber location and user profile data, such as the user’s phone number, which is used to determine the routing of the communication to the home network servicing the target device. Ex. 2015 (“In order for communication to take place with the mobile device of a subscriber, the location of the device must be known in order to route those communications to the part of the mobile network servicing their mobile device.”); Ex. 2013 at 1 (“used to determine the correct routing for incoming and outgoing calls and messages.”); Ex. 1006 (disclosing the HLR as a register “to which a mobile subscriber is assigned for record purpose such as subscriber information.”). Accordingly, a DMA gateway accesses the HLR information stored in the home DMA register to identify the target UE serviced by a home network and routes the communication to the network serviced by the DMA gateway:

To facilitate communications between devices serviced by different networks, the DMA gateways maintain information identifying the devices that each services The DMA gateway is configured to

route the communications by accessing information indicating which DMA servers provide service to which wireless devices The register data describes devices for which the networks they service are the home network as well as for what devices are visiting on their networks. This information is exchanged directly between the DMA gateways or through a central database described further below with reference to FIG 10.

'988 Patent at 13:58-14:14. Therefore, for at least these reasons, it is my opinion that "communications information" must include information identifying devices serviced by a home network.

36. I understand that while Petitioners do not propose an explicit construction for communications information, their anticipation theory depends on an incorrect implicit construction of communications information. Specifically, Petitioners contend that Flore's Packet Data Protocol (PDP) context is communications information. See Pet. at 12-13 ("[T]he PDP context included in the message contains information identifying the UE 110"). A POSITA would understand that A PDP context is not part of the claimed communications information.

37. As I discuss in more detail below, a PDP context is only used to create a cellular communication connection over which UE can subsequently exchange IP packets; it does not identify devices for which networks serviced are the home networks. Compare Ex. 2016 at 1 (explaining that a "Packet Data Protocol (PDP)

context offers packet data connection over which the UE and the network can exchange IP packets”) with ’988 Patent at 11:20-25. Moreover, as I discuss in more detail in Section VIII.E below, the PDP context is stored in a GGSN register, not in a home DMA register as the Challenged Claims require. ’988 Patent at Claim 1 (“storing the communications information in a home DMA register”).

D. Anticipation Legal Standard

38. I have been informed that a patent claim is anticipated if each and every limitation of that claim is disclosed either explicitly or inherently in a single prior art reference or single prior art product. If not explicitly disclosed, a limitation is inherently disclosed in a prior art reference if an unstated limitation is necessarily present in the prior art. Unless all the elements are found in a single piece of prior art in exactly the same situation and united the same way to perform the identical function, there is no anticipation.

39. I have been informed that, in order for a prior art reference to anticipate a patent claim, the reference must also enable one of ordinary skill in the art to make or practice the claimed invention without undue experimentation. To constitute anticipation, the prior art reference must describe the claimed invention in sufficient detail to place it in the possession of a person of ordinary skill in the field of the invention.

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

41. 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.

42. The 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.

43. 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.

44. In 2008, when Lemko filed the '988 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).

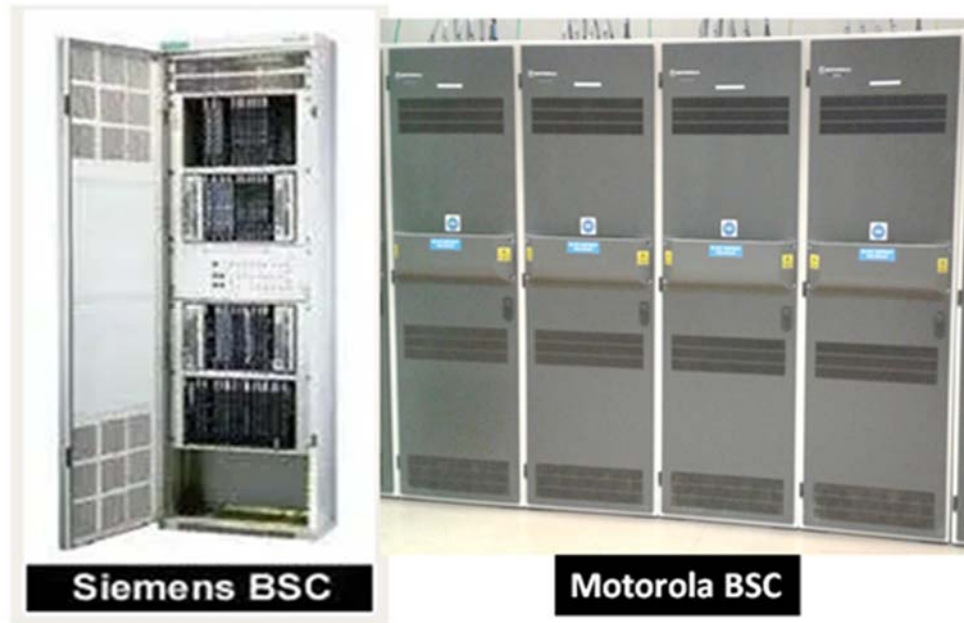
45. Conventional networks were hierarchical because each cell tower (also known as a “base transceiver station” or “BTS”) connects to a single Base Station Controller (“BSC”), which connects to a centralized mobile switching center (“MSC”) that routes calls. See '988 Patent at 1:37-51. Cell towers did not communicate directly with other cell towers, and BSCs did not communicate directly with other BSCs.

46. 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. See Ex. 2002 at 1-3.



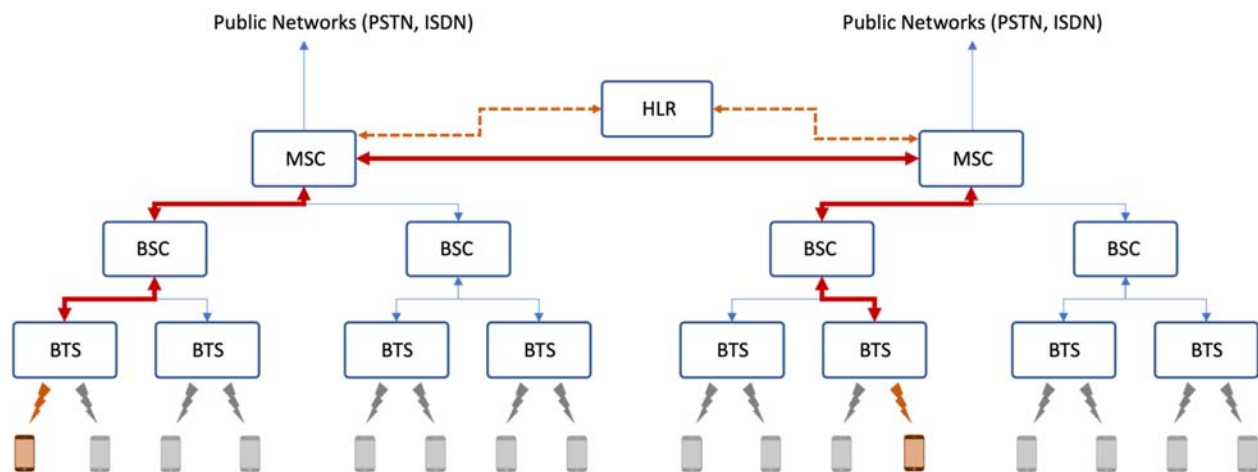
Ex. 2003.

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



Ex. 2005; Ex. 2006.

48. The following figure shows the hierarchical structure of these conventional networks.



In these conventional networks, the backhaul connections were based on T1/E1 communication lines. See Ex. 2007 (explaining that “E1/T1 systems were widely

used in telecommunications when 2G technologies including GSM were being rolled out and deployed”).¹

49. 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.² 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.

50. The hierarchical, hardware paradigm had numerous drawbacks. Such networks were expensive to deploy because they require large amounts of space,

¹ “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.

² “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.

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 (noting the difficulty “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.

51. 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 seven 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.

52. 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.

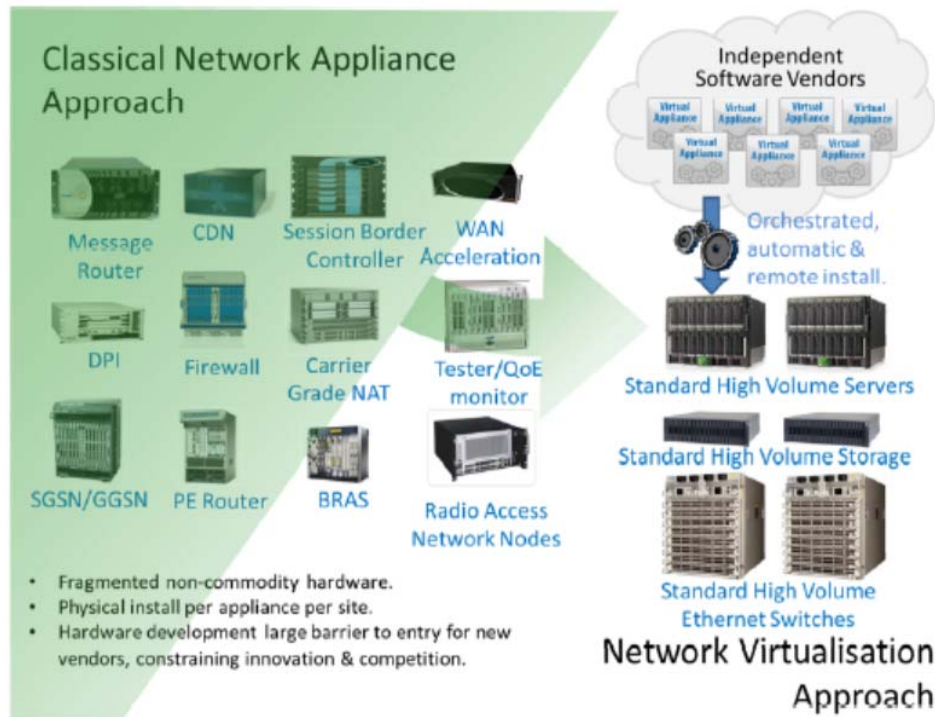


Figure 1: Vision for Network Functions Virtualisation

See Ex. 2008 at 5.

53. The '988 Patent recognized that cellular infrastructure elements such as the BSC and MSC when implemented with dedicated hardware were not only expensive, but difficult to interoperate or to manage in the field. The Patent provides a software implementation together with a novel architecture, as I explain in detail below.

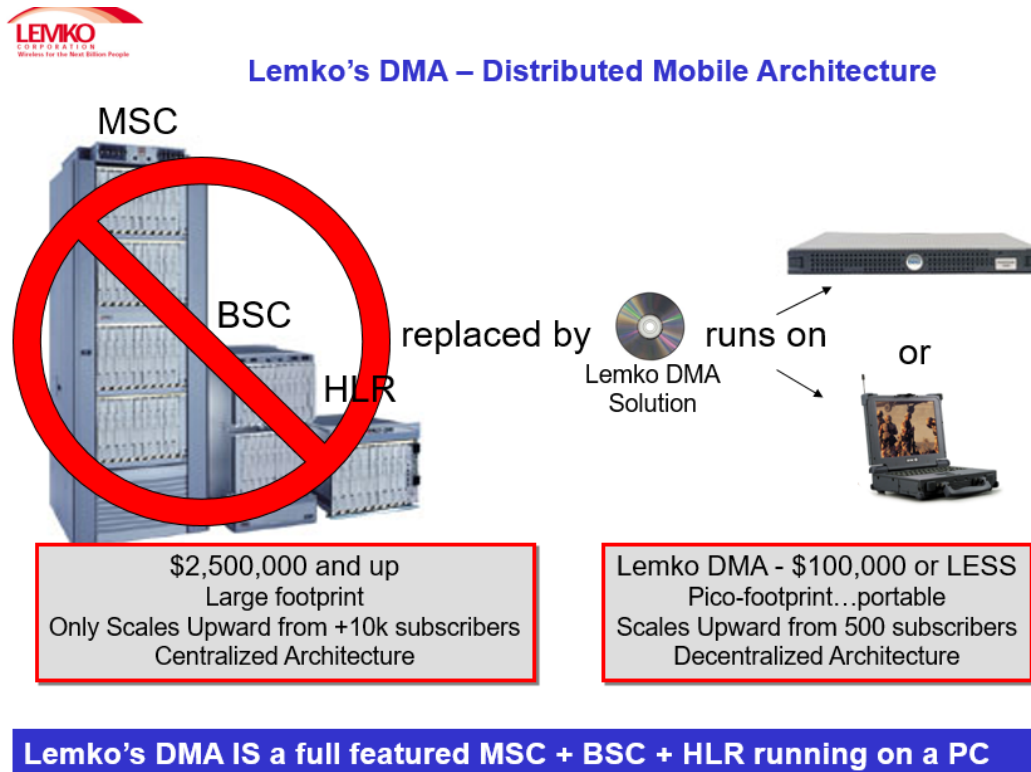
V. OVERVIEW OF LEMKO'S TECHNOLOGY AND THE '988 PATENT

54. 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 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.

55. Several years before the industry proposed solutions for its long-felt needs in the NPV Paper, Lemko filed the application that led to the '988 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."). Indeed, Lemko "developed Network Functions Virtualization (NFV) before that term was coined" because its "software enables all of core network functions, databases and gateways." *Id.*

56. Particularly, a POSITA would recognize that Lemko's DMA implements network functionality, such as MSC, BSC, and home location register

(“HLR”) functionality,³ onto a computer-readable medium running on a standard server, as Lemko’s demonstrative illustration below shows:



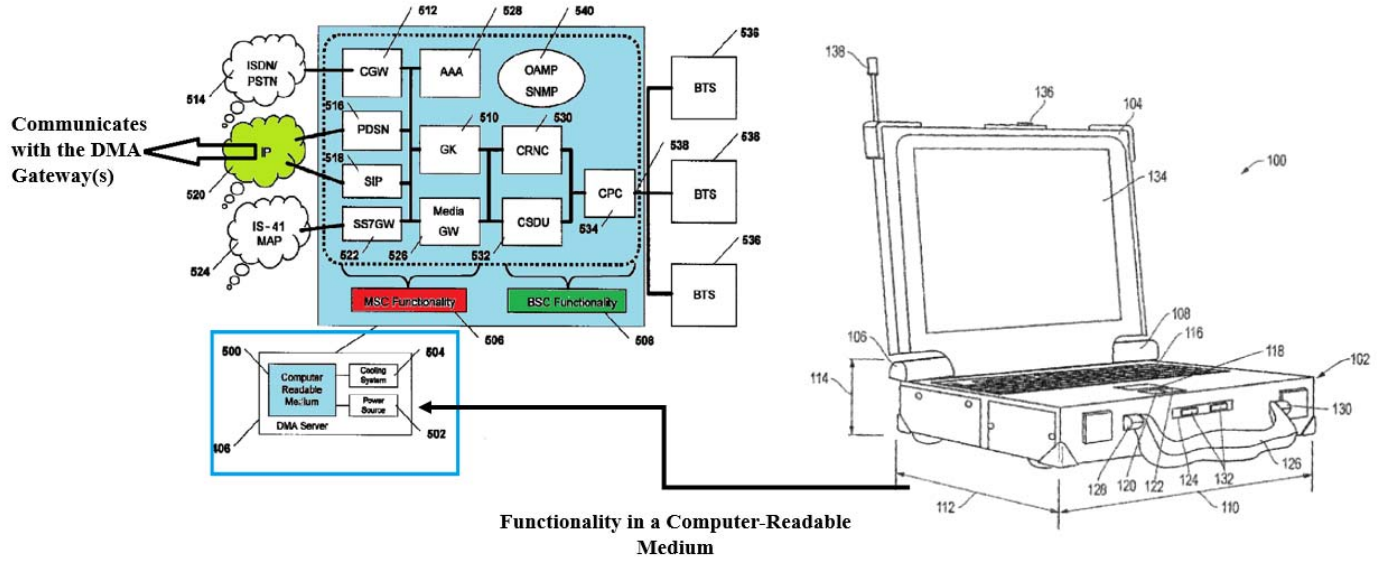
Ex. 2010 (“[T]he heart of DMA is an all-IP software solution,” including the network functionality of an MSC, BSC, radio network controller (RNC) location

³ The HLR is a database used in cellular networks to store subscriber information, such as the subscriber’s mobile number, authentication information, and the services they have subscribed to. *See generally* Exs. 2013-2015. The HLR plays an important role in routing calls and messages within a network and in managing customer mobility and authentication.

registers, and media and data gateways (MSG, GGSN, SGSN); *see also* '988 Patent at Figs. 1 and 3 (depicting the DMA servers of the above figure). Accordingly, 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.

57. The '988 Patent embodies Lemko's technology. Specifically, the specification discloses that the DMA server (or DMAS) has a computer-readable medium (as I highlighted in blue) including MSC (as I highlighted in red) and BSC (as I highlighted in green) network functionality:

DMA Server



Id. at Figs. 1, 5 (annotated); *see id.* at 7:19-21. Accordingly, each DMA server has its own MSC and BSC functionality, including gateways and a cellular radio network controller (CRNC), to allow for a virtualized network. Ex. 2009; Ex. 2010.

58. The DMA server may be interconnected with other DMA servers via an IP network, allowing for peer-to-peer communication between each DMA server in the network. *Id.* at 6:46-49, Fig. 4. DMA servers and the devices they serve can also communicate with other DMA servers and devices located on separate networks and legacy networks, such as conventional telephone or cellular networks using MSCs as in Flore, via DMA gateways. *See id.* at 10:53-66, Claim 5; Flore at ¶ 30 (describing the conventional legacy networks with centralized MSCs); Ex. 2012 at 3. DMA gateways bridge the separate networks and communications via a DMA gateway communications network that the DMA gateways are part of. *See id.* A

POSITA would appreciate that the DMA gateways facilitate communications between devices serviced by DMA servers on separate networks and legacy communication networks.

59. I note that by leveraging the DMA servers, DMA gateways, and DMA gateway communications networks, the claimed inventions route communications between devices serviced by different networks, *e.g.*, between DMA networks or between a DMA network and a legacy communication network. '988 Patent at 9:36-11:27. For instance, Figure 6 exemplifies communication between wireless devices on separate private IP networks. *Id.* at Fig. 6. To enable communication across these separate networks, a first DMA gateway (602) utilizes communications information (not shown) to identify the devices of home networks serviced by other DMA gateways. *Id.* at 11:11-27, *id.* at Fig. 6.

60. In this example (as I illustrate below), DMA gateway 602 uses the communications information to identify a target UE (wireless device 652) of the private IP network 640 serviced by the second DMA gateway 604. *Id.* at 11:11-27, *id.* at Fig. 6. The communication is then routed via DMA gateway communications network 606 to private IP network 640 that is accessible by DMA gateway 604. *See id.* at Abstract, 9:37-40, 15:24-36, Fig. 6. This use of DMA gateways applies equally to connecting calls to a telephone (612) on conventional public-switched telephone network (610, a legacy communications network).

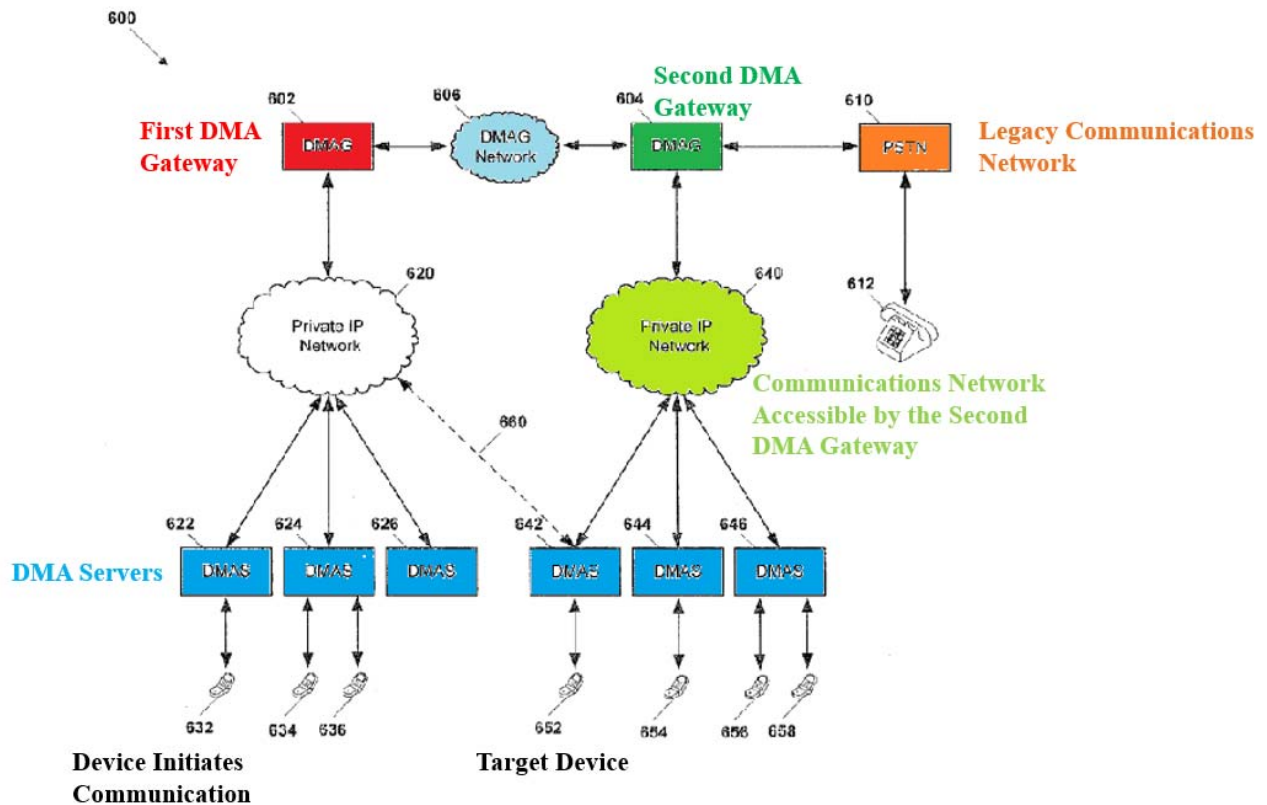


FIG. 6

Id. at Fig. 6 (annotated) (showing the use of a DMA gateway network to connect first and second DMA gateways, allowing for communications from UE associated with a first private network to reach UE associated with a second private network or the public-switched telephone network).

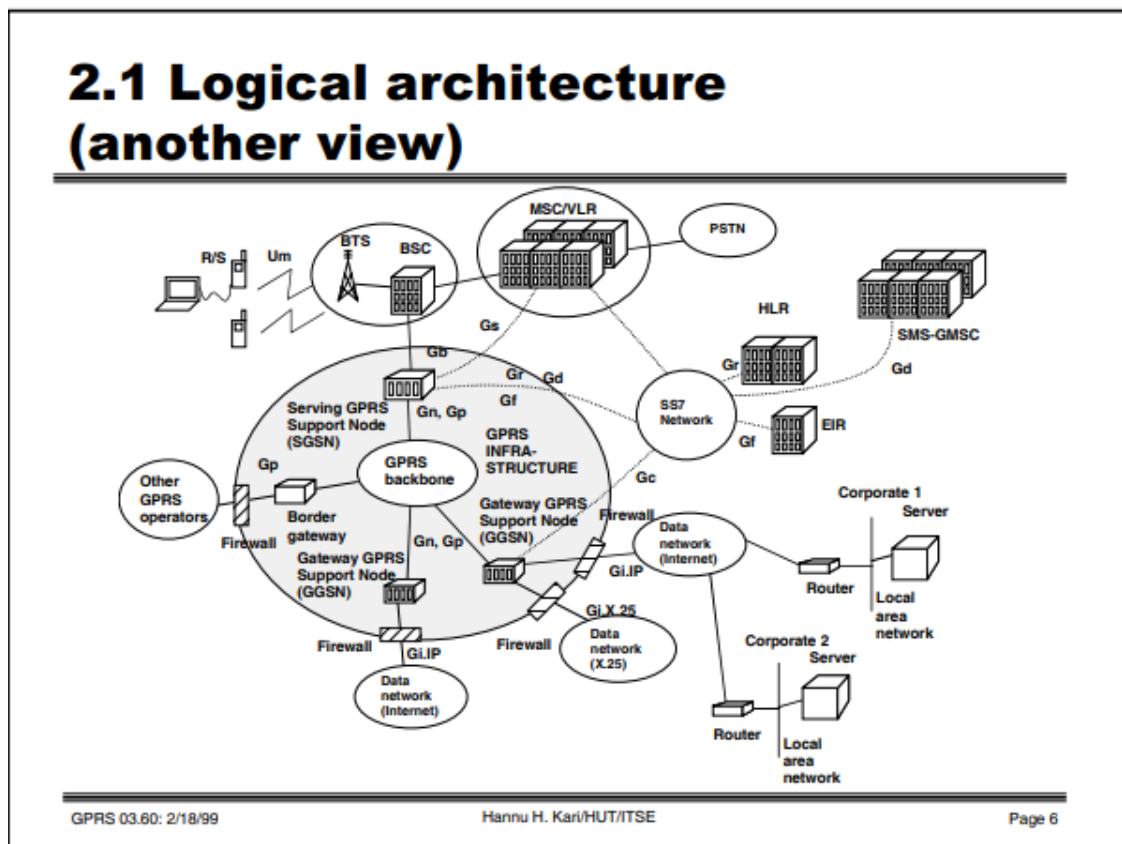
VI. OVERVIEW OF THE ASSERTED REFERENCE

A. The Flore Reference

61. A POSITA would recognize that Flore discloses the then-conventional, hierarchical network architecture that I described above.

62. A POSITA reading Flore's disclosure would understand that it is directed to techniques for performing inter-system handovers between conventional wireless communications networks using different radio technologies, such as managing handovers between a General Packet Radio Service (GPRS) (a 2G network) core network and Evolved Packet Core network (a 4G network). Flore at Abstract, ¶¶ 3, 30.

63. These conventional networks include the conventional, hierarchical network architecture described above. For instance, the illustration below depicts the GPRS network architecture, serviced by a centralized MSC server location and BSC:



Ex. 2012 at 3; Ex. 1006 at 14, 23-25 (describing the GPRS network as disclosed in Flore with MSC and BSC hardware-based physical components); Flore at ¶ 30. In Flore’s architecture, a call between two UE would be routed from (1) an originating UE, (2) to a BTS, (3) to a BSC, (4) to an MSC, (5) to the core for the first network (such as the GPRS core), (6) over Flore’s Gn interface to the core for the second network (such as the GSM core), (7) to an MSC for the second network, (8) to a BSC, (9) to a BTS, and finally (10) to the receiving UE.

VII. THE CHALLENGED CLAIMS

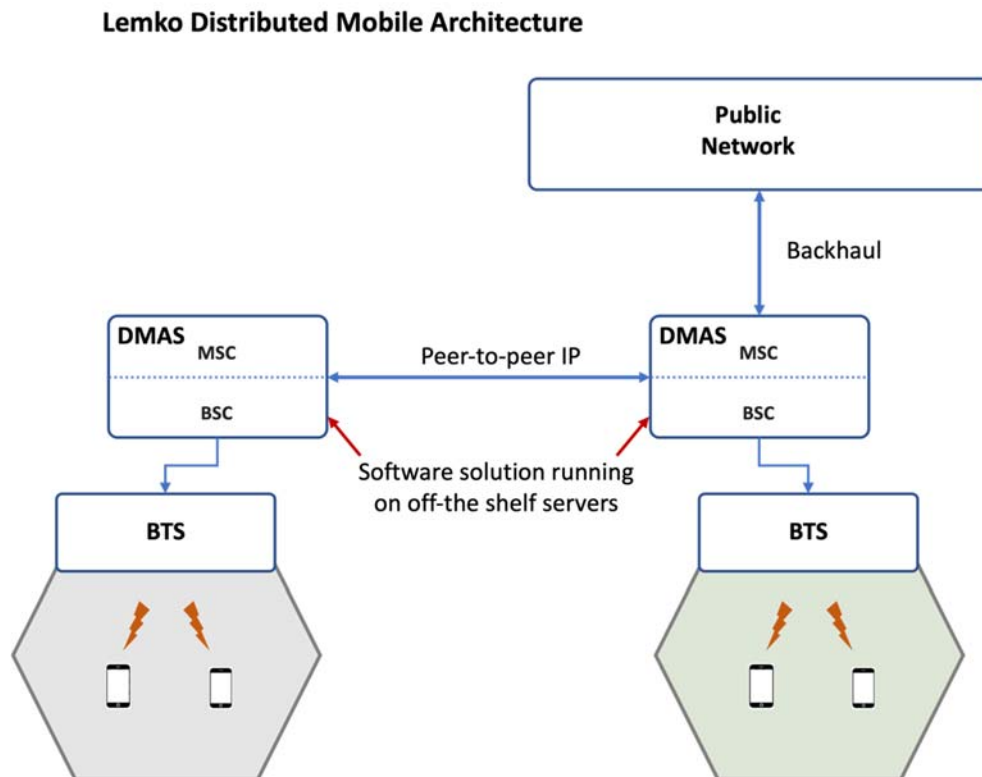
64. I understand that Petitioners have challenged claims 1, 3-9, and 20 of the ’988 Patent under a single ground, as allegedly anticipated by Flore. Pet. at 2.

VIII. IN MY OPINION THE CHALLENGED CLAIMS ARE PATENTABLE OVER FLORE

A. In My Opinion, Flore Does Not Disclose a “DMA server”

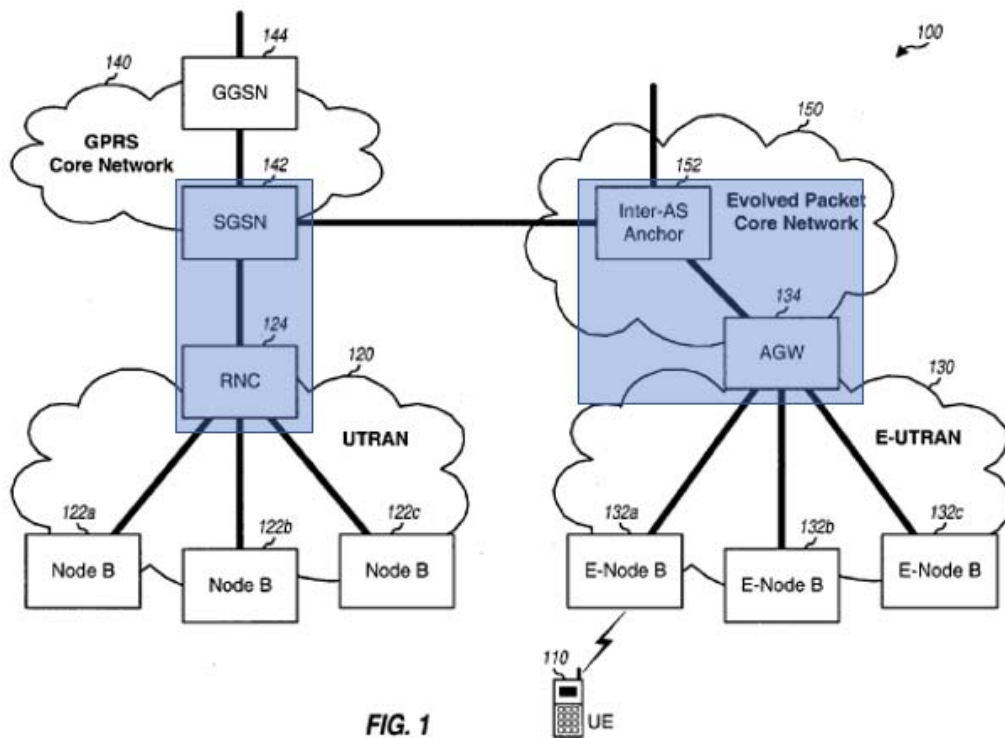
65. I understand that each of the Challenged Claims requires a DMA server. As I established in Section C.1 above, a DMA server is connected to other DMA servers by peer-to-peer connections, which a POSITA would understand is a critical component of Lemko’s claimed distributed mobile architecture network. A POSITA would understand that Flore does not disclose any node that corresponds to a DMA server, as it is based on a conventional, hierarchical network architecture that lacks peer-to-peer connections. See Section VI.A (I describe the conventional networks disclosed in Flore).

66. I understand that Petitioners initially contend that the radio network controller (RNC) and the access gateway (AGW) are DMA servers. Pet. at 9-10 (“Thus the RNC and AGW in Flore serve as the ‘distributed mobile architecture (DMA) servers’ of the asserted claims.”). A POSITA would understand that these nodes cannot be DMA servers because they are part of the conventional network architecture. Ex. 1006 Ex. 1006 at 14, 23-25 (describing the conventional GPRS network serviced by centralized MSCs disclosed in Flore as including an RNC and gateways). Moreover, they are not connected by peer-to-peer connections to corresponding homogeneous devices as required by the ’988 Patent, as I show below.



'988 Patent at 6:46-49, Fig. 4 (depicting a *DMA server* connected by peer-to-peer connection to another *DMA server*).

67. Instead, the RNC 124 connects to SGSN 142 and AGW 134 connects to Inter-AS Anchor 152, as I show below.



Flore at Fig. 1 (annotated).

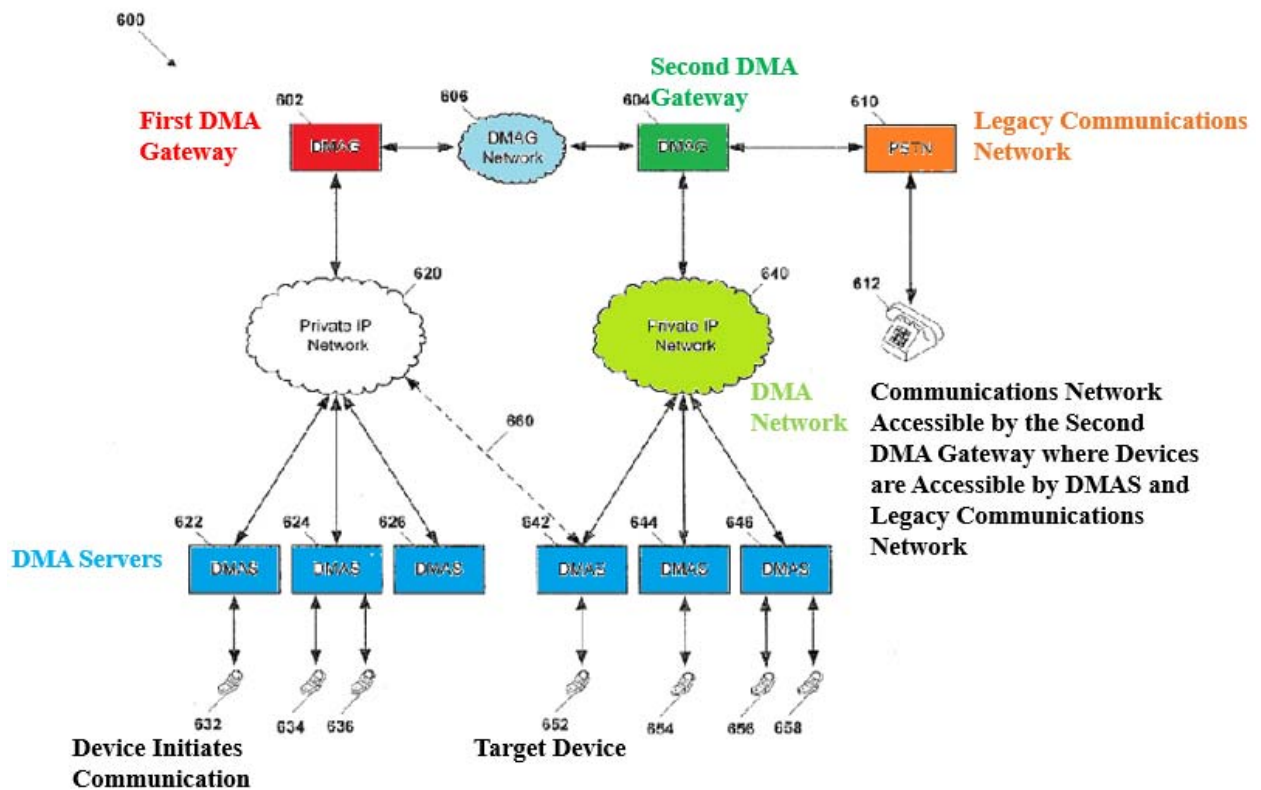
68. I also understand that in addressing the specific claim limitation reciting the “one or more devices accessible by *one of a DMA server*,” Petitioners contend that the DMA server is instead “one or more Node Bs.” Pet. at 13 (alleging that “the UE 110 is accessible by one or more Node Bs.”). Node Bs also cannot be DMA

servers because there are no connections (peer-to-peer or otherwise) between Node Bs as required by the Challenged Claims. Flore at Fig. 1; Section III.C.1 above (I established that DMA servers are connected by peer-to-peer connections).

B. In My Opinion, Flore Does Not Disclose a “Communications Network” That is “Accessible by a Second DMA Gateway”

69. It is my opinion that Flore does not disclose the “communications network [that is] accessible by a second DMA gateway,” as recited in Independent Claim 1. ’988 Patent at Claim 1.

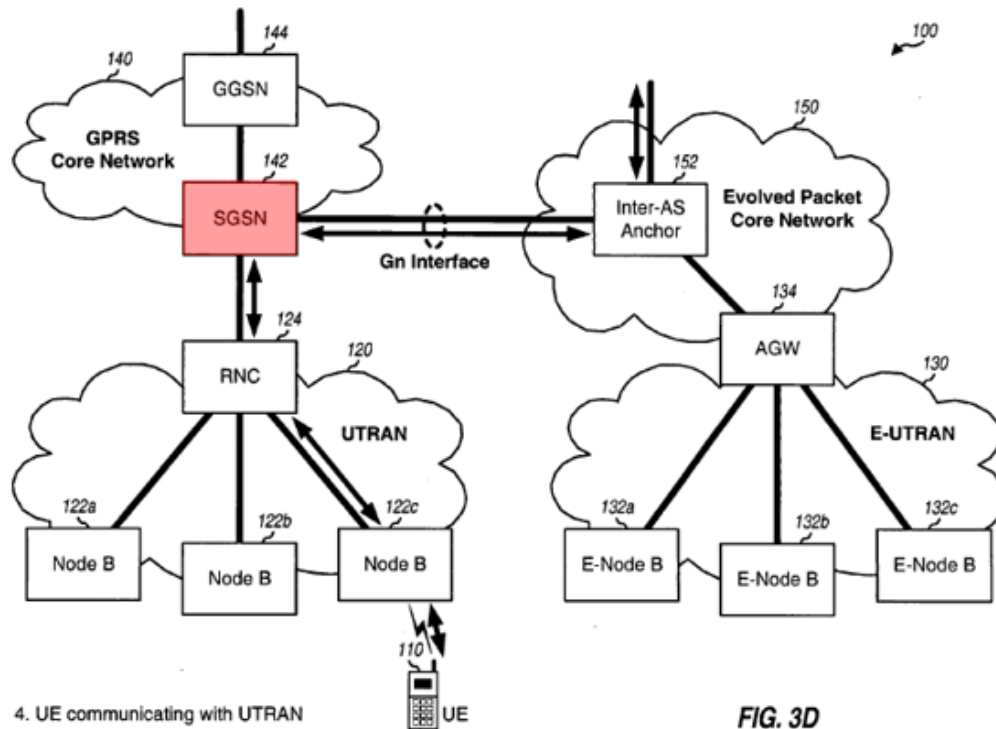
70. Figure 6 of the ’988 Patent (as I reproduce below) shows the “communications network” that is “accessible by a second DMA gateway” is a private IP network with devices accessible by DMA servers that are part of a DMA network:



Id. at Fig. 6 (annotated); *see also id.* at 10:57-59 (“The second private IP network 640 communicates with the second DMA gateway 604.”). Within the communications network, the DMA servers are connected by a peer-to-peer DMA network. *See id.* 6:6:46-49.

71. I understand that Petitioners rely on Flore’s SGSN 142 (shown below) for allegedly satisfying the “second DMA gateway” limitation. Pet. at 13. However, in my reading of the Petition papers, Petitioners do not point to or identify any understandable explanation of a “communications network” accessible by

SGSN 142, let alone one providing peer-to-peer connections as the claimed “communications network” does. *See id.* at 12-13;



Flore at Fig. 3D (annotated).

72. While I do not understand what the Petition identifies as the alleged DMA network in Flore, to the extent Petitioners intended to rely on UTRAN 120, it cannot be a DMA network. The claimed communications network is one where one or more devices are accessible by DMA servers (of a DMA server network) **and** a legacy communications network, allowing communication across these different networks. *See* '988 Patent at Claim 1 (reciting “a communications network accessible by a second DMA gateway” where “one or more devices are accessible

by one of a DMA server **and a legacy communications network**”) (emphasis added).

73. UTRAN 120 cannot be the DMA server network, because Petitioners also assert that UTRAN 120 is the claimed “legacy communications network” which includes nodes B.⁴ Pet. at 13 (legacy networks 120 and 140), *id.* at 20 (“In Flore the ‘legacy network’ is the UTRAN 120 and GPRS core network 140.”). That is, because Petitioners also assert that UTRAN 120 is the claimed “legacy communications network” (which is highlighted in orange in Figure 6 above). Pet. at 13 (legacy networks 120 and 140), *id.* at 20 (“In Flore the ‘legacy network’ is the UTRAN 120 and GPRS core network 140.”). A major point of the ’988 Patent is to provide a distributed, peer-to-peer network that is different and better than legacy network, such as the conventional GPRS network with centralized MSC locations as I discussed above. ’988 Patent at Claim 5 (reciting that the “legacy communications network” is “a wireless communications network services by a mobile switching center” as Flore’s conventional networks).

⁴ It is also my opinion that Petitioners allegation that Nodes B is a DMA server fails for the additional reason that the Node Bs are included in the UTRAN legacy network, not a peer-to-peer DMA network, as required. Pet. at 13; Section V.A above.

74. Thus, it is my opinion that Flore does not disclose a “communications network” that is “accessible by a second DMA gateway.”

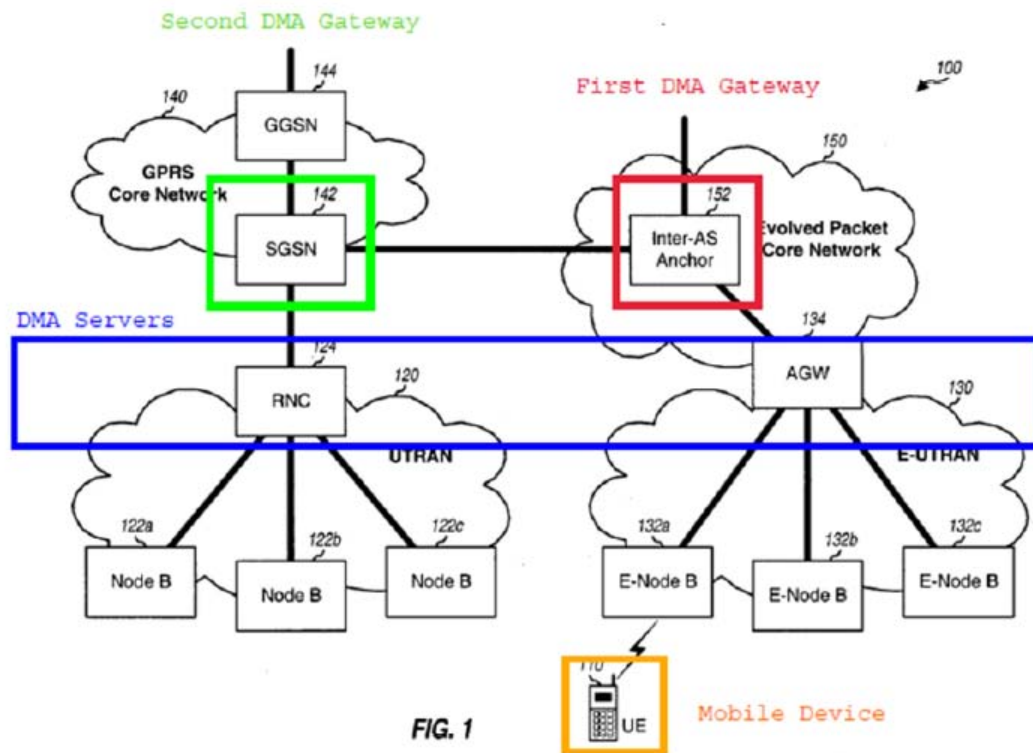
C. In My Opinion, Flore Does Not Disclose a “DMA Gateway Communications Network”

75. In my opinion Flore does not disclose the claimed “DMA gateway communications network” for at least two reasons.

76. **First**, the Gn interface is, as its name suggests, an interface, which is “the point at which a connection is made between two hardware devices.” Ex. 2019 at 199; *see also* Ex. 2020 at 351. A network is “[a] group of computers and associated peripheral devices connected by a communications channel,” which is different from the Gn interface. Ex. 2019 at 286; *see also* Ex. 2020 at 454. Flore describes the legacy GN interface as being within a GPRS network and connecting the SGSNs and GGSNs. *See* Flore at ¶ 29 (“Gn-interface, which is a legacy interface between SGSNs and GGSNs within a GPRS core network.”), *id.* (explaining that the legacy GN interface “allows SGSN 142 to communicate with Inter-AS Anchor 152 in the same manner as another SGSN.”) Accordingly, a POSITA would recognize that the Gn interface is “the point at which a connection is made between [the SGSN and GGSNs] of a network containing “a group of computers and associated peripheral devices.” Ex. 2019 at 199, 286. Thus, Flore’s conventional Gn interface is not itself a network, let alone a DMA gateway communications network.

77. **Second**, the '988 Patent explains that the DMA gateway communications network includes a group of DMA gateways including the claimed first and second DMA gateways. '988 Patent at 9:36-43, Claim at 1 (reciting “a first distributed mobile architecture (DMA) gateway” and “a second DMA gateway.”). A POSITA would have known that Flore’s legacy Gn interface is not a point of connection between two or more DMA gateways.

78. I note that Petitioners concede that the GPRS core network 140 corresponds to a “legacy communications network.” See Pet. at 13 (alleging “‘legacy networks 120 and 140’” correspond to the claimed “‘legacy communications network’”) (quoting Flore at ¶ 29), *id.* at 20 (arguing that “[i]n Flore the ‘legacy network’ is the UTRAN 120 and GPRS core network 140.”). As I discussed in Section VIII.A above, the Challenged Claims distinguish a “legacy communications network” from that of a DMA server network. Flore’s legacy GPRS network includes SGSN 142 that Petitioners allege is the second DMA gateway as the below illustration shows:



See Pet. at 11 (citing Flore at Fig. 1 (annotated)), 13; *see also* Flore at Fig. 3D (depicting the GN interface connecting SGSN 142 of GPRS core network 140 (e.g., 2G network) to Inter-AS Anchor of Evolved Packet core network 150 (e.g., 4G network)), ¶ 29. Accordingly, the conventional GN interface **connects legacy networks** under Petitioner’s theory, it is not connecting a first DMA gateway for a DMA server network to a second DMA.

79. Therefore, for at least these reasons, it is my opinion that Flore does not disclose the claimed “DMA gateway communications network.

D. In My Opinion, Flore Does Not Disclose Communications Information Indicating a Target Device That is Served by the Second DMA Gateway

80. A POSITA would understand that the network of the Challenged Claims of the '988 Patent depends on DMA gateways “communication information” indicating a target device of a home network that is served by the second DMA gateway. See '988 Patent at Claim 1 (“communications information to be served by the second DMA gateway”); see Section III.C.2 above. Locating this functionality at the DMA gateway, instead of in an MSC or network core, is part of Lemko’s novel architecture to allow DMA gateways to identify devices on a home network they service. '988 Patent at 11:10-27 (“DMA gateways provide information to one another . . . by exchanging register data. The register data describes **devices for which the networks they service are the home network** as well as for what devices are visiting on their networks.”) (emphasis added).

81. I understand that the claim limitation recites:

receiving a communication at the first DMA gateway for a target device indicated by the communications information to be served by the second DMA gateway.

'988 Patent at Claim 1. Reading the Petition Papers, Petitioners identify only Flore’s Inter-AS Anchor (the alleged first DMA gateway) and how it supposedly receives packets (the alleged communications). Pet. at 17 (“Flore thus discloses receiving

packets (*i.e.*, ‘a communication’))” and “updates its PDP context”). I do not see anywhere in the Papers where Petitioners address or even reference the term “communications information to be served by the second DMA gateway.” *Id.*

82. To the extent Petitioners rely on Packet Data Protocol (PDP) context field (which to me is unclear), a PDP context field is not the claimed “communications information.” See III.C.1 above (establishing that the term “communications information” must include “information identifying devices serviced by a home network”). A POSITA understands that a PDP context field is used to ***offer a cellular communication connection*** over which the UE can subsequently exchange IP packets with the network rather than identify devices served by a home network. Ex. 2016 at 1 (explaining that a “Packet Data Protocol (PDP) context offers a packet data connection over which the UE and the network can exchange IP packets”); Ex. 2017 at 1 (same).

83. Moreover, the PDP context is not generated until ***after*** the system has already determined the network serving each of the UEs. In other words, the PDP context is only related to the newly created connection between a device and network to exchange packets. This understanding is consistent with Flore’s use of a PDP context used for establishing a connection between the user equipment (UE) and the network. See Flore at ¶ 46 (“Inter-AS Anchor 152 updates its PDP context fields for UE 110 so that future packets for the UE are forwarded to SGSN 142 instead of

AGW 134.”). The PDP context field does not itself contain any information identifying devices serviced by a home network and is not stored in a DMA home register as required by the Challenged Claims (as I discuss in Section VIII.E below).

84. Accordingly, a POSITA would understand that the PDP context does not and cannot be used to identify devices for which the networks serviced by the DMA gateway is the home network. See ’988 Patent at 11:20-25. This is an important distinction from the claimed communications information, which is used to enable the DMA gateways to perform the call routing functions conventionally performed at an MSC.

E. In My Opinion, Flore Does Not Disclose “a Home DMA Register of the First DMA Gateway”

85. In my opinion, Flore does not disclose a “home DMA register of the first DMA gateway.” See ’988 Patent at Claim 1 (“storing the communications information in a home DMA register of the first DMA gateway”).

86. A POSITA reading the ’988 Patent would recognize that a “home DMA register” stores “communication information,” which, as I discuss above in my claim construction section, includes information identifying devices serviced by a home network. This corresponds to the functionality provided by a home location register (HLR) in a conventional network, as the ’988 Patent explains, although, in the network of the ’988 Patent, the information is stored at a DMA server or DMA gateway (unlike in conventional networks). *Id.* at 15:14-17.

87. Petitioners incorrectly contend that Flore’s GGSN location register is a “home DMA register.” Pet. at 15-16. The GGSN location register is different from the home DMA/HLR, as recognized in Petitioners’ Exhibit 1006 at 13-14 (explaining that “the location register is handled by four different entities” which includes the HLR and the separate GGSN register). Specifically, the home DMA/HLR entity “is the location register to which a mobile subscriber is assigned for record purposes.” *Id.* at 13. Whereas the GGSN register entity is the “the location register function . . . [that] stores subscription information and routing information . . . for each subscriber for which the GGSN has at least one PDP context active.” *Id.* at 13-14. Given that the GGSN register and the home DMA/HLR are two separate and distinct entities, a POSITA would understand that the GGSN location register function does not equate to the “home DMA register.” *Id.* at 13-14.

88. I also understand that Petitioners assert that a POSITA would understand that a PDP context field is a “home DMA register” because it “necessarily has a list of entries for the UEs it serves, such as UE 110.” Pet. at 16-17. I disagree. The PDP context field includes information for a data connection between a UE and network, it is not a home DMA register. *See generally* Ex. 2018 at 1 (The PDP context “defines aspects such as Routing, QoS (Quality of Service), Security, Billing, etc.” for a connection between a UE and network). In fact, the

“PDP context fields” are stored in the GGSN location register which, as I note above, is separate and distinct from a home DMA/HLR entity. Ex. 1006 at 13-14 (disclosing that the “GGSN has at least one PDP context active.”). Based on this, a POSITA would not find the reference to PDP context fields to disclose a “home DMA register.”

89. Thus, it is my opinion that Flore does not disclose a “home DMA register of the first DMA gateway.”

IX. CONCLUSION

90. 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.

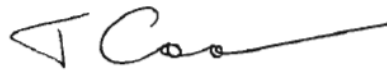
91. I understand that my opinions discussed above support a legal conclusion that the challenged claims are nonobvious.

92. 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.

93. 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 30, 2023

Respectfully Submitted,

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

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

Education

- | | |
|---------------|---|
| 1995 | <i>Tokyo Institute of Technology, Tokyo, Japan,</i>
Doctor of Philosophy in Electrical Engineering |
| Dissertation: | Regular Perfect-Reconstruction Filter Banks and Wavelet Bases |
| 1988 | <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.
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Contributions to 3GPP

- 1) "CQI Definition for CoMP," 3GPP TSG-RAN WG1 Meeting #68 R1-120243, Dresden, Germany, February 6th – 10th 2012. (on behalf of Hitachi)
- 2) "Specification Impact of Non-Zero Power ABS", 3GPP TSG-RAN WG1 Meeting #68R1-120241, Dresden, Germany, February 6th – 10th 2012. (on behalf of Hitachi)
- 3) "Way Forward on CSI Feedback for CoMP," R1-120901, (authored by a group of companies)
- 4) "WF on CSI-RS based measurement," R1-120895 (authored by a group of companies)
- 5) LS to RAN3 – "X2 enhancements in support of non-zero power ABS," 3GPP TSG RAN WG1 Meeting #69, Prague, Czech Republic, May 2012 (on behalf of Hitachi)
- 6) "WF on signalling details for non-zero transmit power ABS," R1-123948, (co-authored with representatives from several companies), Prague, Czech Republic, May 2012 (on behalf of Hitachi)
- 7) "WF on X2 signalling for reduced power ABS for FeICIC," (co-authored with representatives from several companies) R1-123881, Prague, Czech Republic, May 2012

Contributions to IEEE 802.11

- 8) G. Venkatesan, A. Ashley, Ed Reuss, and T. Cooklev, "IEEE 802 Tutorial: Video over 802.11," March 2007. (on behalf of Hitachi America Ltd)
- 9) T. Cooklev, "Video over WLAN", doc. 11-07-0105r0, 2007. (on behalf of Hitachi America Ltd)
- 10) S. Gaur, T. Cooklev, "MAC improvement using random AIFS", doc. 802.11-06/0657, July 2006. (on behalf of Hitachi America Ltd)
- 11) C. Tavares, T. Cooklev, S. Gaur, "On video over 802.11," doc. 802.11-06/0039, Jan. 2006. (on behalf of Hitachi America Ltd)
- 12) C. Tavares, T. Cooklev, "MAC extensions for HDTV," doc. 802.11-05/0632, July 2005. (on behalf of Hitachi America Ltd)
- 13) M. Tzannes, T. Cooklev, D. Lee, C. Lanzl, "Extended data rate 802.11a", doc. 802.11-02/232, March 2002. (on behalf of Aware, Inc.)
- 14) S. Prestwich, D. Ostermiller, K. Dobson, T. Cooklev, "Dynamic frequency hopping," IEEE 802.15, Tel Aviv, Israel, January 2000. (on behalf of Aware, Inc.)

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