UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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MICROSOFT CORPORATION and AFFIRMED NETWORKS, INC.,
Petitioner,

v.

LEMKO CORPORATION,
Patent Owner.

_____

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

DECLARATION OF TODOR COOKLEV, PH.D.

TABLE OF CONTENTS

I. INTRODUCTION 1

II. QUALIFICATIONS 2

III. LEGAL STANDARDS 5

A. Priority Date 5

B. Level of Ordinary Skill In The Art 5

C. Claim Construction 7

D. Obviousness Legal Standard 7

E. Anticipation Legal Standard 9

IV. THE '988 PATENT IS BASED ON LEMKO'S NEW DISTRIBUTED-MOBILE-ARCHITECTURE PARADIGM 11

A. Conventional Cellular Networks Used a Centralized, Hierarchical Network Architecture 11

B. Lemko's Claimed Distributed Mobile Architecture (DMA) Introduced a Distributed Cellular Network Architecture 17

V. FLORE DISCLOSES TECHNIQUES FOR HANDOVER OF A UE BETWEEN HIERARCHICAL 4G AND 3G NETWORKS 23

VI. CLAIM CONSTRUCTION 26

A. In my Opinion, "Distributed Mobile Architecture (DMA)" is Distributed with Call-Routing Functionality Located on DMA servers 27

B. In my Opinion, Each "DMA Server" is Connected to Other DMA Servers Through Peer-to-Peer Connections 30

C. In my Opinion, "Distributed Mobile Architecture (DMA)" Networks are Not Legacy Communications Networks 34

VII. IN MY OPINION, FLORE DOES NOT ANTICIPATE THE CHALLENGED CLAIMS 37

A. In My Opinion, Flore Does Not Disclose a "Distributed Mobile Architecture" 37

1. Flore Does Not Disclose a Network with Distributed Routing Functionality 37

2. Flore Does Not Disclose "DMA Servers" Connected Via Peer-to-Peer Connections....39

3. Flore's Legacy Networks Are Not a "Distributed Mobile Architecture" 41

B. Flore Does Not Disclose a "DMA Gateway Communications Network" 41

C. Flore Does Not Disclose "communications information for a communications network accessible by a second DMA gateway" 43

1. Flore's PDP Context Does Not Identify any Network Accessible by a Second Gateway 43

2. Flore's PDP Context Does Not Identify a Device "Accessible by One of a DMA Server and a Legacy Communications Network" Via the Second DMA Gateway 44

3. Flore Does Not Disclose Storing the Communications Information in a Home DMA Register of the First DMA Gateway 45

D. In My Flore Fails to Disclose the Additional Limitations Recited in the Dependent Claims 47

1. Dependent Claim 7: In my Opinion Flore Does Not Disclose "the First DMA Gateway Automatically Sending at Least a Portion of the Communications

Information to the Second DMA Gateway via the Gateway Communications Network" 47

2. Dependent Claim 8: In my Opinion Flore Does Not Disclose "in response to receiving a query from the second DMA gateway for the communications information, the first DMA gateway sending at least a portion of the communications information to the second DMA gateway via the gateway communications network 48

3. Dependent Claim 9: In my Opinion, Flore Does Not Disclose "Communications Register Data Including at Least one of . . . a Portion of the Home Location Register (HLR) Data for the Communications Network" 49

4. Dependent Claim 20: In my Opinion Flore Does Not Disclose that "the First DMA Gateway Receives the Communications Information From the Second DMA Gateway".....50

VIII. CONCLUSION.....51

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 challenged claims 1, 3-9, and 20 (the "Challenged Claims"). 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. In preparation of this declaration, I have reviewed the Papers, Petitioner's exhibits, and Patent Owner's exhibits filed in this proceeding. 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 ’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 anticipation 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 Claims 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 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.

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.

E. Anticipation Legal Standard

31. I understand 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.

32. I understand 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.

33. I understand that the asserted Patents are to be evaluated under post-AIA law. Under post-AIA law, any claimed invention that was available to the public before the effective filing date of the claimed invention is invalid. A claimed invention is anticipated if each and every limitation of that claim is disclosed either explicitly or inherently in a single prior art reference that predates the effective filing date of the patent claim unless the prior art reference is owned by the same entity or has overlaps of inventorship, in which case, the reference is not considered as prior art unless it is dated more than one year prior to the effective filing date of the patent claim. Under post-AIA law, I have been informed that an inventor has one year from the time he or she discloses an invention within which to file a patent application. If an inventor publicly discloses his or her invention prior to filing, then any third party disclosure made in the interim shall not be considered prior art to defeat patentability of the claimed invention.

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

IV. THE '988 PATENT IS BASED ON LEMKO'S NEW DISTRIBUTED-MOBILE-ARCHITECTURE PARADIGM

A. Conventional Cellular Networks Used a Centralized, Hierarchical Network Architecture

35. A cellular network is a network distributed over areas of land, referred to as cells. Ex. 1006 at 14. At least one transceiver, commonly referred to as a "base transceiver station," or "BTS," provides radio network coverage for user equipment ("UE") within each cell. *Id.* at 24.

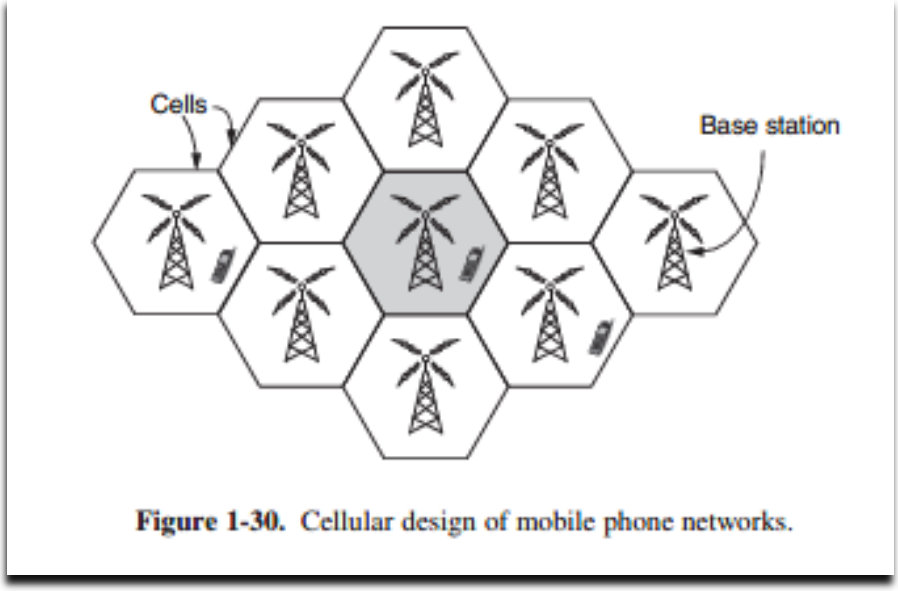
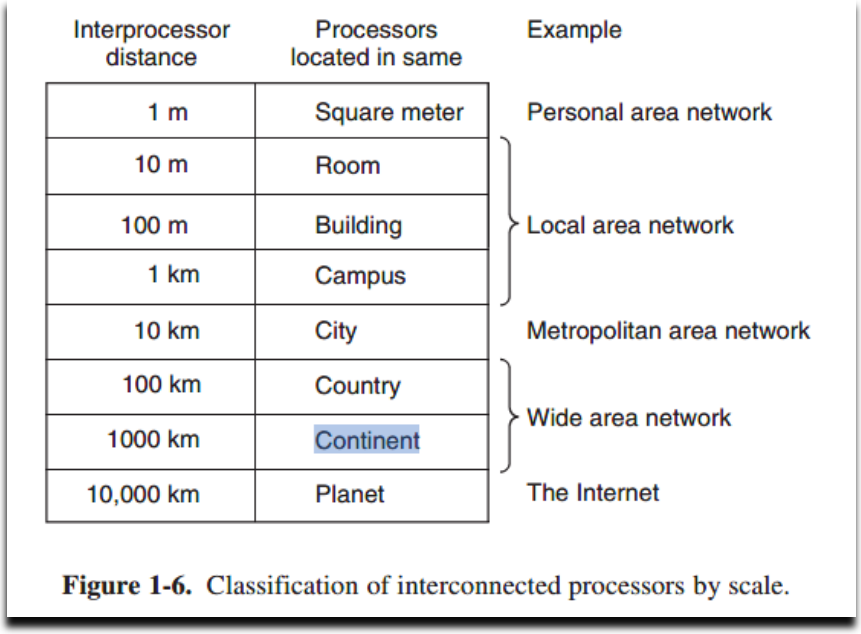


Figure 1-30. Cellular design of mobile phone networks.

Ex. 2030 at 66. Multiple BTSs connect to a single Base Station Controller ("BSC"), and multiple BSCs connect to a single mobile switching center ("MSC"). *See* '988 Patent at 1:37-51.

36. In order to build wireless wide area networks (WWANs) using this technology, carriers like Verizon® and AT&T® established multiple MSCs and built out the BSCs and BTSs necessary to cover a new geographic area. Ex. 2030 at 168. The geographic area covered by these WWANs span entire nations or continents:



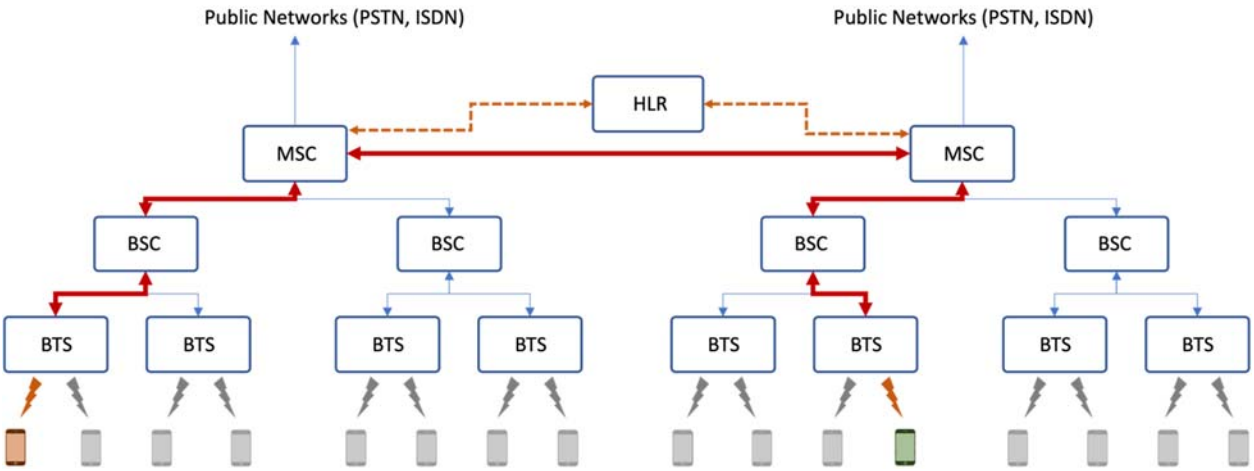
Interprocessor distance	Processors located in same	Example
1 m	Square meter	Personal area network
10 m	Room	Local area network
100 m	Building	
1 km	Campus	
10 km	City	Metropolitan area network
100 km	Country	Wide area network
1000 km	Continent	
10,000 km	Planet	The Internet

Figure 1-6. Classification of interconnected processors by scale.

Id. at 18.

37. In these conventional cellular WWANs, each BTS is connected to one and only one BSC. BTSs do not have any ability to route calls, other than to connect to the single BSC. *Id.* Each BSC is connected to one and only one MSC (or SGSN). *Id.* BSCs do not have any ability to route calls beyond forwarding them to the single MSC. *Id.* Expensive backhaul connections connect BSCs to MSCs.[1]

[1] Backhaul connections use T1/E1 communication lines. *See* Ex. 2007 at 2 ("E1/T1 systems were widely used in telecommunications when 2G technologies including GSM were being rolled out and deployed").

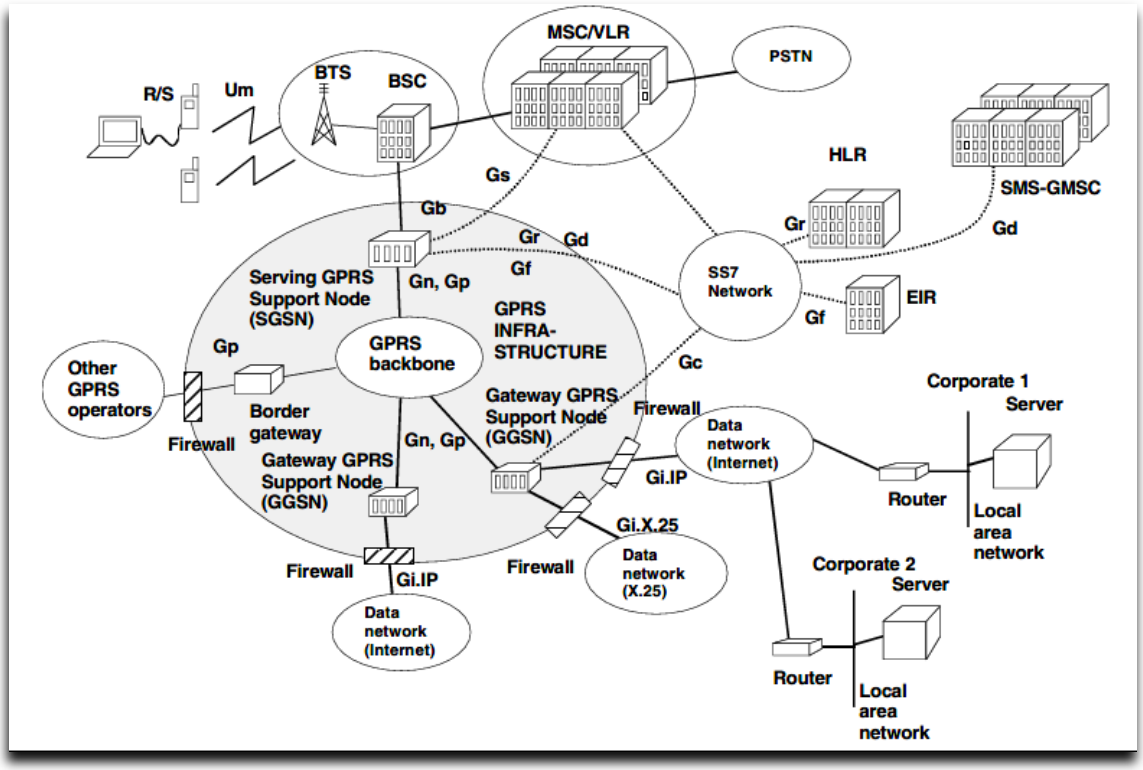


38. Centralized MSCs authenticate callers and route calls to other users (referred to as UEs by convention). Ex. 2022 at 4-5; Ex. 2023 at 25-26 ("There actually is a central database that can give information about the location of a subscriber. This database will always be interrogated when a particular subscriber is called. It is called the home location register (HLR)). When a user (UE shown in orange on the left in the illustration above) wishes to call another user (UE shown in green on the right), the call is routed from a BTS (left) to a BSC (left) to an MSC (left). Ex. 2022 at 4-5. The MSC polls the carrier's home location register (HLR) and visitor location register (VLR) to determine whether the UE is registered with the MSC's network or whether the UE is visiting (roaming). Ex. 2014 at 1. After authenticating the UE, the MSC routes the call to another MSC (if the party being called is another mobile user) or to a public telephony network, like PTSN.). Ex. 1006 at 20-22.

39. MSCs are large installations housed at server centers and depend on network-card-based hardware.

Ex. 2003.

40. The first generation (1G) of cellular network technologies, released between the late 1970s and early 1980s, carried only analog telephony signals. Ex. 2024 at 5, 9; Ex. 2030 at 166-70. These analog systems were soon replaced by second generation (2G) digital telecommunications networks, which introduced limited data services, like SMS text messaging via a packet-switched "general purpose radio service" ("GPRS"). Ex. 2024 at 5, 9; Ex. 2030 at 170-74. While voice phone calls were routed between MSCs over circuit-switched networks to ensure lag-free voice calls, data signals were routed via the GPRS to packet-switched networks, like the Internet. Ex. 2030 at 67-68; Ex. 1006 at 13.



Ex. 2012 at 3 (showing routing of voice and data calls).

41. In the GPRS, a Serving GPRS Support Node ("SGSN") performs the role of the MSC. Ex. 2025 at 6; Ex. 2026 ("Proctor Tr. 1") at 21:5-6. Like the MSC, it receives data from the BSC and routes it, with the help of a Gateway GPRS Support Node ("GGSN"), to the appropriate recipient within the IP network. Ex. 2025 at 1-2, 5-6, 13. It is also responsible for keeping track of which UEs are registered to which BSCs (or Node Bs). *Id.*

42. Expanding cellular network coverage using this hierarchal hub-and-spoke network architecture was very expensive, due in large part to the cost of

installing an MSC and connecting a new spokes (BTSs/Node Bs) and BSCs/RNCs to a hub (the MSC or SGSN) over backhaul connections.

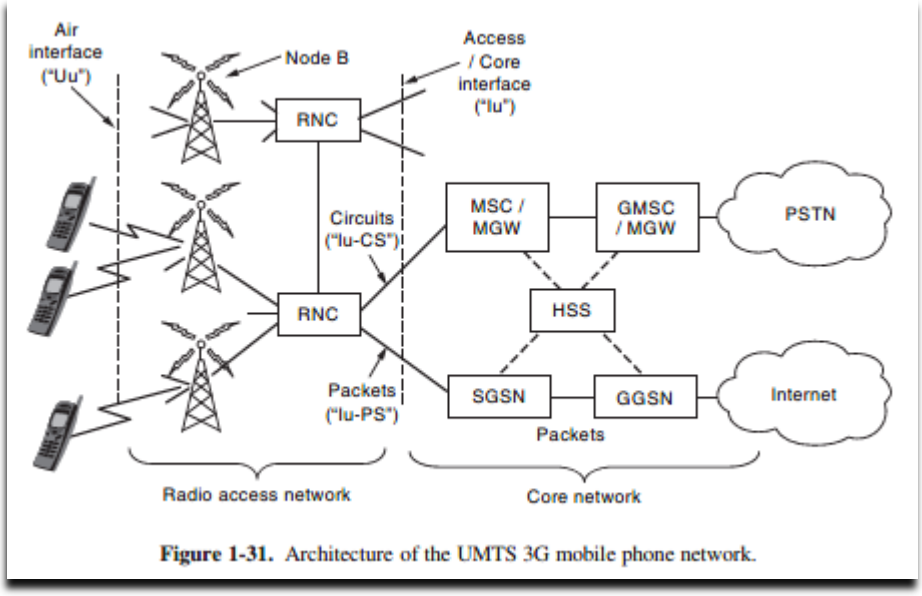


Figure 1-31. Architecture of the UMTS 3G mobile phone network.

Ex. 2030 at 67. Consequently, telecom companies were slow to expand cellular network service to rural areas, which could not muster the user base necessary to justify the expense of building new cell towers, installing BSCs, and connecting those BSCs to MSCs or SGSNs over expensive backhaul connections. '988 Patent at 1:37-51.

B. Lemko's Claimed Distributed Mobile Architecture (DMA) Introduced a Distributed Cellular Network Architecture

43. In my review of the '988 Patent, the patent discloses and claims a **distributed** mobile architecture ("DMA"). In the DMA, "controlling logic can be distributed and de-centralized." '988 Patent at 6:64-65. Rather than one centralized MSC controlling the routing for a set of BTSs (via intermediary BSCs), the MSC

and BSC controlling logic is distributed to each node of the DMA, which are called "DMA servers." Particularly, distributing the routing functionality to the DMA servers eliminates the need to carry every call over an expensive backhaul connection to a centralized MSC for switching and routing. Instead, when calls are made between UE located within the same DMA network, calls are routed directly between DMA servers via peer-to-peer connections:

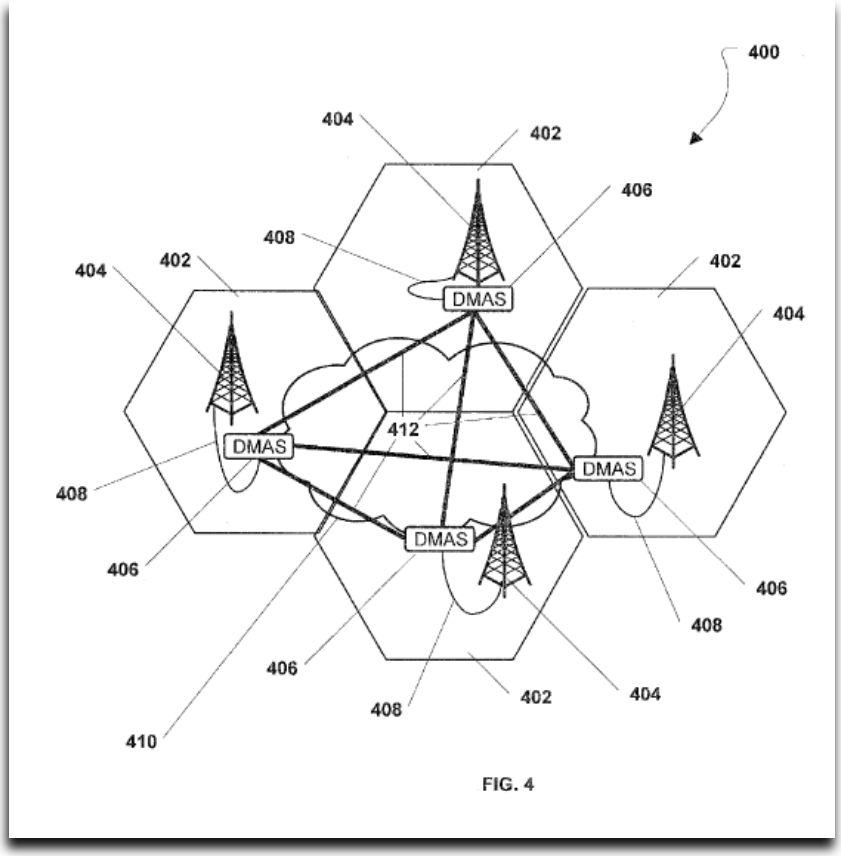


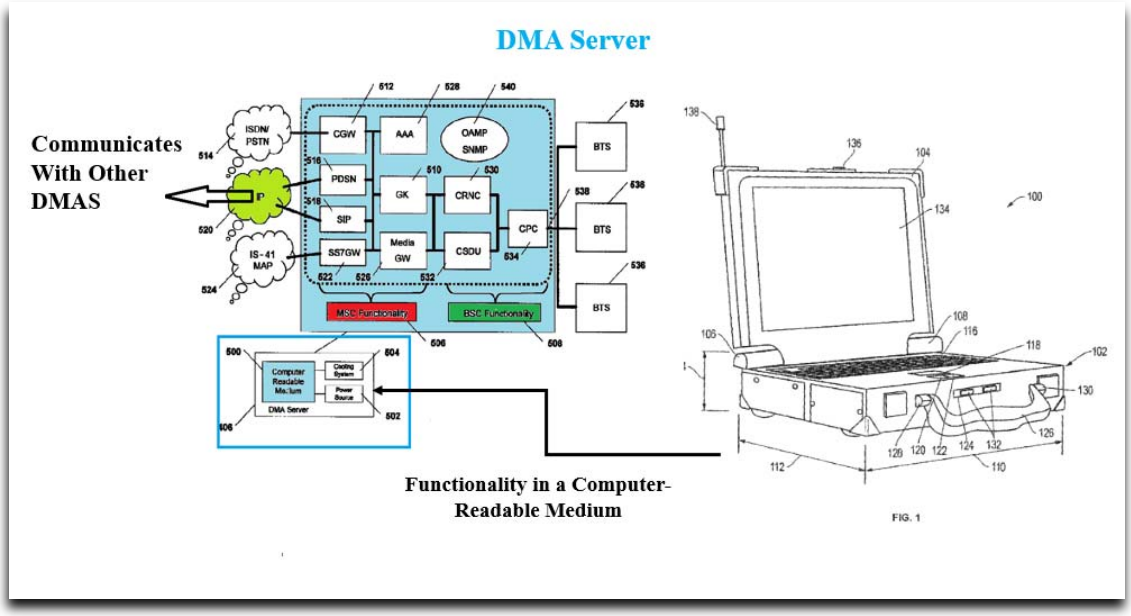
FIG. 4

'988 Patent at Fig. 4, 6:46-49, 6:64-65.

44. Because the DMA servers route calls between each other, the distributed mobile architecture eliminates the need for expensive centralized hubs

and the expensive backhaul connections necessary to connect to those hubs. Ex. 2010 at 1 ("The heart of DMA is an all-IP software solution that contains infrastructure for cellular service" that eliminates a "center or hub").

45. Importantly, to enable this decentralized architecture, the '988 Patent teaches implementing the functionality conventionally provided at the MSC and BSC in software located at the DMA servers. *See* '988 Patent at Abstract, 4:1-19, 9:36-11:27; Ex. 2010 (DMA is "an architecture that allows multiple cellular nodes to be linked via IP connections" as the "heart of dMA is an all-IP solution that contains mobile infrastructure cellular service" including MSC and BSC functionality). The DMA servers include a computer-readable medium (light blue) storing an MSC module (red) and a BSC module (green):



'988 Patent at Figs. 1, 5 (annotated); *see id.* at 7:19-21. The DMA servers are connected to BTSs that provide cellular service to UEs in the area. *Id*. at 6:46-51, Fig. at 4.

46. The DMA servers route calls amongst themselves via peer-to-peer connections within a private IP network (a virtualized DMA network 410). '988 Patent at 6:56-58, 9:9-12. Expanding the DMA network only requires connecting a new DMA server to the existing peer-to-peer IP network and connecting the new DMA server to a BTS. *See id.* at 6:31-62, 7:9-12.

47. Membership in a particular DMA network might be limited for security, business, or efficiency reasons. A user connected to a DMA network may seek to make a call to a UE that is not part of the same DMA network. For example, the target UE may be connected to a different DMA network or to a conventional, legacy network. To enable communication of devices serviced by different networks, the '988 Patent discloses that home location register ("HLR") and visitor location register ("VLR") information is exchanged between DMA gateways servicing the different networks. '988 Patent at 11:10-27, 15:14-23.

48. Particularly, the register information describes devices for which the networks the DMA gateways service are the home network (*i.e.* the HLR register information) as well as devices visiting their networks (*i.e.* the VLR register information). *Id.* at 11:10-27, 14:9-14; Ex. 2014 ("When a MSC detects a mobile

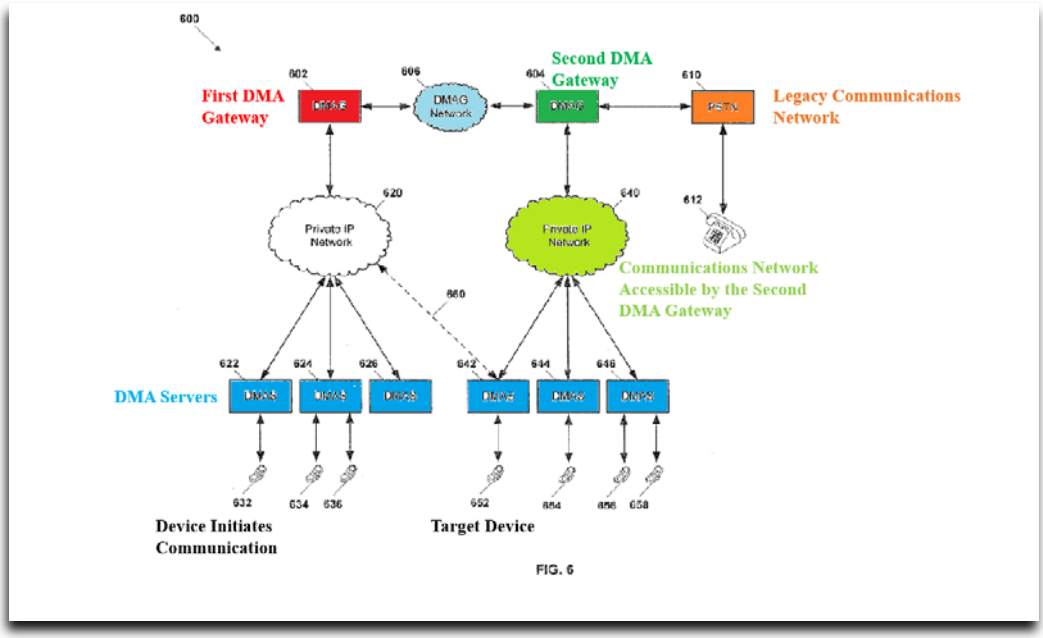
user's presence in the area covered by its network, it first checks a database to determine if the user is in his/her home area or is roaming"), *id.* ("The user's location is recorded in the HLR, and in the case the user [is] roaming, it is also recorded in the VLR."); Ex. 2027 at 26:1-28:4, 31:12-32:3. In this regard, a DMA gateway accesses the register information to identify what DMA gateway services the target UE to route the communication to that DMA gateway. '988 Patent at 11:12-19, 15:24-37.

49. DMA gateways interface a DMA network with another network, such as a different DMA network or a legacy communications network, like the 3G UTRAN and 4G E-UTRAN networks disclosed in Flore. *See* '988 Patent at 3:15-26, 9:43-47. The DMA gateways are connected together to form a DMA gateway communications network, which provides bridges between the DMA network and other networks (*e.g.*, a second DMA network) to route communications to and from devices on these different networks. *See id.* at 10:53-66, Claim 5; Ex. 2012 at 3.

50. The '988 Patent provides and claims solutions for routing calls outside of (and between) decentralized DMA networks that lack the centralized hubs, MSCs and the like, found in legacy communications networks. Figure 6 (reproduced below) illustrates how a call from an initiating UE (632) in a first DMA network is routed to a target UE (652) in another DMA networks. '988 Patent at Fig. 6.

51. To facilitate communication between these devices, a first DMA gateway (602, shown in red) receives information about "a communications network accessible by a second DMA gateway" (604, shown in green). The first DMA gateway then stores the second DMA gateway's home register information in the "DMA home register of the first DMA gateway." *Id*. at 11:10-27, 14:9-11, 15:14-23, Claim 1.

52. The second DMA gateway services a DMA network (640, shown in light green) and a legacy communications network (610, shown in orange) such that the served communications information "indicates the devices accessible by one of a DMA server [of the DMA network] and legacy communications network" which are accessible by the second DMA gateway. *Id*. And, in this example, the communications information indicates that the target device is accessible by the DMA server (642, shown in blue). *Id*. Based on this information, the communication is routed to the target device by relaying the communication from the first DMA gateway to the second DMA gateway via a DMA gateway communications network (606, shown in light blue). *See id.* at Abstract, 9:37-40, 15:24-36, Claim 1.



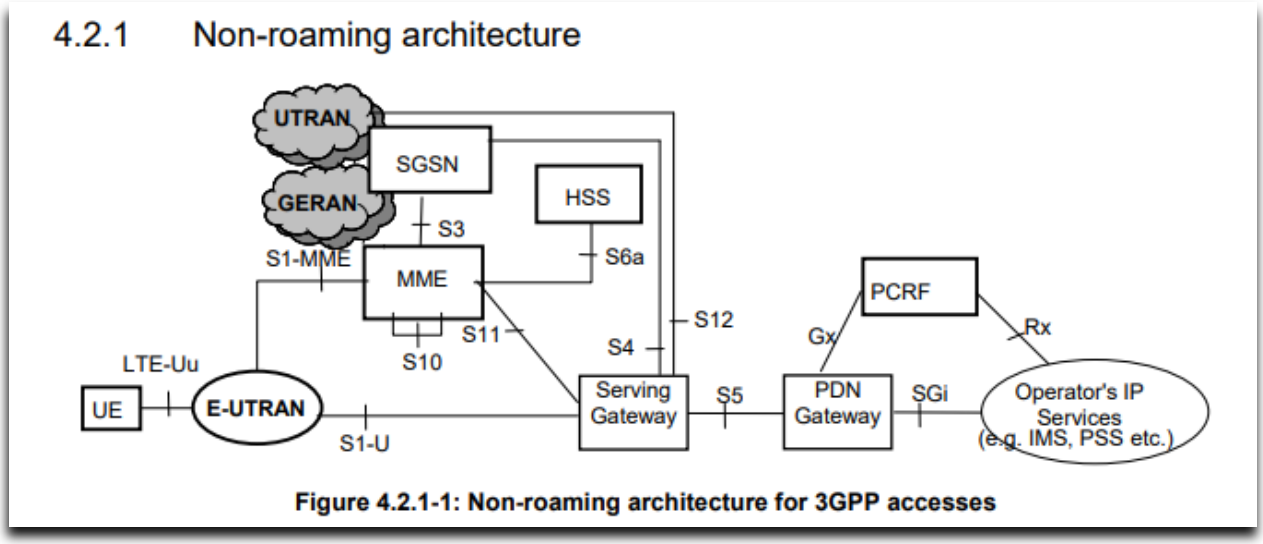
Id. at Fig. 6 (annotated).

53. This use of the distributed mobile architecture infrastructure applies both to routing communications from a device serviced by a DMA network to a telephone (612) of the legacy communications network and to a telephone (e.g., 652) serviced by a different DMA network. As noted above, the second DMA gateway (604) provides connectivity to both the DMA network (640) and a legacy communications network (610). Thus, the communications information also identifies devices accessible by the legacy communications network for which a communication is directed to. *See* '988 Patent at Claim 1.

V. FLORE DISCLOSES TECHNIQUES FOR HANDOVER OF A UE BETWEEN HIERARCHICAL 4G AND 3G NETWORKS

54. A POSITA reading Flore would understand that it is directed to providing for handover of UE between two conventional hierarchical networks. In

2006 when Flore was filed, the industry was transitioning from 3G to the fourth generation (4G) of wireless communications technologies. Ex. 2024 at 28. 4G networks led to more widespread use of IP telephony (*e.g.*, Voice Over IP, or "VoIP"), which carries voice signals over packet-switched networks like the Internet. Thus, rather than a BSC routing voice calls to an MSC and data signals to an SGSN, a serving gateway ("SGW") routes all signals to a packet data network gateway ("PGW") that connects the UE to an external packet-switched network, as shown in the figure below.

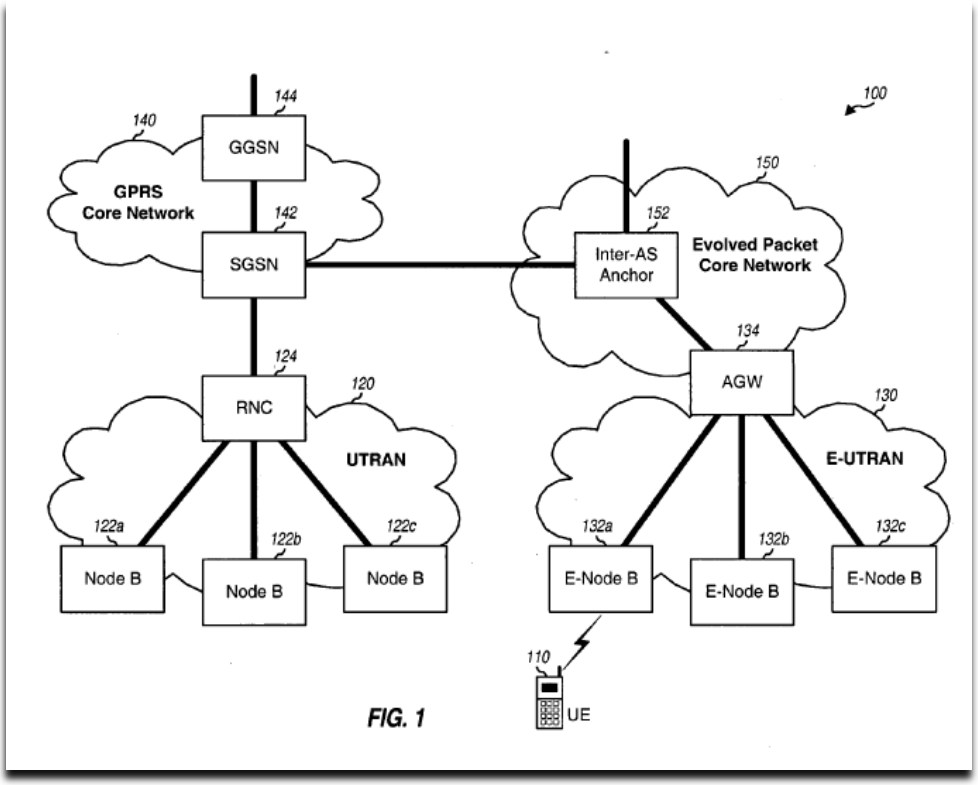


Ex. 2028 at 16.

55. Flore (Ex. 1005) discloses techniques for handing over data service when UE moves between a BTS that supports 4G service (E-Node B) and a cell tower that only supports 3G service (Node B). Flore at ¶¶ 25-30, 37-39, Figs. 1, 3A-3D). This technique is referred to as an "inter-system handover" because it describes

a UE handover process between communications networks using different radio technologies and protocols. *See generally*, Flore at Abstract, ¶¶ 6, 24-30 (the handover of a UE from a 4G network to a 3G network).

56. The 3G and 4G networks that are connected in Flore both rely on the centralized and hierarchical network architecture described in § II.A, *supra*. In the 3G network, a "radio network controller" routes data from the BTS ("Node B") to a radio network controller ("RNC"). The RNC forwards voice calls to an MSC and other data to an SGSN. In the 4G network, an SGW (referred to in Flore as an access gateway ("AGW")) routes all data from the BTS ("E-Node B") to a PGW (referred to in Flore as an "Inter-AS Anchor"):



Flore at Fig. 1.

57. Because it takes time to roll out the infrastructure necessary to support new technologies, Flore devised a solution to ensure that the new 4G EPC network was compatible with existing 2G/3G GPRS networks:

> A major challenge in development and deployment of a new wireless network is interoperability with existing wireless networks. It is desirable for a wireless user to be able to roam seamlessly between the new wireless network and existing wireless networks. This would allow the user to enjoy the performance advantages of the new wireless network and the coverage benefits of the existing wireless networks.

Flore at ¶ 7. As a UE moves out of the coverage of E-UTRAN (4G) network the UE is handed over to the UTRAN (3G) network. *Id.* at ¶¶ 36-40, Figs. 3A-3D.

VI. CLAIM CONSTRUCTION

58. 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.

59. The term "distributed mobile architecture (DMA)" should be construed as:

> (1) a network architecture where DMA servers have distributed call-routing functionality and (2) are connected with other DMA servers

through peer-to-peer connections (*i.e*. without connecting through a hierarchical, network-hub architecture), and (3) that is not a legacy communications network.

Flore does not satisfy any of these three requirements, as I discuss in detail below.

A. In my Opinion, "Distributed Mobile Architecture (DMA)" is Distributed with Call-Routing Functionality Located on DMA servers

60. In my opinion, the term "distributed mobile architecture (DMA)" requires a mobile architecture with distributed functionality and organization, instead of centralized functionality and hierarchal organization, as this is consistent with the plain meaning of its words and the inventor's description. Rather than routing calls from individual nodes (BTS, Node 1, or Node 1-B) through centralized hubs (MSCs, SGSNs, or AGWs), the distributed mobile architecture shares the task of routing calls among each node (DMA Server) of the DMA network.

61. Distributed systems differ from traditional computer networks in that "a collection of independent computers appears to its users as a single coherent system." Ex. 2030 at 2. In concert with this understanding, the '988 Patent consistently uses the term "distributed mobile architecture" to refer to a mobile communications architecture where routing functionality, and the information necessary to route calls, is distributed among DMA servers of a DMA network. '988 Patent at 6:63-65 ("Within the distributed and associative telecommunications

system 400 the controlling logic can be distributed and decentralized); *see also id.* at Abstract, 4:1-19, 9:36-11:27, Figs, 1, 5).

62. A POSITA readining the specificaiton would understand that it is this distributed nature of the DMA network that allows DMAs to seamlessly route messages among one another without having to traverse a centralized switching device, like an MSC or SGSN:

> As illustrated in FIG. 4, ***each DMA server 406 is interconnected with the other DMA servers*** 406 via an Internet protocol network 410. As such, there exists a peer-to-peer connection 412 between each DMA server 406 in the system 400. As described in detail below, the DMA servers 406 can handle telephony traffic that is communicated at each antenna 404. For example, ***the DMA servers 406 can switch and route calls received via each antenna 404***. Additionally, the ***DMA servers 406 can hand-off calls to each other as mobile communications devices move around and between the cellular coverage sites*** 402. The DMA servers 406 can communicate with each other via the IP network 410 and can further transmit calls to each other via the IP network 410.

'988 Patent at 6:46-6:62 (emphasis added).

63. Specifically, the distinction between the claimed DMA and conventional, hierarchal network topologies is that the DMA network is self-healing and redundant:

> 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 6:65-7:12.

64. The distributed nature of the DMA means that there are no centralized points of vulnerability as there are in conventional hierarchal networks. *Id.* The distributed mobile architecture, therefore, is distributed because it has "no center or hub" (like a centralized MSC) because each DMA server routes calls directly to other DMA servers in the DMA network. '988 Patent at 6:31-65, 7:32-49, Fig. 4; Ex. 2010; Ex. 2009; Ex. 2010.

65. I understand that Petitioner's expert, Mr. Proctor, agreed that the term's use of "distributed" requires that call routing functionality be distributed among the DMA systems. During cross-examination, Mr. Proctor acknowledged that the inclusion of "distributed" in the term "distributed mobile archictecture" requires that some functionality be distributed. Proctor Tr. 1 at 74:3-22 (testifying that under a

plain and ordinary meaning of "distributed mobile architecture" in light of the specification, "distributed" means that "[t]here needs to be functionality distributed"), *see also id*. at 71:19-72:4 (testifying "[m]obile architecture … has got to be an architecture that addresses mobile devices" and "distributed means that something has got to be in multiple places").

B. In my Opinion, Each "DMA Server" is Connected to Other DMA Servers Through Peer-to-Peer Connections

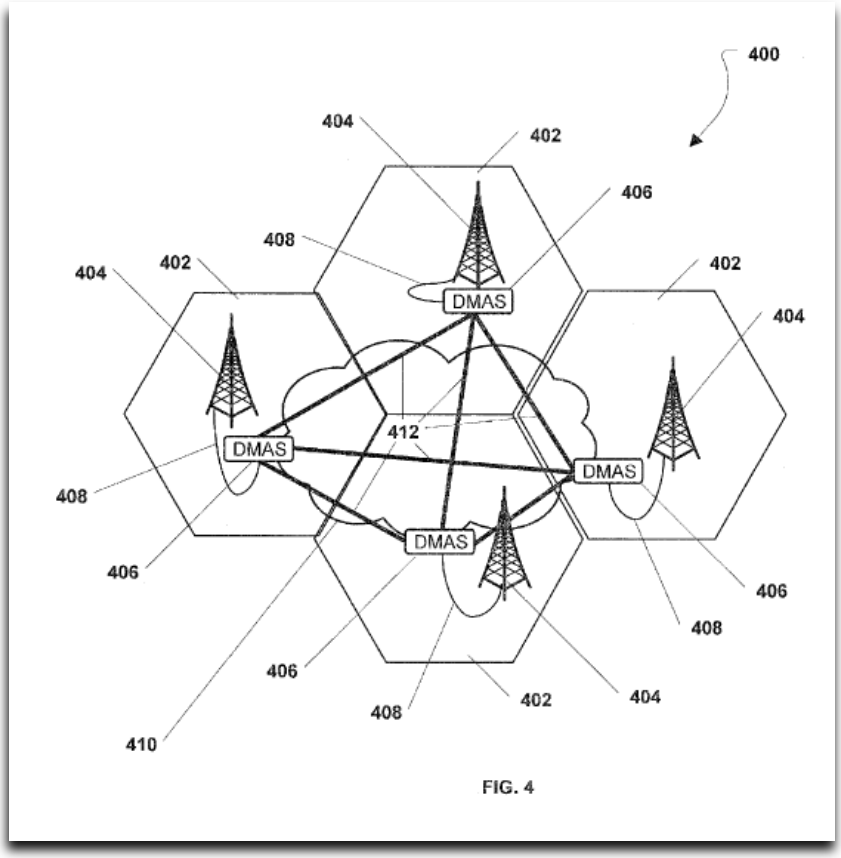
66. In my opinion, because the distributed mobile architecture (DMA) is a distributed and decentralized architecture with call-routing functionality on DMA servers, each DMA server is connected to other DMA servers through peer-to-peer connections. '988 Patent at 4:46-49.

67. A POSITA would appreciate that the use of such peer-to-peer connections between DMA servers in the same DMA network stands in contrast to hierarchical legacy networks, where BTSs do not directly connect to each other, instead relying on traversing backhauls to the BSC and MSC to connect to another BTS:

> Each DMA server 406 is interconnected with the other DMA servers 106 via an Internet protocol network (410). As such, there ***exists peer-to-peer connection*** 412 between each DMA server 406 in the system"

Id. at 6:46-37 (emphasis added);

68. The '988 Patent explains that DMA servers are "able to participate as peers in an IP network 410" when they use "an IP network through which the communications are routed between the DMA servers 406." '988 Patent at 9:9-14 (explaining that a DMA gateway is needed when the DMA servers cannot connect as peers in an IP (DMA) network). Figure 4 (reproduced below) shows the peer-to-peer connections of DMA servers within a DMA network. Importantly, the DMA servers communicate without an intervening MSC. Importantly, the DMA servers communicate without an intervening MSC.



'988 Patent at Fig. 4.

69. I understand that at institution, the Board noted that the '988 Patent indicates that "in not all cases will the DMA servers be able to participate as peers in an IP network 410." Institution Decision at 13 (citing '988 Patent at 6:31-33, 9:12-14) (quotations omitted). But the '988 Patent describes two different scenarios. Where the DMA servers are able to connect as peers with an existing DMA network, they do so. '988 Patent at 9:9-24. When a new DMA server cannot join an existing DMA network, a DMA gateway connects the new DMA server to the existing DMA network (and/or one or more legacy networks) via a DMA gateway network. *Id.*

70. A POSITA would appreciate, however, that that new DMA server is just the initial node in a new DMA network, and any DMA server seeking to join this new DMA network connects to the new DMA server as a peer in the DMA network:

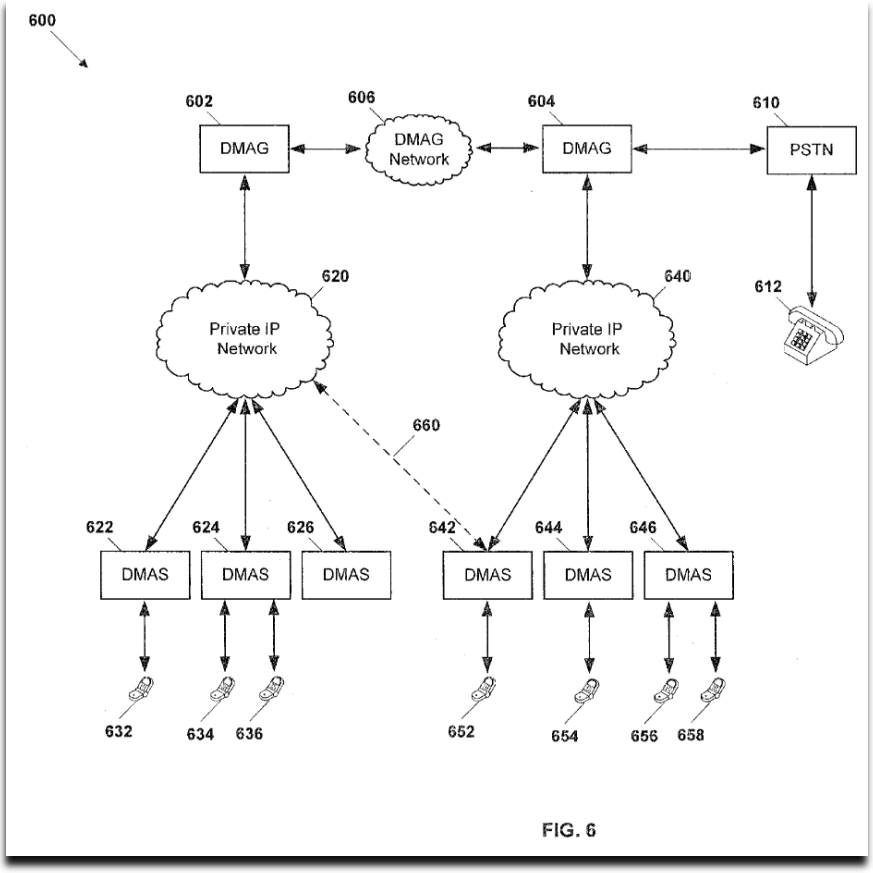


FIG. 6

'988 Patent at Fig. 6.

71. In other words, if DMAS 622 could not join DMA network 640 as a peer, the '988 Patent discloses connecting the server to DMA gateway 602 so that it could still communicate with UEs registered with DMA network 640. *Id*. at 9:18-21, 9:36-54. However, DMAS 622 communicates with the **other** DMA servers (DMAS 624 and 626) in the same DMA network via peer-to-peer connections. *Id.* at 6:46-58.

72. Reading these disclosures, a POSITA would understand that the relevant property of a DMA network is that the DMA servers within a DMA network

communicate as peers. It does not mean that DMA servers communicate with each other using something other than a peer-to-peer protocol. The use of the DMA gateway to provide additional connections outside of the DMA network does not change this fundamental property that distinguishes DMA servers from conventional BTS and BSC components.

73. Based on the foregoing, it is my opinion that distributed mobile architecture" as one where DMA servers are connected through peer-to-peer connections to other DMA servers is consistent with all embodiments in the '988 Patent and aligns with the claimed process of routing calls between devices serviced by different networks via the distributed mobile architecture (DMA).

C. In my Opinion, "Distributed Mobile Architecture (DMA)" Networks are Not Legacy Communications Networks

74. A POSITA reading the '988 Patent understands that the '988 Patent distinguishes the inventive DMA from a host of different "existing" systems, which the '988 Patent calls "legacy communications networks." '988 Patent at 1:37-64, Claim 5. These legacy networks include "existing public switched telephone network (PSTN) services, Voice over Internet Protocol (VoIP) systems, wireless communications systems, and other systems." *Id*. at 1:55-59; Ex. 2027, Proctor Tr. 2 at 36:14-37:7. Further examples of "legacy networks" are "a wireless communications network serviced by mobile switching center (MSC)," "a public internet protocol (IP) network," and "an American National Standards Institute 41

(ANSI-41) network." *Id*. at Claim 5. What all of these legacy networks have in common is that they are not private peer-to-peer networks, like the DMA networks of the '988 Patent.

75. For example, every independent claim enumerates a DMA as separate from a legacy communications network. Claim 1 recites "one or more devices accessible by ***one of*** a DMA server and a legacy communications network." Claim 22 recites that a DMA gateway includes a "first interface adipate to communicate with a legacy communications network" and a different "interface adapted to communicate with a DMA gateway communications network." And claims 33 and 42 require communications from a DMA server to a "destination device accessible via a legacy communications network" via a DMA gateway. Thus, every claim distinguishes DMA networks from legacy communications networks.

76. The specification further differentiates the two architectures by separating the distributed mobile architecture (DMA) network from the legacy communications network and depicting them as having different components and architecture. Specifically, as shown in Figure 6 (reproduced below), the components of the "DMA" infrastructure (highlighted in the blue box), including DMA servers, DMA gateways, DMA networks, and a DMA gateway communications network, are separated from the legacy communications network (PSTN) and its components (highlighted in the orange box):

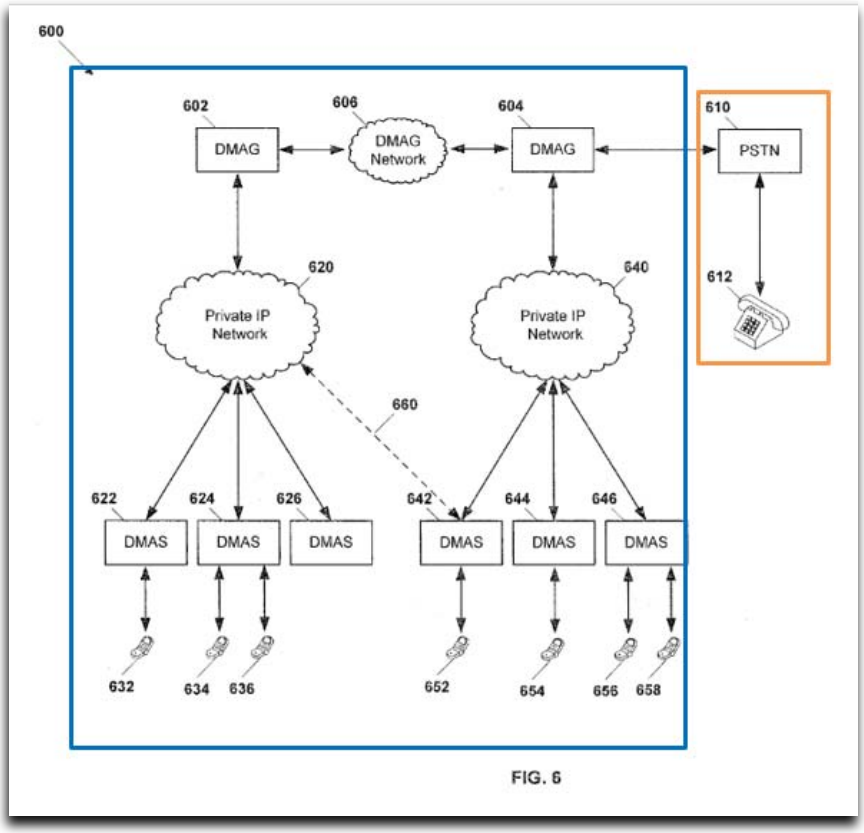


FIG. 6

'988 Patent at Fig. 6 (annotated); *see also id.* at 1:55-60 (describing existing PSTN services and wireless communications system); *id*. at Claim 5 (reciting that a legacy communications network includes a "public switched telephone network (PSTN) or a "wireless communications network serviced by a mobile switching center (MSC)" as in Flore).

77. Thus, a POSITA understands that "distributed mobile architecture (DMA)" should be construed to be different from legacy communications networks.

VII. IN MY OPINION, FLORE DOES NOT ANTICIPATE THE CHALLENGED CLAIMS

A. In My Opinion, Flore Does Not Disclose a "Distributed Mobile Architecture"

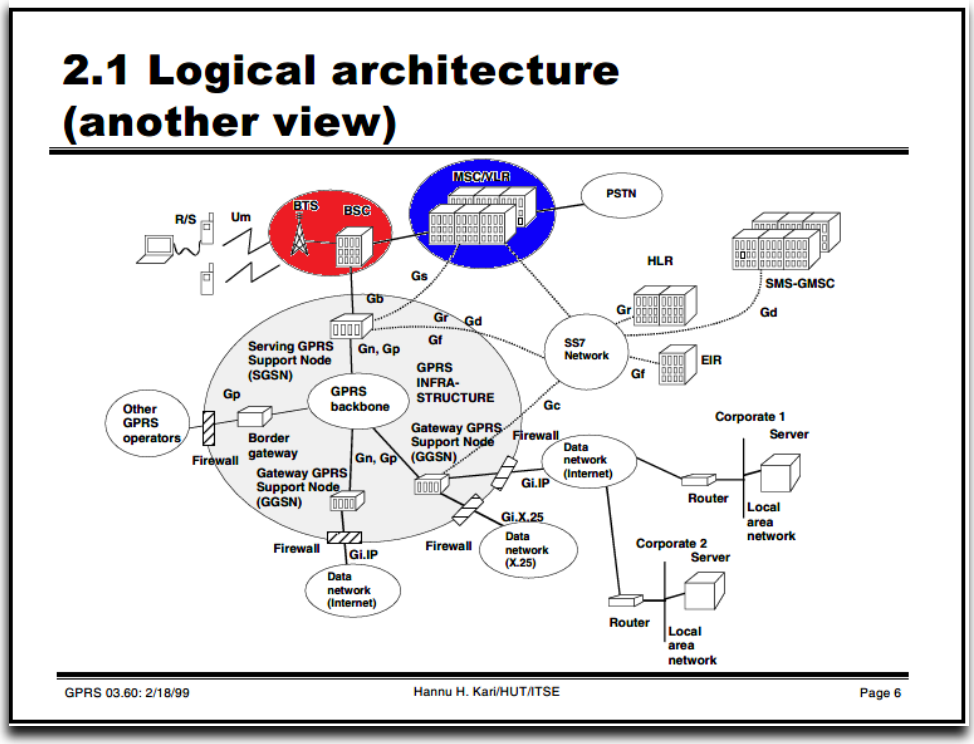
78. As I discuss in my claim construction section, it is my opinion that the term distributed mobile architecture" should be construed as "(1) a network architecture where DMA servers have distributed call-routing functionality and (2) are connected with other DMA servers through peer-to-peer connections, and (3) that is not a legacy communications networks." As I discuss below, Flore's networks do not satisfy any aspect of this construction and, therefore, Flore cannot anticipate any of the Challenged Claims.

1. Flore Does Not Disclose a Network with Distributed Routing Functionality

79. Flore's legacy networks are not distributed network architectures where DMA servers have call-routing functionality. Thus, Flore does not disclose the claimed "distributed mobile architecture (DMA)," as correctly construed.

80. I understand that Petitioners contend that the Flore's RNC and AGW nodes are DMA servers. Pet. at 9-10 (asserting that the "RNC and AGW in Flore serve as the '***distributed mobile architecture (DMA) servers***' of the asserted claims.") (emphasis added). I disagree as the RNC and AGW nodes have no ability to route calls. I disagree.

81. In the GPRS 140 (2G), UTRAN 120 (3G), and Evolved Packet Core Network (4G) networks disclosed in Flore, calls are routed by centralized MSCs, SGSNs, and Inter-AS Anchors, respectively. Pet. at 9-11; *see also id.* at 20 (asserting that the legacy networks are "wireless communications network[s] serviced by a mobile switching center."). The figure below depicts the structure of a 2G network, as disclosed in Flore, which is serviced by a centralized MSC (depicted in blue) and receives calls from a BTS (Node B) (depicted in red):



Ex. 2012 at 3 (annotated); *see also* Ex. 1006 at 14, 20-22 (3GPP TS 23.002 standard document describing the networks as serviced by an MSC); Flore at 30 (describing UTRAN 120 (3G) and GPRS core network 140 (2G) as documented in 3GPP TS 23.002 (Ex. 1006)). Likewise, Flore's 3G and 4G networks rely on centralized hubs.

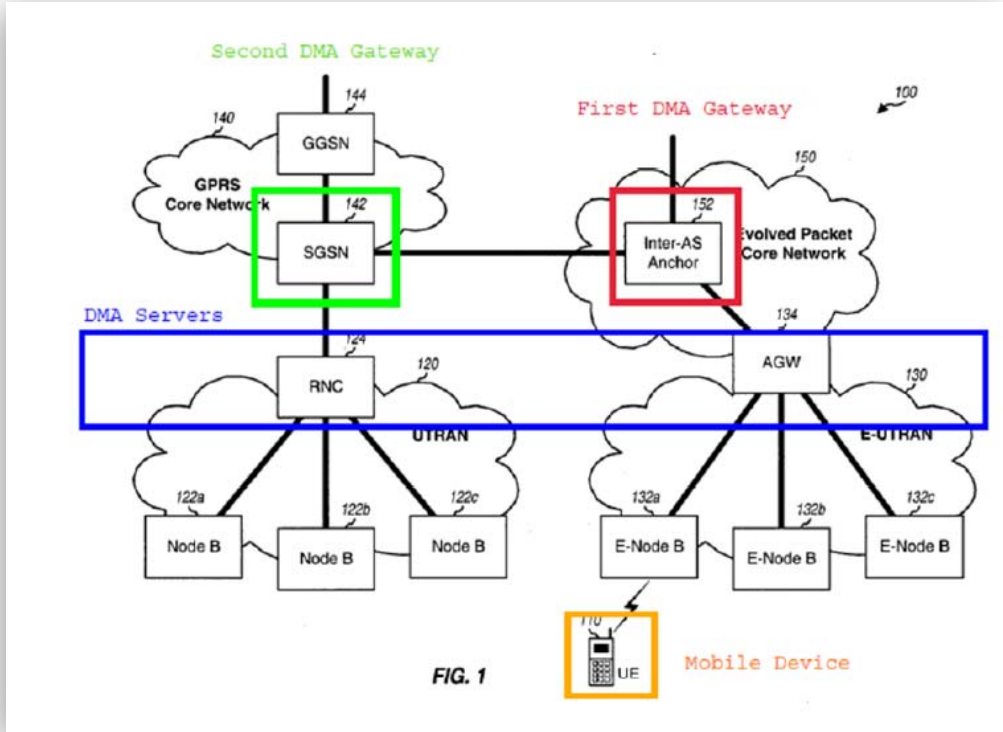
In the 3G UTRAN network, the RNC transfers calls from the BTS (Node B) to a centralized SGSN, while in the 4G E-UTRAN network, the AGW transfers calls from BTS (E-Node B) to the centralized Inter-AS-Anchor. *See* § II.B, *supra* (citing Flore at Fig.1).

82. Accordingly, every network disclosed in Flore (i.e., legacy 2G, 3G, and 4G networks) uses communication paths from BTSs to centralized hubs for call routing to target UEs.

83. Therefore, it is my opinion that Flore does not disclose a distributed mobile architecture (DMA) network where DMA servers have call-routing functionality.

2. Flore Does Not Disclose "DMA Servers" Connected Via Peer-to-Peer Connections

84. It is also my opinion that Flore does not disclose a DMA network with DMA servers that are connected to other DMA servers through peer-to-peer connections, as the Challenged Claims require. As shown in Petitioners' annotated version of Flore's Fig. 1 reproduced below, the RNC 124 and AGW 134, which Petitioners incorrectly contend are DMA servers, are conventional BSCs that manage multiple BTSs (Node B and E-Node B, respectively) and send calls to an MSC (SGSN and Inter-AS Anchor, respectively). Both the RNC and AGW lack the ability to communicate with other RNCs or AGWs as peers. Thus, RNC 124 and AGW 134 in Flore are not DMA servers.



Pet. at 11 (citing Flore at Fig. 1).

85. For purposes of the "devices accessible by one of ***a DMA server*** and legacy communication network" limitation, Petitioners shift their allegation and contend that the "one or more Node Bs" are the DMA servers (not the RNC and AGW). Pet. at 13 ("the UE 110 is accessible by one or more Node Bs and "'legacy networks 120 and 140'"). Petitioners do not explain how conventional "Node Bs" can satisfy the DMA servers limitation. *See* Pet. at 13. Nor could they in my opinion, as Node Bs are not connected via peer-to-peer connections (and do not have any call-routing capabilities). Thus, in my opinion, Flore does not disclose DMA

servers when that term is construed to require peer-to-peer connections between DMA servers.

3. Flore's Legacy Networks Are Not a "Distributed Mobile Architecture"

86. Flore is directed to a method for connecting different legacy networks, such as 2G, 3G, and 4G networks. Outside of its proposed interconnect, Flore does not purport to provide any modification to these underlying networks. Indeed, Petitioners contend that these legacy networks (120 and 140) satisfy the claimed "legacy communications network" limitation and acknowledge that they depend on centralized MSCs for routing. Pet. at 13-14, 20 (characterizing networks 120 and 140 as "legacy networks" serviced by centralized MSCs).

87. Because a POSITA would understand that distributed mobile architecture are distinct from legacy networks, a POSITA would not agree with Petitioner's identification of Flore's legacy networks as serving as the DMA infrastructure.

B. Flore Does Not Disclose a "DMA Gateway Communications Network"

88. In my opinion, Flore also does not anticipate the Challenged Claims because it does not disclose a "DMA gateway communications network." The DMA gateway communications network is a ***network*** that connects DMA gateways in order for them to communicate amongst one another. *See* '988 Patent at 3:10-14

("The communication is routed from the first DMA gateway to the target device by relaying the communication from the first DMA gateway to the second DMA gateway ***via the DMA gateway communications network***") (emphasis added).

89. I understand that in the Petition, Petitioners identified the Gn interface as the "gateway communications network." Pet. at 22 ("The Update PDP Context Response message is sent across the Gn interface, ***which is a 'gateway communications network***.'") (emphasis added). At institution, the Board stated that "Petitioner[s have] not contended that a Gn interface is a network" and asserted that Petitioners only identified that the SGSN 142 and Inter-AS Anchor 152 communicate "via a Gn interface." Institution Decision at 28.

90. However, the claims require that a "network" be used to connect the DMA gateways. Thus, Petitioners have not identified any ***network*** in Flore used to connect the DMA gateways. Moreover, the Gn interface is part of the conventional network architectures that are different from the claimed distributed mobile architecture network. Flore at ¶ 29 ("The use of the Gn interface allows SGSN 142 to communicate with Inter-AS Anchor 152 in the same manner as with another SGSN, which minimizes the impact to ***legacy networks 120 and 140***") (emphasis added).

91. Therefore, it is my opinion that Flore does not disclose a DMA gateway network.

C. Flore Does Not Disclose "communications information for a communications network accessible by a second DMA gateway"

92. A POSITA reading the claims would recognize that they require communications information for a communications network accessible by a second DMA gateway that is (1) received at a first DMA gateway, (2) indicates one or more devices accessible by one of a DMA server and a legacy communications network, (3) is stored in a home DMA register of a first DMA gateway, and (4) indicates a target device to be served by a second DMA gateway. '988 Patent at Claim 1

93. Petitioner contends that Flore's PDP context meets the claimed "communications information." Pet. at 12-13 (alleging that "the PDP context disclosed in Flore qualifies as 'communications information'"). I disagree. Flore's PDP context is not "communications information for a communications network accessible by a second DMA gateway," and is not stored in a first DMA gateway's home register.

1. Flore's PDP Context Does Not Identify any Network Accessible by a Second Gateway

94. A PDP context "contains various parameters such as routing information for IP packets." Pet. at 12. There is nothing in a PDP context that identifies any network ***accessible by*** a second gateway. At most, the PDP context identifies what Petitioners contend is the second DMA gateway (*i.e.* SGSN 142), so that when a UE moves from a 4G enabled cell site to a 3G cell site, "future packets

for the UE are forwarded to SGSN 142 instead of AGW 134." Pet. at 13. No information about any networks accessible by SGSN 142 is contained in this PDP context. Thus, Flore does not disclose "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***."

2. Flore's PDP Context Does Not Identify a Device "Accessible by One of a DMA Server and a Legacy Communications Network" Via the Second DMA Gateway

95. Flore's PDP context is sent ***before*** the UE is handed over to the new communications network. Pet. at 13; Flore at ¶ 46 (sending the PDP context at step 11). At the time the PDP context is sent, the UE is still subscribed to the first network's AGW 134, and cannot be accessed by SGSN 142, which Petitioners contend is the second DMA gateway. Pet. at 11, 12-13; *See* Flore at Fig. 7; Flore at ¶ 46.

96. Particularly, in Figure 7 of Flore, PDP context messages are exchanged with the second network entity to handover the UE (at step 718), but not until after the handover is complete is the UE accessible by the SSGN (at step 724). *See* Flore at Fig. 7; *see also id.* at ¶ 58. Accordingly, the UE that is the subject of the PDP context is not a device identified as "accessible by one of a DMA server and a legacy communications network" via the second DMA gateway.

3. Flore Does Not Disclose Storing the Communications Information in a Home DMA Register of the First DMA Gateway

97. In my opinion, Flore's PDP context is not "communications information" that is stored in "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"). The PDP context is stored at the GGSN register, as Petitioners acknowledge. Pet. at 15-16. Therefore, it is my opinion that Flore's GGSN location register is not the claimed "home DMA register."

98. The '988 Patent explains that the "home DMA register" stores "communications information," which indicates devices serviced by networks accessible by the second DMA gateway. '988 Patent at 3:4-7, 11:10-27, 15:14-28. More specifically, the '988 Patent discloses that the "communications information" includes "register information, such as home location register (HLR) information" stored in the home DMA register. '988 Patent at 15:14-16; *see also id.* at 15:14-28, 14:9-11 (this type of register information "describes devices for which the networks they [DMA gateways] service are the home network.").

99. A POSITA would understand that this corresponds to the functionality provided by a home location register (HLR) in a legacy network, as the '988 Patent explains, although, in the network of the '988 Patent, the information is distributed to and stored at a DMA server or DMA gateway (unlike in legacy networks, where

it is stored at the MSC/SGSN. '988 Patent at 15:14-17; Ex. 2022 at 10-11; Ex. 2012 at 3; Ex. 2014 at 1 (each network has its own HLR which determines whether the user is in its home network or is roaming)).

100. The GGSN register is not store a home DMA register because it does not store location register information for its own network *or* any other networks. Indeed, unlike the home DMA register of the DMA gateway, which stores the HLR information for the network served by the DMA gateway *and* communications information for UEs served by another DMA gateway (up to and including their HLRs), the PDP context stored at the GGSN does not even store location information. The only information stored in the GGSN is the address of the UE and the address of the SGSN that serves it. Ex. 1006 at 13-14 (the GGSN "stores subscription information and routeing [sic] information (needed to tunnel packet data traffic destined for a GPRS MS to the SGSN)"). Accordingly, Flore does not disclose that HLR functionality is also located at the GGSN location register. '988 Patent at 14:9-11, 15:14-28, Ex. 2016 at 1; Ex. 2017.

101. I also understand that Petitioners also 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.

102. The home DMA register, and HLRs more generally, include more than a "list of entries for the UEs it serves." *Id*. HLRs, and the home DMA register, store "location" information for the subscribers it serves, not just their identities. ON the other hand, "PDP context fields" are stored in the GGSN which, as described above, are categorically different than the location information stored in an HLR/home DMA register. Ex. 1006 at 13-14 (disclosing that the "GGSN has at least one PDP context active."). This is a further reason a POSITA would not find the reference to PDP context fields to disclose a "home DMA register."

D. In My Flore Fails to Disclose the Additional Limitations Recited in the Dependent Claims

103. In addition to the reasons Flore fails to anticipate Independent Claim, as I described above, Flore also fails to disclose additional limitations recited in the dependent Challenged Claims.

1. Dependent Claim 7: In my Opinion Flore Does Not Disclose "the First DMA Gateway Automatically Sending at Least a Portion of the Communications Information to the Second DMA Gateway via the Gateway Communications Network"

104. Flore does not disclose "the first DMA gateway automatically sending at least a portion of the communications information to the second DMA gateway via the gateway communications network," as recited by Claim 7. For this limitation, Petitioners allege that an "Update PDP Context Response message" as

forwarded from the alleged first DMA gateway to the alleged second DMA gateway contains portions of the communications information. Pet. at 21. I disagree.

105. The claimed "communications information" indicates "one or more devices accessible by one of a DMA server and a legacy communications network" via the second DMA gateway *See* '988 Patent at Claim 1. As established above, PDP context messages are sent **before** the handover is complete, therefore it does not identify a UE device accessible via alleged second DMA gateway. *See* § VI.C.2, *supra*. Additionally, none of the elements in the Update PDP Context Response message indicates the UE device, let alone one accessible via the alleged second DMA gateway. *See* Ex. 2029 at 33 (depicting the information elements in an Update PDP Context Response message).

106. Thus, for at least these reasons, it is my opinion that Flore does not anticipate Dependent Claim 7.

2. Dependent Claim 8: In my Opinion Flore Does Not Disclose "in response to receiving a query from the second DMA gateway for the communications information, the first DMA gateway sending at least a portion of the communications information to the second DMA gateway via the gateway communications network

107. For the same reasons as those I set forth directly above, Flore does not anticipate "in response to receiving a query from the second DMA gateway for the communications information, the first DMA gateway sending at least a portion of

the communications information to the second DMA gateway via the gateway communications network."

3. Dependent Claim 9: In my Opinion, Flore Does Not Disclose "Communications Register Data Including at Least one of . . . a Portion of the Home Location Register (HLR) Data for the Communications Network"

108. Flore's PDP context also does not include "communications register data including at least one of . . . a portion of the home location register (HLR) data for the communications network," as required by Claim 9. '988 Patent at Claim 9.

109. I understand that Petitioners assert that the PDP context "contains information such as the IP address of the Inter-AS-Anchor" which is "a portion of the Home Location Register (HLR) data." Pet. at 23. For support, Petitioners rely on the 3GPP TS 23.0002, V7.1.0 standard document, which provides that "the Home Location (HLR) is the location register to which a mobile subscriber is assigned for record purposes such as subscriber information." *Id.* at 23 (citing Ex. 1006 at 13)(quotations omitted).

110. But this document does not support Petitioners' proposition. While the HLR stores home location register data of a subscriber, ***it does not store the PDP context***. Rather, the PDP context is stored in the GGSN location register, which provides the information for exchanging packets between the UE and the network, as described above. Ex. 1006 at 13-14 (the GGSN location register store the "subscription information and routing information (needed to tunnel packet data

traffic . . . for which the GGSN has at least one PDP context active"); Ex. 2016 at 1 (explaining that the PDP context "offers a packet data connection over which the UE and the network can exchange packets."). Because the PDP context is stored in the GGSN location register, not the HLR, the PDP context does not contain information that is part of "a portion of the home location register (HLR) data for the communications network." '988 Patent at Claim 9.

111. Thus, in my opinion, Flore cannot anticipate Claim 9.

4. Dependent Claim 20: In my Opinion Flore Does Not Disclose that "the First DMA Gateway Receives the Communications Information From the Second DMA Gateway"

112. Claim 20 requires that "the first DMA gateway receives the communications information from the second DMA gateway." '988 Patent at Claim 20. In reading the Petition, Petitioners contend throughout that Inter-AS Anchor 152 (the alleged "first DMA gateway") receives the PDP context from AGW 134 and then "forwards the information" to the SGSN 142 (the alleged "second DMA gateway"). *See* Pet. at 12-13 (alleging that for Claim 1, the "AGW 134 sends a 'PDP context' to Inter-AS Anchor 152"), 13 ("the PDP context disclosed in Flore qualifies as communications information"), 21-22 (alleging that for Claims 6-8, AGW 134 stores and forwards the PDP context to Inter-AS Anchor 152 which "then 'forwards the information in an Update PDP context Response message to SGSN 142' (the 'second DMA gateway')."). By Inter-AS Anchor receiving the PDP context from

AGW 134 and then forwarding the information to SGSN 142, Petitioners advance a theory in which the ***alleged second DMA gateway*** receives the alleged communications information from ***the alleged second DMA***.

113. I understand, however, for Claim 20, Petitioners turn that theory on its head. Pet. at 24. Specifically, Petitioners contend that SGSN 142 provides the PDP context message to Inter-AS Anchor 152 to facilitate handovers from the UTRAN to the E-UTRAN, not the other way around as Petitioners contended for the other Challenged Claims. *Compare id.* (for Claim 20, facilitating handovers from the UTRAN to the E-UTRAN) *with id.* at 13-14 (contending that the PDP context message is meant to facilitate handover from the E-UTRAN 130 to the UTRAN 120 and GPRS core network 140).

114. Thus, for at least the above reasons, it is my opinion, Flore cannot anticipate Claim 20.

VIII. CONCLUSION

115. 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 anticipated by Flore.

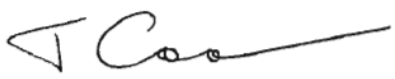
116. I understand that my opinions discussed above support a legal conclusion that the challenged claims are nonobvious.

117. 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.

118. 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.

December 21, 2023

Respectfully Submitted,



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

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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 S^2ERC I/UCRC, "FPGA implementation of shared-memory middleware", 2017-2019, PI

3. National Science Foundation S^2ERC 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 S^2ERC I/UCRC, "The performance of middleware solutions for SDR", 2013-2014, PI

8. National Science Foundation S^2ERC 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 S^2ERC 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.

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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 *Tokyo Institute of Technology, Tokyo, Japan,*
Doctor of Philosophy in Electrical Engineering
Dissertation: Regular Perfect-Reconstruction Filter Banks and Wavelet Bases

1988 *Technical University of Sofia, Bulgaria,* 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

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- 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.

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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.

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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 and A. Yagle, *Modern Communication Systems: A first course*, Michigan Publishing, 2023 (in preparation).
2) T. Cooklev, W*ireless 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.

5) V. Kolev, T. Cooklev, F. Keinert, "Matrix spectral factorization for the SA4 multiwavelet," *Journal of Multidimensional Systems and Signal Processing*, vol.29, Issue 4, pp 1613–1641, 2018.

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6) H. Dogan, T. Cooklev, and J. Darabi, "Improved low-complexity zero-padded OFDM receivers", *Digital Signal Processing*, vol. 51, pp. 92–100, April 2016.

7) P. Baltiiski, I. Iliev, B. Kehaiov, V. Poulkov, and T. Cooklev, "Long-Term Spectrum Monitoring with Big Data Analysis and Machine Learning for Cloud-Based Radio Access Networks," *Wireless Personal Communications*, vol. 87, issue 3, pp. 815-835, April 2016.

8) T. Cooklev, J. Darabi, C. McIntosh, and M. Mosaheb, "Cloud-based approach for spectrum monitoring," *IEEE Instrumentation and Measurement Magazine*, vol. 18, no. 2, pp. 33-37, April 2015.

9) Sven Bilen, A. Wyglinski, C. Anderson, T. Cooklev, C. Dietrich, B. Farhang-Boroujeny, "On Software-Defined Radio as an integrative educational resource," *IEEE Communications Magazine*, vol. 52, no. 5, pp. 184-193, May 2014.

10) Hakan Yıldız, Yusuf Acar, Todor Cooklev, Hakan Dogan, "Generalized Prefix for Space-Time Block Coded OFDM Wireless Systems over Correlated MIMO Channels," *IET Communications*, vol. 8, no. 9, pp. 1589-1598, June 2014.

11) T. Cooklev, A. Nishihara, "An Open RF-Digital interface for software-defined radios," *IEEE Micro,* vol. 33, no. 6, pp. 47-55, Dec. 2013.

12) T. Cooklev, R. Normoyle, and D. Clendenen, "The VITA 49 RF-digital interface," *IEEE Circuits Systems Magazine*, vol. 12, no. 4, pp. 21-32, Dec. 2012.

13) T. Cooklev, "An improved prefix for OFDM-based cognitive radios", *Electron. Lett.*, vol. 48, No. 4, Feb. 2012.

14) Y. Alqudah and T. Cooklev, "Hands-on open access broadband wireless technology lab", *Int. J. Interactive Mobile Tech.*, Vol. 6, No 4, 2012, pp. 13-18.

15) T. Cooklev, H. Dogan, R. Cintra, H. Yildiz, "Generalized prefix for OFDM wireless systems over quasi-static channels," *IEEE Transactions on Vehicular Technology,* vol. 60, No. 8, pp. 3684 – 3693, *Nov.* 2011.

16) F. Ramirez-Mireles, T. Cooklev, and G. A. Paredes-Orozco, "UWB-FSK: Performance tradeoffs for high-complexity receivers," *IEEE Transactions on Consumer Electronics*, vol. 56, no. 4, pp. 2123-2131, 2010.

17) S. Hossain, D. Batovski, and T. Cooklev, "Eight-channel transmultiplexer with binary matrix sequences," *Assumption Univ. Journal of Technology (Thailand),* vol. 13, No. 4, pp. 193-202, 2010.

18) T. Cooklev, "Engineering standards and engineering education," *Journal of IT Standardization Research*, vol. 8, 2010, pp. 1-10.

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19) R. Cintra and T. Cooklev, “Robust image watermarking using non-regular wavelets,” *Journal of Signal, Image, and Video Processing*, 2008.

20) T. Cooklev, A. Pakdaman, J. Eidson, “IEEE 1588 over IEEE 802.11 for synchronization of wireless local area nodes,” *IEEE Trans. Instrumentation and Measurement*, vol. 56, No. 5, pp. 1632-1639, Oct. 2007.

21) T. Cooklev and A. Nishihara, “Analytic constructions of complementary sequences,” *IEICE Trans. Fundamentals*, November 2006.

22) T. Cooklev, “An efficient architecture for orthogonal wavelet transforms,” *IEEE Signal Processing Letters*, Feb. 2006.

23) T. Cooklev, “Standards for the wireless Internet,” *Annual review of communications*, vol. 57, Dec. 2004.

24) T. Cooklev, G. Berbecel and A. N. Venetsanopoulos, ``Wavelets and differential-dilation equations,'' *IEEE Trans. Signal Processing*, vol. 48, pp. 2258-2268, 2000.

25) T. Cooklev and A. Nishihara, “Biorthogonal coiflets,”*IEEE Trans. Signal Processing*, vol. 47, pp. 2582-2588, 1999.

26) T. Cooklev, A. Nishihara, T. Yoshida, and M. Sablatash, ``Multidimensional two-channel linear phase FIR filter banks and wavelet bases with vanishing moments," *Journal of Multimensional Systems and Signal Processing*, vol. 9, pp. 39-76, January 1998.

27) T. Cooklev, A. Nishihara and M. Sablatash ``Regular orthonormal and biorthogonal wavelet filters," *Signal Processing*, vol. 57, pp. 121-137, Feb. 1997.

28) T. Yoshida, T. Cooklev, A. Nishihara, and N. Fujii, "Design of non-separable 3-D QMF banks using McClellan transformations," *IEICE Trans. Fundamentals*, vol. E79-A, No. 5, May 1996, pp. 716-720.

29) M. Sablatash and T. Cooklev ``Coding of high-quality audio signals by wavelets and wavelet packets," *Digital Signal Processing: A Review Journal*, vol. 6, No. 2, pp. 96-107, April 1996.

30) V. Dimitrov, T. Cooklev, and B. Donevsky ``Number-theoretic transforms over the golden-section quadratic field," *IEEE Trans. Signal Processing*, No. 8, pp. 1790-1797, August 1995.

31) V. Dimitrov and T. Cooklev, ``Hybrid algorithm for computing the matrix polynomial," *IEEE Trans. Circuits Syst.*, No. 7, pp. 377-380, July 1995.

32) V. Dimitrov and T. Cooklev ``Two algorithms for modular exponentiation based on nonstandard arithmetics,'' Special issue on cryptography and information security, *IEICE Transactions on Fundamentals*, Jan. 1995.

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33) M. Sablatash , Todor Cooklev and Takuro Kida,``The coding of image sequences by wavelets, wavelet packets and adaptive wavelet packets," *IEEE Trans. Broadcasting*, Dec. 1994.

34) T. Cooklev and A. Nishihara, ``Partial and generalized FFT," *IEICE Trans. on Fundamentals*, Sept. 1994.

35) V. Dimitrov, T. Cooklev and B. Donevsky, "Generalized Fermat-Mersenne number theoretic transforms," *IEEE Trans. Circuits Syst.,* vol. 41, pp. 133-139, Feb. 1994.

36) T. Cooklev, T. Yoshida and A. Nishihara, ``Maximally flat half-band diamond-shaped FIR filters using the Bernstein polynomial," *IEEE Trans. Circuits Syst.,* vol. 40, pp. 749-751, Nov. 1993.

37) T. Cooklev and A. Nishihara, ``Maximally flat FIR Hilbert transformers," *Int. Journal Circuit Theory and Applications*, vol. 21, pp. 563-570, 1993.

38) T. Cooklev, S. Samadi, A. Nishihara and N. Fujii, Efficient implementation of all maximally flat FIR filters of a given order," *Electronics Lett.,* vol. 29, No. 7, pp. 598-599, 1993.

39) S. Samadi, T. Cooklev, A. Nishihara and N. Fujii, ``Multiplierless structure for maximally flat linear phase FIR filters," *Electronics Lett.,* vol. 29, No. 2, pp. 184-185, 1993.

40) V. Dimitrov, T. Cooklev and B. Donevsky, "Generalized Fermat number transforms," *ASME Journal on Numerical Modeling*, 1992, N. 4 pp. 11-22.

41) T. Cooklev, V. Dimitrov and B. Donevsky, "Systolic implementation of the complex Chebyshev structure," *Int. J. Electronics*, vol. 73, pp. 1247-1252, Dec. 1992.

42) T. Cooklev and A. Nishihara, "Efficient design of N--D hyperspherically symmetric FIR filters," *IEICE Transactions on Fundamentals of Electronics, Inform. and Comput. Sci.*, vol. E75-A, pp. 1739-1742. Dec. 1992.

43) T. Cooklev, V. Dimitrov and B. Donevsky, "An improved systolic implementation of complex digital filters," *Archiv fuer Elektronik und Uebertragungstechnik (Germany)*, vol. 46, pp. 434-436, Nov.-Dec. 1992.

44) V. Dimitrov, T. Cooklev and B. Donevsky, "On the multiplication of reduced biquaternions and applications," *Information Processing Letters,* vol. 43, pp. 161-164, Sept. 1992.

Conference Papers

1) T. Cooklev, “The analog RF-digital interface: the VITA 49 standard and evolution roadmap” First IEEE Next G Summit, Johns Hopkins University, June 2022.

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2) Plamen Semov, Pavlina Koleva, Vladimir Poulkov, and Todor Cooklev, "Evolution of Mobile Networks and C-RAN on the Road Beyond 5G," 43rd Int. Conf. on Telecommunications and Signal Processing, Milan, Italy, July 2020.

3) Y. Acar, S. Colak, T. Cooklev, "Dual-Mode Index Modulation Aided OFDM with Generalized Prefix", *Int. Symp. Networks, Computers, and Communications*, June 2019, Istanbul, Turkey.

4) T. Cooklev, "Making Software Defined Networks Semantic," *Proc. WINSYS*, July 2015, Colmar, France.

5) T. Cooklev, L. Stanchev, "A comprehensive and hierarchical ontology for wireless systems," *Wireless World Research Forum*, Marrakech, Morocco, May 2014.

6) Yusuf Acar, H. Yildiz, H. Dogan, and H. Dogan, "Generalized Prefix Approach for Alamouti Coded OFDM Systems over Gaussian Channels Correlated in Space," IEEE 2014 World Congress on Computer Applications and Information Systems (WCCAIS), Hammamet, Tunisia, January17-19, 2014.

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