UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

RESMED CORP,
Petitioner,

v.

CLEVELAND MEDICAL DEVICES, INC.,
Patent Owner.

Case IPR2025-00160
U.S. Patent No. 11,786,680

DECLARATION OF DR. MICHAEL T. GOODRICH IN SUPPORT OF PATENT OWNER'S RESPONSE

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I. INTRODUCTION

I, Dr. Michael T. Goodrich, declare:

1. I have been retained as an expert witness for Patent Owner ("CleveMed") in connection with the above-captioned *Inter Partes Review* ("IPR") before the Patent Trial and Appeal Board ("PTAB" or "Board") regarding claims 1-5, 7-8, 10-13, 15-18, and 20-31 (the "Challenged Claims") of U.S. Patent No. 11, 786,680 (the "'680 Patent").

2. I am being compensated for my work in this matter. My compensation does not depend on the outcome of this proceeding.

3. I have been asked to provide my technical opinions relating to the '680 Patent in relation to arguments raised by Petitioner in its Petition.

4. My opinion is based on a person having ordinary skill in the art (which I understand is sometimes abbreviated "POSITA") at the time of the earliest potential claimed priority date, which I understand to be 2005. '680 Patent at Cover. My opinions in this declaration are based on my years of education, research, and experience, as well as my investigation and study of relevant materials.

II. MATERIALS CONSIDERED

5. I have reviewed both Petitioner's and Patent Owner's exhibits (including Dr. Borkholder's declaration (Ex. 2016)) and the PTAB papers for the above captioned IPR. I have also considered documents that I cite in this declaration.

III. QUALIFICATIONS

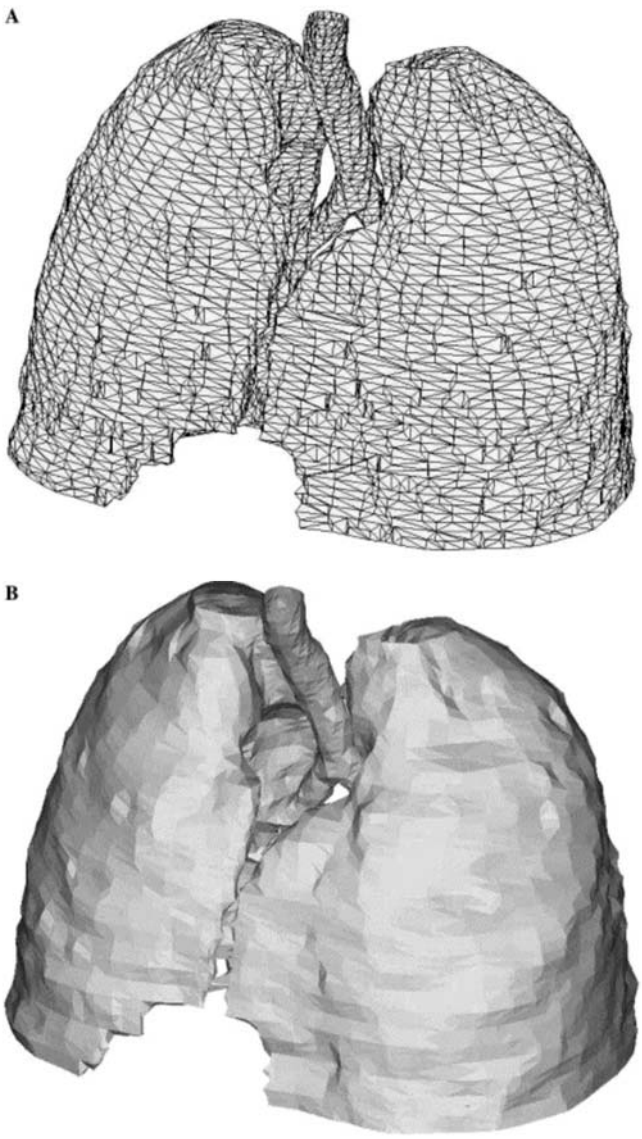
6. I summarize some of the relevant information regarding my CV (Appendix A) as follows. I received a Bachelor of Arts degree in Mathematics and Computer Science from Calvin University, in Grand Rapids, Michigan, in 1983, a Master of Science (M.S.) degree in Computer Science from Purdue University, in West Lafayette, Indiana, in 1985, and a Ph.D. in Computer Science from Purdue University in 1987.

7. I am a Distinguished Professor in the Department of Computer Science at the University of California, Irvine, where I have been a faculty member since 2001. The Distinguished Professor title is a campus-level distinction and is reserved for faculty who have achieved the highest levels of scholarship over the course of their careers. Prior to this, I was a professor in the Department of Computer Science at Johns Hopkins University from 1987-2001.

8. I have authored or coauthored over 350 publications, including several widely adopted books, such as Data Structures and Algorithms in Java, Data Structures and Algorithms in C++, Data Structures and Algorithms in Python, Introduction to Computer Security, and Algorithm Design and Applications. Altogether, my publications have, according to Google Scholar, been cited over 18,500 times. My publications include contributions to data structures and algorithms, information visualization, networking, graph algorithms, computational

geometry, distributed and parallel algorithms, cloud security, information security and privacy, and algorithm engineering. For example, using the indexing of publications listed in my CV, I have publications on networking and parallel and distributed computing, including publications Ch-1, Ch-3, Ch-6, Ch-10, J-1, J-5, J-7, J-10, J-16, J-19, J-24, J-30, J-38, J-56, J-61, J-69, J-96, C-1, C-2, C-7, C-25, C-26, C-39, C-106, C-112, C-127, C-137, C-228, C-230. Also, several of my textbooks include entire chapters on software engineering, and several of my publications, including Ch-8, Ch-12, J-45, C-53, C-62, C-63, C-64, are on algorithm engineering. In addition, I have many publications on topics specifically relevant to the subject matter of the challenged patent, as I explain below.

9. For example, I have several publications that describe technologies with medical applications. For instance, in my publications J-51 and C-93, my coauthors and I presented an efficient algorithm for interpolating a piecewise-linear surface between parallel image slices, each consisting of an arbitrary number of (possibly nested) polygons that define "material" and "non-material" regions, which is a problem with applications to medical imaging, e.g., for constructing 3-dimensional representations of organs from parallel 2-dimensional image slices, as we illustrated, for instance, by building a 3-dimensional representation of a pair of lungs from a series of 2-dimensional image slices:



J-51 at Fig. 8.

10. In my publications J-67, J-80, J-81, C-132, and O-12, I studied methods for learning someone's DNA, which of course has many medical applications, from a series of simple database queries, and in my J-80 publication I provided a case study involving 1000 (anonymized) human mitochondrial DNA sequences that showed the effectiveness of my approach to this learning problem. In my publication

C-225, my coauthors and I studied methods for learning phylogenetic trees, such as for representing the evolution of viruses, by sequences of parallel comparison queries, and, in my publication C-222, my coauthors and I studied methods for visualizing such trees.

11. Naturally, given the privacy concerns regarding patient data, information security and privacy is another important topic that has applications to medical data capture, retention, and transmission, and I have several publications in this area as well, including publications P-1, P-2, P-3, P-5, P-6, P-7, P-8, B-10, J-61, J-63, J-64, J-66, J-71, J-96, J-99, C-80, C-83, C-85, C-87, C-90, C-91, C-92, C-95, C-99, C-101, C-102, C-104, C-105, C-109, C-113, C-119, C-123, C-126, C-134, C-146, C-149, C-151, C-156, C-161, C-166, C-167, C-168, C-182, C-192, C-193, C-194, C-200, C-203, C-208, C-211, C-235, and C-243. For example, in my publication C-99, my coauthors and I studied the problem of broadcasting confidential information to a collection of small-memory devices/sensors while providing the ability to revoke an arbitrary subset of those devices (e.g., due to compromise or loss). In my publication C-101, my coauthors and I presented computationally lightweight schemes for performing biometric authentication that carry out the comparison stage without revealing any information that can later be used to impersonate the user (or reveal personal biometric information). Unlike some previous computationally expensive schemes, which made use of slower

cryptographic primitives, our work was directed at ways to authenticate users with biometric smartcards, sensors, and other computationally limited devices. Also, in my publication C-102, I presented two new approaches to improving the integrity of network broadcasts and multicasts with low storage and computation overheads, e.g., to a collection of computationally weak sensors.

12. I have also studied other computational problems involving collections of wireless sensors, such as sensors used to gather medical data. In my publications Ch-9 and C-116, my coauthors and I how to support a location authentication and authorization protocol to securely authenticate the location claims of mobile wireless users and to securely distribute shared keys for data encryption purposes. In my publication C-118, my coauthors and I designed a mechanism for secure wireless networking, where we proposed placing fixed localization sensors that enable mobile communication devices to prove they belong to a secure region that is defined by the interior of a region, like a hospital. Each localizer views an infinite wedge of the plane, and a device can prove membership in the secure region if it is inside the wedges for a set of localizers whose common intersection contains no points outside the region. In my publications J-62 and C-115, my coauthor and I presented group-testing algorithms for resolving broadcast conflicts on a multiple access channel (MAC) and for identifying the dead sensors in a mobile ad hoc wireless network. We gave adaptive algorithms that are provably more efficient than previous

algorithms and we showed how our algorithms can be applied to solve dead sensor diagnosis. In my publications C-113 and J-66, my coauthors and I presented a protocol for securely pairing wireless electronic devices, such as between a medical sensor relay and a laptop computer, that lack any previous association and for which we wish to avoid a man-in-the-middle attack during data transmission between these devices. In this work, we investigated the use of audio for human-assisted authentication of previously un-associated devices by using a text-to-speech engine for vocalizing a robust-sounding and syntactically-correct sentence derived from the hash of a device's public key that is communicated wirelessly (e.g., using Bluetooth or IEEE 802.11 a/b/g) and by coupling vocalization on one device with the display of the same information on the other device.

13. When medical devices use cellphones to communicate data using cell towers, it is of course important that they can communicate their data effectively and efficiently, and I have done research on this topic as well. For example, in my publication C-155, my coauthors and I studied the problem of assigning a moving point to a base-station region that contains it. For instance, the moving object could be a cellphone, and the base station could represent the coverage zones of cell towers. The optimization goal we studied was to minimize the number of handovers that occur when the point moves outside its currently assigned region and must be assigned to a new one, so as to optimally maintain communication connections. We

studied this problem in terms of a competitive analysis comparing our methods against an algorithm for the offline version of this problem, when object motions are known in advance and a simple greedy strategy suffices to determine an optimal assignment of objects to base stations with as few handovers as possible.

14. My research has been supported by grants from the Defense Advanced Research Projects Agency ("DARPA"), the National Security Agency ("NSA"), the Office of Naval Research ("ONR"), the Army Research Office ("ARO"), and the National Science Foundation ("NSF").

15. In addition, I have technical expert and testifying expert consulting experience in matters involving algorithms, cryptography, machine learning, digital rights management, computer security, mobile devices (including power management), networking, software, video streaming, and storage technologies.

16. I am a Fellow of the American Association for the Advancement of Science ("AAAS"), a Fellow of the Institute of Electrical and Electronics Engineers ("IEEE"), and a Fellow of the Association for Computing Machinery ("ACM"), as well as being named as a Foreign Member of the Royal Danish Academy of Sciences and Letters. I am also a recipient of a Fulbright Scholarship (for senior specialist service to University of Aarhus, Denmark). In addition, I am a recipient of the IEEE Computer Society Technical Achievement Award ("for outstanding contributions to the design of parallel and distributed algorithms for fundamental combinatorial and

geometric problems") and the Pond Award for Excellence in Undergraduate Teaching. Also, I am an ACM Distinguished Scientist.

17. I am a co-inventor on several U.S. patents, including U.S. Patent No. 7,257,711, "Efficient Authenticated Dictionaries with Skip Lists and Commutative Hashing," which discloses secure distributed data authentication schemes. I am also co-inventor of U.S. Patent No. 7,299,219, "High Refresh-Rate Retrieval of Freshly Published Content using Distributed Crawling," which discloses a technology for quickly retrieving website data that can change frequently, so as to be stored in a search engine. I am also co-inventor of U.S. No. Patent 8,681,145, "Attribute Transfer Between Computer Models Including Identifying Isomorphic Regions in Polygonal Meshes," which teaches how to map one mesh-based computer model to another. In addition, I am co-inventor of U.S. Patent No. 9,152,716, "Techniques for Verifying Search Results Over a Distributed Collection," which discloses a system for searching the Internet so as to produce verifiable search results that can be produced by a search engine.

18. I have taught courses at Johns Hopkins University, Brown University, and University of California, Irvine, at both the undergraduate and graduate levels. Topics of my courses have included computer security, algorithms, data structures, information visualization, computer graphics, networking, algorithm engineering, computational geometry, and parallel processing. In addition, I have mentored 26

PhD students over the years, who have written their PhD theses on topics in algorithms, data structures, information visualizations, networking, parallel processing, and computer security and privacy.

19. I have served as an editor on several technical journals, including Computational Geometry: Theory and Applications, Journal of Computer & System Sciences, Journal of Graph Algorithms and Applications, Int. Journal of Computational Geometry & Applications, and Information Processing Letters. I have also served on many program committees (PCs) for top conferences and workshops in Computer Science, including serving as PC chair in several instances. Examples include ACM Symposium on Computational Geometry ("SoCG"), ACM Symposium on Theory of Computing ("STOC"), Workshop/Symposium on Algorithms and Data Structures ("WADS"), Algorithm Engineering and Experimentation ("ALENEX"), which I cofounded with Dr. Catherine McGeoch in 1999), IEEE Symposium on Foundations of Computer Science ("FOCS"), ACM-SIAM Symposium on Discrete Algorithms (SODA), International Symposium on Graph Drawing ("GD"), International Colloquium on Automata, Languages, and Programming ("ICALP"), ACM Conference on Computer and Communications Security ("CCS"), European Symposium on Algorithms ("ESA"), IEEE International Parallel and Distributed Processing Symposium ("IPDPS"), ACM Symposium on Parallel Algorithms and Architectures ("SPAA"), ACM Symposium

on Advances in Geographic Information Systems ("GIS"), IEEE Symposium on Security and Privacy ("S&P"), IEEE International Conference on Big Data, IEEE International Conference on Data Engineering ("ICDE"), and International Symposium on Algorithms and Computation ("ISAAC"), and DAGS Conference on Electronic Publishing and the Information Superhighway.

IV. APPLICABLE STANDARDS AND CONTROLLING PRINCIPLES

A. Claim Construction

20. I have been informed through counsel that during this inter partes review proceeding (because this petition for inter partes review was filed after November 13, 2018), claims terms should be given their "ordinary and customary meaning as would be understood by a person of ordinary skill in the art in question at the time of the invention." I have further been informed that for determining the meaning of a disputed claim term, it is appropriate to "look principally to the intrinsic evidence of the record, examining the claim language itself, the written description, and the prosecution history." I understand that a term is introduced with an indefinite "an" article and subsequently referred to with the definite "the" article. I further understand that extrinsic evidence can be helpful in demonstrating how a term is used in the art, and how the plain meaning is applied in the context of the intrinsic record.

21. I understand that the Patent Office will look to the specification and prosecution history in construing a given claim term. I understand the Patent Office will also sometimes look to other evidence, which I am informed is called "extrinsic" evidence, including dictionary definitions, for how a person of ordinary skill in the art would have understood a claim term.

22. I understand that a patent's "specification" includes all of the figures, discussion, and claims within the patent, including those that are incorporated by reference. I understand that the "prosecution history" includes the statements made to and dialogue with the patent office in the course of obtaining the patent, and that the prosecution history of any parent application can contain relevant information.

B. Obviousness

23. I understand that an issued patent claim is invalid as obvious if it can be shown that the differences between the patented subject matter and the prior art are such that the subject matter as a whole would have been obvious, at the time the invention was made, to a person having ordinary skill in the art. Relevant considerations include the level of ordinary skill in the art; the scope and content of the prior art; differences between the prior art and the claims at issue; and the so called objective indicia, or secondary considerations, of nonobviousness.

24. I understand that in order to evaluate the obviousness of any claim of the '680 Patent over a given prior art combination, I should analyze whether the prior

art references, included collectively in the combination, disclose each and every element of the allegedly invalid claim as those references are read by the person of ordinary skill in the art at the time of the invention. Then I am to determine whether that combination makes the claims of the '948 Patent obvious to the person of ordinary skill in the art by a preponderance of the evidence, at the time of the inventions. I understand that such preponderance of the evidence is satisfied if the proposition is likely to be true than not true.

25. I understand that the obviousness inquiry requires that the prior art be considered in its entirety.

26. I understand that even where all of the claim limitations are expressly disclosed in the prior art references, there must be some showing that a person of ordinary skill in the art would have been motivated to combine such prior art references and that there would have been a reasonable expectation of successfully achieving the claimed invention from such combination.

27. I understand in considering the obviousness of a claimed invention, one should not view the invention and the prior art with the benefit of hindsight. It is for that reason, I understand that obviousness is assessed by the person of ordinary skill in the art at the time the invention was made. In this regard, I am informed and I understand that the invention cannot be used as a guide to selecting and understanding the prior art. I understand that the appropriate standard is to determine

whether a person of skill in the art would be motivated to combine references, not whether they could.

28. I understand that obviousness cannot be predicated on what was unknown at the time of the invention, even if the inherency of a certain feature is later established. I understand that unknown properties of the prior art may not be relied upon to provide the rationale for modifying or combining the prior art to reach the claimed subject matter.

29. 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, or would be led in a direction divergent from the path that was taken by the applicant.

V. OVERVIEW OF THE ’680 PATENT AND ASSERTED ART

A. The ’680 Patent

30. The ’680 Patent discloses an integrated diagnosis and treatment device for patients suffering from sleep apnea and other sleep disorders. ’680 Patent at Abstract. The device monitors a patient’s breathing metrics and the device’s usage data while simultaneously providing a sleep-disorder treatment, such as applying continuous positive airway pressure or a pharmaceutical intervention. *See id.* at Abstract, 12:63-13:4, 35:12-36:2. In a preferred embodiment, the ’680 Patent discloses a positive airway pressure (“PAP”) device with internal airflow sensors

that monitor the patient's airflow. *Id.* at 53:64-54:29. An exemplary embodiment of the PAP device, shown below, includes a pressure generator, a blower, a hose, a mask or nasal cannula, an airflow sensor, and a pressure sensor for measuring breathing metrics (for example, respiratory airflow), and processor(s) for collecting and processing breathing metrics:

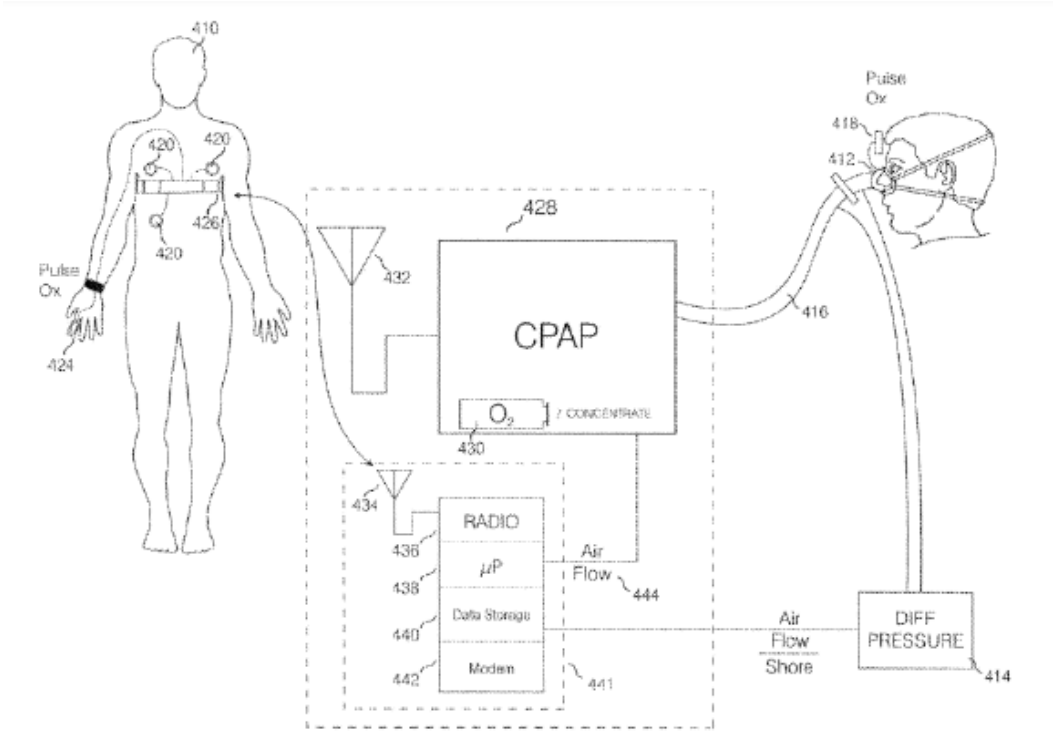


Fig. 8

Id. at FIG. 8. While treatment is ongoing, the PAP device also collects usage data and breathing metrics and passes that data to the processor for calculation of the PAP usage and severity of a patient's sleep disorder symptoms. *Id.* at 53:64-54:29.

31. After the severity and usage data are collected and calculated, that data (and/or the index of treatment efficacy calculated based on that data) is transferred

to a remote internet site and is downloadable on a computer for display. *Id.* at 50:55-60 ("[A] PDA, computer or cell phone, which receives the physiological data transmission, optionally re-processes the information, and re-transmits the information . . . to a remote site for analysis."); *id.* at 50:28-65. That computer may be a PC, PDA, cell phone, or any other suitable computer with a processor and display capabilities. *Id.* at 50:28-65. The calculated index may also be fed back to the PAP device and used to adjust the patient's treatment in real time. *See id.* at 53:64-54:29.

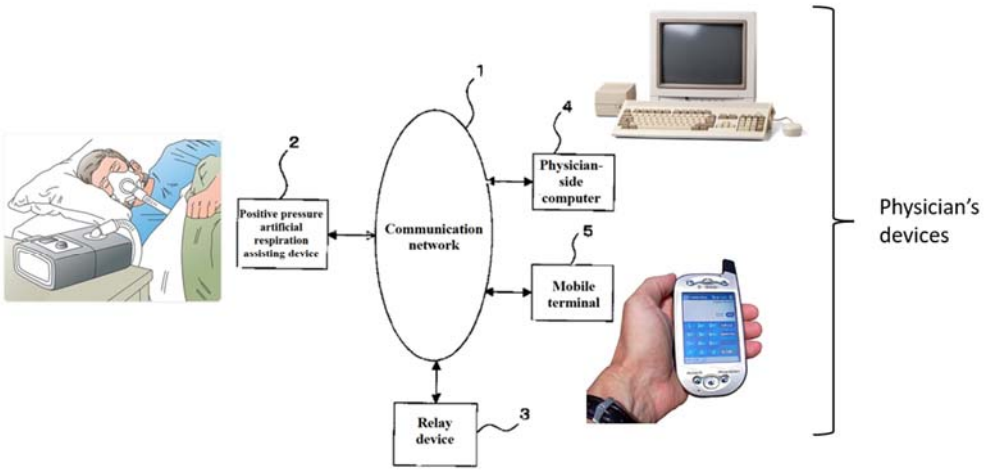
B. Toge

32. Rather than sending data to a "remote internet site," as disclosed and claimed in the '680 Patent, Toge discloses transmitting data directly to physician-side devices to carry out its objective of physicians (or other medical professionals) receiving necessary or crucial treatment data that requires medical intervention. *See, e.g.*, Toge at Abstract, ¶¶ [0039], [0047], [0054].

33. In Toge's system, physicians set threshold values that, when met, trigger the PAP device to push treatment data to the physician-side computer/mobile device so that physicians can take emergency measures. *See id.* at ¶¶ [0039], [0047], [0061]. For example, if a patient's oxygen saturation falls below 90%, the physician-side devices are pushed this "crucial data" from the PAP device (*id.* at ¶ [0054])

where, in turn, the physician can increase the prescription pressure. *See id*. at ¶ [0047].

34. Toge's system includes a PAP device, a relay device (incorporated in the PAP device or at a nurse station), a physician-side computer, and mobile device, as depicted below:



Toge at Fig. 1 (annotated). In Toge's system infrastructure, the PAP device pushes treatment data to physician-side computer and mobile device without any request.

C. Kumar

35. Kumar discloses transmitting data to a web server, which hosts a browser-based engine that manages the transmission of data to client devices. As the figures reproduced below show, treatment data is sent from a patient-side device 102 (blue, below) to its central server 106 (red, below) where the browser-based engine accesses database servers and facilities the transfer to a medical

professional's device once the device has accessed the web page (e.g., TeleVital) and requested the treatment data:

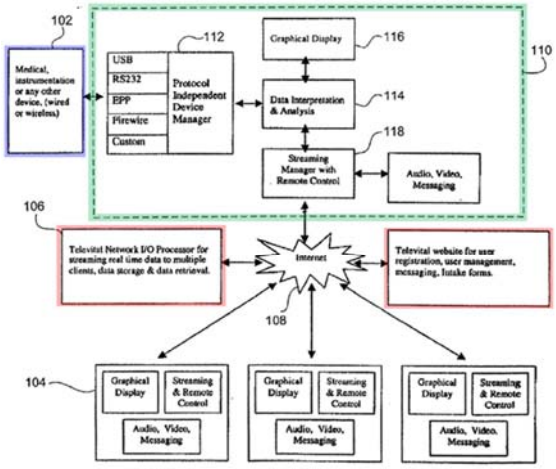


Fig. 1A

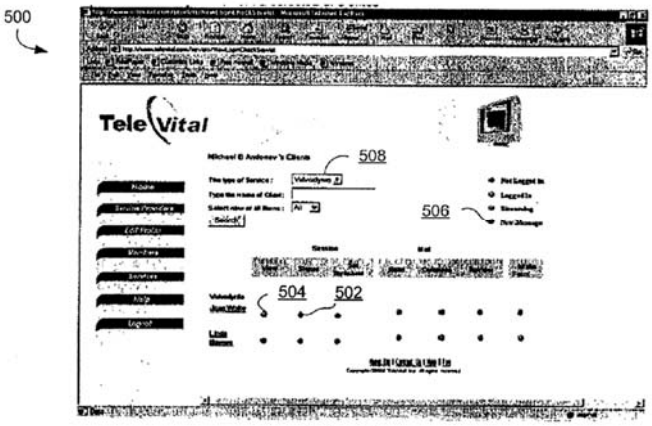


Fig. 5

Pet. at 14 (citing Ex. 1008, FIG. 1A (annotated)); Kumar at FIG. 5; *see also* Kumar at ¶ [0067] ("[T]he system includes one or more patient-side devices 102 for collecting data from a patient/client, one or more provider-side devices 104, and an engine implemented on a central server 106."), ¶¶ [0078]-[0083], [0091]-[0092].

VI. PERSON OF ORDINARY SKILL IN THE ART

36. I understand that the factors to be considered in determining the level of ordinary skill in the art to be: (1) the educational level of active workers in the field, including the named inventors of the patent; (2) the type of problems encountered in the art; (3) prior art solutions to those problems; (4) the rapidity with which innovations are made; and (5) the sophistication of the technology in the art.

I further understand that in a given case, every factor may not be present, and one or more factors may predominate.

37. I understand that CleveMed has adopted Petitioner's proposed definition of a POSITA in 2005, which is a person having "a bachelor's degree in mechanical engineering, electrical engineering, computer science, biomedical engineering, or a similar technical field, with at least two years of relevant product design experience working with diagnostic sensor systems and network data systems, such as networked PAP machines. Additional experience could substitute for less education, and additional education could likewise substitute for less experience." Pet. at 17.

38. Based on my training and experience, I believe that I am a person of at least ordinary skill in the relevant art (as highlighted in the Qualifications section and Appendix A), and have been since at least the earliest priority date of the '680 Patent, which I understand permits me to give an opinion about the qualifications of one of ordinary skill at the time of the invention. In addition, I have taught undergraduate and graduate computer science and engineering students since the mid-1980s.

VII. GROUND 1: IN MY OPINION THE CHALLENGED CLAIMS ARE PATENTABLE OVER TOGE TAKEN ALONE OR IN VIEW OF KUMAR AND BURTON

A. Toge in View of Kumar Does Not Render Obvious a "Remote Internet Site and a Database" That is "Hosted on At Least One Server"

39. It is my opinion that Toge does not disclose a ""remote internet site and database" that is "hosted on at least one server,"[1] and I disagree with Petitioner's argument that the claims are obvious over Toge view of Kumar.

40. In my opinion, Petitioner's argument suffers from the flaw that no POSITA would have modified Toge's physician-side computer to include a web server that hosts patient data for other devices to access. A POSITA was well aware of the risks of such an implementation in terms of data security and system performance, as I discuss below.

41. Yet that is what Petitioner and its experts argue would have been "obvious" in view of Toge with Kumar:

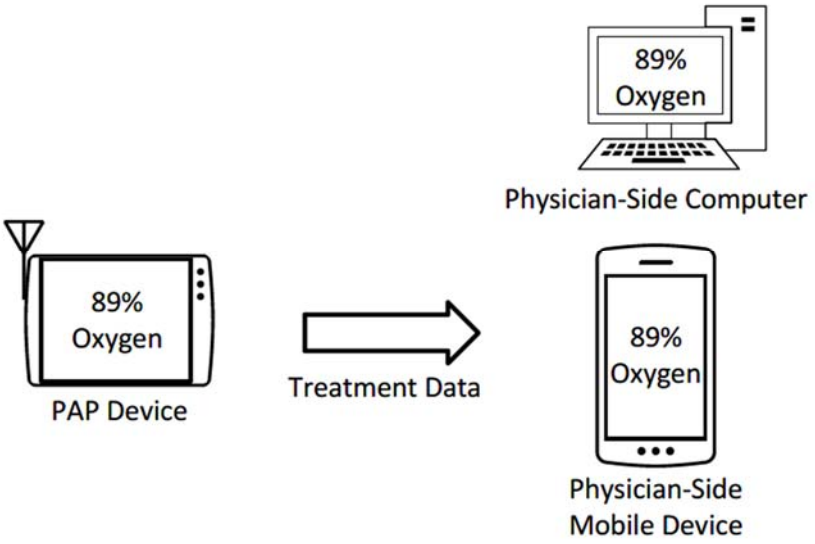
[1] I understand that Petitioner consistently identifies a web server that is accessible via a web page as the alleged "remote internet site." *See* Pet. at 18-19, 22, 26, 29-31, 45-46; Chatterjee at ¶ 66; Ex. 2018 ("Chatterjee Tr.") at 22:20-23:1 (identifying "Apache web server" as web server software that is run on a server).

> [A] POSITA would have improved the physician-side computer of Toge by implementing it with the browser-based engine accessible through web pages as taught by Kumar.

Pet. at 18; *see also* Chatterjee at ¶ 86 ("[m]odifying the physician-side computer to be a web server to allow others to access the data transmitted"), ¶¶ 70, 89.

1. Toge Does Not Expressly or Inherently Disclose a "Remote Internet Site and a Database" That is "Hosted on At Least One Server"

42. Instead of disclosing a "remote internet site," which Petitioner identifies as a web server where data is accessible through a web page request, Toge's system includes a relay device that pushes patient data to the doctor's computer and mobile device without request. *See* n.1, above; Toge at ¶¶ [0050]-[0054]; Ex. 2001 at 25-26 (describing that in a push protocol, the "receiver[] ***passively accept[s]*** whatever the sender[] push[es]to them") (emphasis added). The physician's devices, therefore, automatically receive "necessary" and "crucial" treatment data (e.g., oxygen saturation of 89%) so that they can take emergency measures. *See* Toge at ¶¶ [0019], [0047], [0054]. As reproduced below, is a rendition of Toge's figure 1 where the relay device is incorporated within the PAP device which transfers the treatment data directly to the physician-side devices.



Toge at Fig. 1, ¶¶ [0060]-[0061]. Even in the embodiment where the relay device is separate from the PAP device, this "necessary" or "crucial" treatment data is still pushed to the physician-side devices. Toge at ¶¶ [0016], [0054]; Ex. 2001 at 25.

43. A POSITA would appreciate that there is no "remote internet site" in Toge's system because patient data is pushed to the necessary client devices without traversing any such site. *See* Toge at ¶ [0009]. In fact, changing Toge's system to require client devices to request data from a web server—which uses a pull protocol instead of a push protocol—would have interfered with Toge's ability to push crucial treatment data to the physician-side devices. *See* Ex. 2002 at 2-3 (describing that "HTTP is a pull protocol" as "information can only be pulled from a web server after a client's request")). And, for the reasons that follow, a POSITA would not have

implemented a web server on a client device, as Petitioner's obviousness case demands. *See* Section VII.A.2, below.

2. A POSITA Would Not Have Been Motivated to Make Toge's Physician-Side Computer Into a Web Server in View of Kumar

44. In my opinion, there is no motivation to combine Toge and Kumar in the way envisioned by Drs. Kirkness and Chatterjee, as I explain below. *See, e.g.*, Kirkness Decl. ¶¶ 137-150, Chatterjee Decl. ¶¶ 70-81. That is, a POSITA would not have been motivated to make Toge's physician-side computer into a web server based on Kumar because: (1) Toge's physician-side computer operates as a client device and client and server would not be on the same computer; and (2) implementing the physician-side computer only as a web server, would have interfered with Toge's purpose.

i. A POSITA Would Not Have Implemented a Web Server on Toge's Physician-Side Computer That Operates as a Client Device Because Client and Server Are on Separate Machines in a Client-Server Architecture

45. A POSITA would not have made Toge's physician-side computer, a client device, into a web server because clients and servers are intentionally kept separate in client/server network embodiments because of security and performance reasons. I understand that Petitioner's (and its experts') proposed modification introduces a client/server relationship between client devices that present data to the

user (*i.e.* the physician-side computer and mobile device) and a web server that hosts and transfers data upon HTTP request. *See, e.g.*, Chatterjee at ¶¶ 32-36, 70, 86; Ex. 2020 at 4 (a client device presents the data and a server hosts and transfers the data).

46. This proposed combination, however, violates the principle that "the client and server are not on the same computer." Ex. 2003 at 5 (explaining that the client's "user [] layer" and the server's "database layer" are "located on two different machines"). Specifically, a POSITA would understand that the "user layer" runs on a client machine while the "database layer" runs on a separate server machine. Ex. 2021 at 1 (describing this model as a two-tier "software architecture in which the presentation layer or user interface runs on client machine, and data layer or database [is] stored on a server"); *see also* Ex. 2022 at 4 (similar); Ex. 2023 at 2-3 (explaining that in client-server architecture, the server software "runs on a computer that is separate from the user's device").

47. Separating the user layer and database layer onto different machines is a fundamental security practice for web applications, particularly given web server vulnerabilities. Ex. 2017 at 372-378 (discussing the types of web server vulnerabilities). Because a web server introduces multiple security vulnerabilities, implementing a system as a multiple tier architecture ensures multiple defenses to protect sensitive data from cybersecurity attacks. For example, an attacker who gains a foothold through a client-side application might be able to exploit

vulnerabilities in the operating system to gain administrative control over the entire machine. They can then access, modify, or destroy server data. With colocation, a malicious actor who gains access to the local machine has direct access to both the client and server software and data. *See, e.g.*, Ex. 2026. As another example, a failure of the underlying hardware, operating system, or software on that single machine will cause both the client and server applications to fail simultaneously. This results in total downtime for the application and is a major risk for the patient monitoring. *See, e.g.*, Ex. 2027.

48. Data security is especially critical in medical device applications because such a system contains the patients' personal, sensitive information. *See* Ex. 2028 at 9 ("hacking to cause intentional harm"); Toge at ¶ [0047] (disclosing that the physician-side devices can remotely adjust the PAP therapy). A POSITA, therefore, would not have implemented Toge's physician-side client computer as a web server in the client-server-based application given the security risks involved.

49. Apart from security, a POSITA would also appreciate that performance is also critical for real-time medical systems that need to respond to patient emergencies, such as disclosed in Toge. Toge at ¶¶ [0019], [0039]-[0042], [0044], [0046]-[0047], [0055]-[0057]. For example, a POSITA would understand that implementing multiple services, such as a web server and the client software on the same machine would create contention for the CPU(s), memory, network bandwidth,

and input/output resources on that machine, which would lead to decreased system performance. As shown in a whitepaper discussing "Factors Impacting Scalability," there are "[s]everal factors must be considered when plans to upscale involve increasing the number of concurrent connections to the server" and that "[t]rying to run a database server on a system that is running competing services, such as a web server, Exchange server, domain server, etc., will risk having those other services steal resources (RAM and CPU time) from the database server, denying Superserver even the 2 Gb that it is capable of using or limiting the number of connections to Classic, and slowing down database response time." Ex. 2029 at 1, 3. A POSITA, therefore, also would not have implemented Toge's physician-side client computer as a web server given the performance reductions that would have ensued.

50. In my opinion, Petitioner's experts failed to appreciate these client/server web application issues. Dr. Kirkness testified that such limitations of client/server architecture were outside his field of expertise. Ex. 2019 ("Kirkness Tr.") at 83:6-19 (testifying that he is not a "specific expert in the field" of network architecture and does not know "all of the limitations"). And Dr. Chatterjee merely testified that he believed that his proposed combination would work because "it's not magic." Ex. 2018 ("Chatterjee Tr.") at 13:3-11, 18:15-19:2 (testifying that he only considered "what the combination would look like" because "[i]f you implement it that way, then you can. It's not magic."). These are not motivations

for making major deviations from standard client/server implementation architectures, they are instead apparent hindsight rationalizations for combining various prior art elements into a system that resembles what CleveMed claims.

51. For at least the reasons discussed above, a POSITA would not have been motivated to implement the physician-side client computer as a web server since client and server would not operate on the same machine.

ii. Changing the Physician-Side Computer into Just a Web Server Would Have Interfered with Toge's Purpose

52. A POSITA also would not have changed Toge's physician-side computer into only a web server because it would have interfered with Toge's purpose.

53. The purpose of Toge's system is to push "necessary" or "crucial" data to physician-side devices so that physicians can monitor their patients and take emergency action when needed. *See* Toge at Abstract, ¶¶ [0001]-[0006], [0046], [0047], [0054], [0057]. For instance, Toge explains that by setting a threshold (for example, 90% oxygen saturation), the physician-side devices are pushed "crucial data" when the threshold is met such that physicians "can take emergency measures" (adjusting the pressure of the PAP device, for example). *Id*. at ¶ [0047]; *see also id.* at ¶¶ [0039], [0054] ("[I]t becomes possible to selectively transmit only the

necessary or crucial data to the physician-side computer 4 or portable device 5.”).[2] In this way, physicians can care for their patients who are in critical condition without having to manually log into a web page and make requests for data.

54. Changing Toge’s physician-side computer into a web server that transmits the data upon a client request would also interfere with Toge’s purpose. Particularly, this change introduces a two-tier client/server architecture where the web server stores patient data and sends it to clients in response to client HTTP requests. Pet. at 19 (in the proposed modification, “the physician or provider can access the data” through web pages “as opposed to downloading specialized software”); Chatterjee at ¶ 81; Chatterjee Tr. at 26:11-27:5; Kirkness at ¶ 138; Kirkness Tr. at 98:19-99:4.[3] I have reproduced below the two-tier model of the proposed Toge-Kumar combination:

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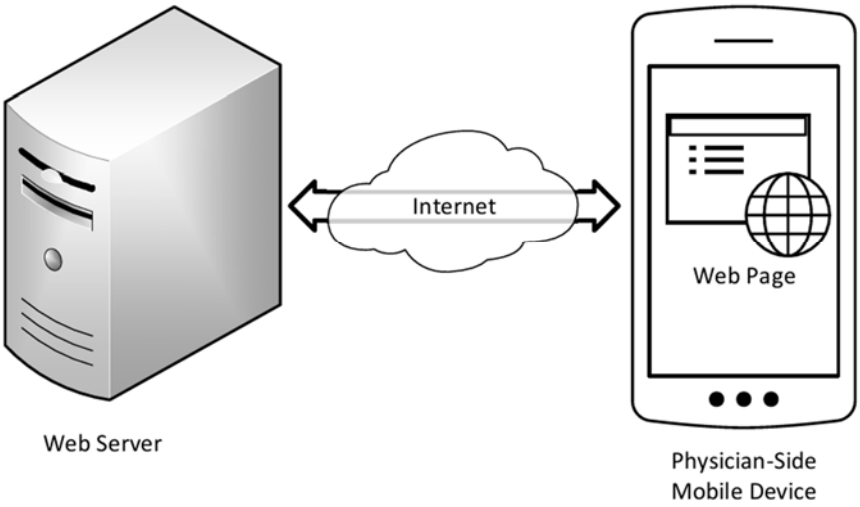
[2] A push protocol is where a “sender can deliver traffic ***at will*** to a receiver” and the “receiver[] ***passively accept*** whatever the sender[] push[es] to them.” Ex. 2001 at 25-26 (emphases added).

[3] In a two-tier architecture, “the **client (tier 1)** is primarily responsible for the presentation of data to the user, and the **server (tier 2)** is primarily responsible for supplying data services to the client.” Ex. 2020 at 4 (emphases added); *see also* Ex. 2025 at 2.



Chatterjee at ¶¶ 32-34 (explaining how a web server stores the Internet's data and provides the data to clients when requested by HTTP), ¶ 86 (modifying the "physician-side computer to be a web server"); Ex. 2021, Ex. 2024 at 2-3. Because data is pulled only upon request, Toge's purpose of pushing, without request, "necessary" or "crucial" (Toge at ¶ [0054]) treatment data would be interfered with. Ex. 2001 at 25-26; Ex. 2002 at 2-3.

55. A POSITA would understand that in Toge's system, urgent patient data is transmitted (*i.e.* pushed) to a physician's device in real-time or almost real-time so as to allow the physician to quickly respond to emergencies, such as when a threshold is met. *See, e.g.*, Toge at [0006], [0016], [0030-31], [0039], [0040], [0041], [0044], [0046], [0047], [0050-54]. However, converting the physician-side computer of Toge into a web server would hamper its ability to push urgent patient data through the physician-side computer 4 to the mobile terminal 5. For example,

at the time of the priority date of the '680 Patent, a POSITA would understand that if a web client were connected to a web server and wished to get updated data, the general method would be for the web client to refresh a web page from the web server. That is, the web client would need to perform a data **pull** action rather than receiving a data push from the web server to receive an update. Of course, requiring a data pull instead of push would reduce the ability of the Toge system to push urgent patient data to a physician's mobile terminal 5 in an emergency. It would not be until after the priority date for the '680 Patent that general web push solutions such as HTTP/2 Server Push[4] and Google Cloud Messaging[5] would be introduced, for instance. For example, in the HTTP/1.1 specification of 1999 (dictating how web servers behave) a web connection could be terminated after a timeout period.[6]

56. In my opinion, Petitioner's purported benefits provide nonexistent motivations and as such do not outweigh the modification's interference. First, Petitioner's "general market trend" benefits (Pet. at 19) are not tied to the specific modification proposed and would not have motivated a POSITA to have made the modification. Second, Petitioner's "convenience and efficiency" benefit (Pet. at 18)

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[4] *See, e.g.*, HTTP/2 Server Push, https://en.wikipedia.org/wiki/HTTP/2_Server_Push.
[5] *See, e.g.*, Google Cloud Messaging, https://en.wikipedia.org/wiki/Google_Cloud_Messaging.
[6] *See, e.g.*, RFC 2616, Hypertext Transfer Protocol -- HTTP/1.1, https://datatracker.ietf.org/doc/html/rfc2616.

is already achieved by Toge's system that allows data to be accessed anywhere. Particularly, Toge's physician-side mobile device allows a physician to "remotely monitor" and "[c]ollect[] data accessible anywhere." *Id*. at 19; Toge at ¶¶ [0018]-[0019], [0061] (disclosing that mobile device 5 is "***mobilized***" to collect treatment data) (emphasis added). Kumar's web server implementation is therefore unnecessary as Toge's system already solves for convenience and efficiency.

57. Third, and finally, Petitioner's "allow[ing] anyone with an Internet browser" benefit (Pet. at 19) would also not have been a motivating factor because of the obstacles a POSITA would have encountered in making the proposed modification. As my above illustration shows, Toge's modification represents a two-tier client/server-based application. A POSITA would appreciate that this architecture model can only "support a relatively small number of users, because the transaction of information is usually low, and security is not necessarily the top priority." Ex. 2030 at 1. Consequently, this model is not suitable for a web application that "allow[s] anyone . . . access" (Pet. at 19) as it would encounter a loss of performance and be exposed to security vulnerabilities. *See, e.g*., Ex. 2031 at 4 (describing that two-tier architecture "results in performance loss whenever the users increase rapidly" and "is less secured"); Ex. 2030 at 1 (describing that two-tier architecture is "not used for applications with large user bases due to their limited flexibility").

58. For at least the reasons I discuss above, a POSITA would not have been motivated to change Toge's physician-side computer into a web server.

B. A POSITA Would Not Have Been Motivated to Add a Patient's Cell Phone that Receives and Displays Treatment Data to Toge's System

59. I understand that Petitioner concedes that Toge does not disclose a patient's cell phone with the downloadable software features recited in Independent Claim 1. I disagree with Petitioner that it would have been obvious to modify Toge with Kumar to reach the claimed invention. Pet. at 30 (citing Kirkness at ¶ 172 ("Toge does not expressly disclose 'a cell phone of a subject(s) receiving treatment' and the features recited in limitations [1.b]-[1.b.iv], a POSITA would have been motivated and found it obvious to implement these features in view of Kumar")).

60. The alleged motivation for the combination adds functionality to Toge's system that it already has, namely features that "would have allowed the patient to view the treatment data." Pet. at 33 (alleging that the "cell phone associated features would have allowed the patient to view the treatment data."). A POSITA would not have solved a problem that Toge does not have. As Petitioner acknowledges, Toge's PAP device includes a display screen that allows a patient to access and review their treatment data. *Id.* (admitting that a PAP device as in Toge includes "a screen suitable for displaying data to the patient"). As such, a cell phone

with downloadable software for receiving and outputting the data for display would be completely unnecessary.

61. I understand that recognizing that its proposal would add unnecessary redundancy to Toge's system, Petitioner and its expert reason that its modification would have allowed for the removal of the PAP display screen to thereby reduce the size of the PAP device. Pet. at 33 (citing Kirkness at ¶ 181 (alleging that with "such a modification . . . the PAP device would not need to include a screen suitable for displaying data to the patient")). I disagree.

62. Cell phone capability in the early 2000s renders nonsensical Petitioner's replacement of the PAP screen with that of a patient's cell phone. In the early 2000s, the majority of cell phones were largely only capable of voice communication and text messaging. At that time, ***only two percent*** of American cell phone subscribers even owned a smartphone that could receive and output data via applications downloaded on the device. Ex. 2033 at 2. The remaining cell phone subscribers had simple cell phones used largely "for voice conversations and sending short 'texts.'" Ex. 2034 at 5; Ex. 2035 at 2-3. Because most patient's would have had cell phones not capable of downloading specialized software for receiving and displaying data, a POSITA would not have been motivated to replace the PAP display screen with a patient's cell phone, as Petitioner urges.

63. It is also my opinion that Petitioner's "Motivation to Combine" section also contradicts Petitioner's assertion that a POSITA would have added a patient's cell phone with downloadable specialized software. Pet. at 33 (for the specific claim limitations, asserting that a POSITA would have added Kumar's "plug-and-play" specialized software to a patient's cell phone in Toge). In that section, Petitioner and its experts assert that a POSITA would have modified Toge's physician-side computer into a web server because it would allow client devices access to data through web pages "***as opposed to downloading specialized software***." *Id.* at 19 (emphasis added); Chatterjee at ¶ 81 (asserting implementing web pages allows "anyone with an Internet-browser to access the data ***without downloading additional software***"); Chatterjee Tr. at 26:19-27:5 (testifying that the combination would "***not requir[e] specific software***."); Kirkness at ¶ 138 (asserting that physicians, providers, and patients "***need not download particular software to access the data***") (emphases added).

64. In my opinion, those assertions belie Petitioner's assertion here that a POSITA would have found it obvious to configure downloadable software on a patient's cell phone to receive and output treatment data from the PAP device. To the contrary, such downloadable software on a patient's cell phone would not part

of a POSITA's modification, as proposed by Petitioner, because the data would be accessed through a web page, which does not require specialized software.[7]

65. In view of the foregoing, a POSITA would not have been motivated to add a patient's cell phone to Toge's system as in the manner required by the Challenged Claims.

VIII. GROUND 2: THE CHALLENGED CLAIMS ARE PATENTABLE OVER TOGE IN VIEW OF KUMAR, BURTON, AND KISNER

66. I understand that Ground 2 challenges only Dependent Claims 10, 15 and 20 and therefore does not resolve any of the issues of Toge in view of Kumar in relation to Independent Claim 1 in Ground 1. Accordingly, it is my opinion that Ground 2 fails for the same reasons Ground 1 fails

IX. CONCLUSION

67. In view of the foregoing, it is my opinion that the '680 Patent is patentable over Toge in view of Kumar.

68. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and

[7] I do not concede that a POSITA would have been motivated to implement Toge's physician-side computer into a web server, I only reference Petitioner's "Motivation to Combine" section to highlight the juxtaposition between Petitioner's two arguments.

that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code.

Executed on the 16th day of September 2025 in Irvine, California.

Dr. Michael T. Goodrich

APPENDIX A

CURRICULUM VITAE
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EDUCATION

Ph.D.	1987	*Efficient Parallel Techniques for Computational Geometry* Computer Science, Purdue Univ. (Mikhail J. Atallah, advisor)
M.S.	1985	Computer Science, Purdue Univ.
B.A.	1983	Mathematics and Computer Science, Calvin Univ.

PROFESSIONAL EXPERIENCE

July '19 to present	Distinguished Professor, Dept. of Computer Science Univ. of California, Irvine
March '10 to present	Technical Director, Center for Algorithms and Theory of Computation Univ. of California, Irvine
April '07 to June '19	Chancellor's Professor, Dept. of Computer Science Univ. of California, Irvine
July '12 to June '13	Chair, Dept. of Computer Science Univ. of California, Irvine
October '06 to June '12	Assoc. Dean for Faculty Dev., Bren School of Info. and Comp. Sci. Univ. of California, Irvine
July '01 to March '07	Professor, Dept. of Computer Science Univ. of California, Irvine
Fall '00	Visiting Professor of Computer Science Brown Univ.
July '96 to June '02	Professor of Computer Science (on leave, from July '01) Johns Hopkins Univ.
July '92 to June '96	Associate Professor of Computer Science Johns Hopkins Univ.
Spring '94	Visiting Associate Professor of Computer Science Univ. of Illinois, Urbana-Champaign
July '87 to June '92	Assistant Professor of Computer Science Johns Hopkins Univ.
Aug. '83 to June '87	Teaching Assistant, Research Assistant Purdue Univ.
Summer '83	Summer intern Argonne National Laboratory

RESEARCH INTERESTS

Algorithm and data structure design
Networking and parallel and distributed computing
Computer security and information assurance and privacy
Machine learning and computer vision
Databases and high-performance data management
Information visualization and graph drawing
Computational geometry and computer graphics

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PRIZES, HONORS, AND AWARDS

- *Compere Loveless Fellowship in Computer Sciences*, Purdue Univ., 1985
- *Research Initiation Award*, National Science Foundation, 1988
- *Oraculum Award for Excellence in Teaching*, Johns Hopkins, 1993, 1994, 1995
- *ACM Recognition of Service Award*, 1996
- *Robert B. Pond, Sr. Award for Excellence in Undergraduate Teaching*, Johns Hopkins, 1998
- *Elected Senior Member*, the Institute of Electrical and Electronics Engineers (IEEE), 1999
- *Spirit of Technology Transition Award*, DARPA Dynamic Coalitions Program, 2002
- *Brown Univ. Award for Technological Innovation* (with Roberto Tamassia, Nikos Triandopoulos, Danfeng Yao, and D. Ellis), 2006
- *ACM Distinguished Scientist*, 2006
- *Edward J. McCluskey Technical Achievement Award*, IEEE Computer Society, "for outstanding contributions to the design of parallel and distributed algorithms for fundamental combinatorial and geometric problems," 2006
- *Fulbright Scholar*, for senior specialist service to University of Aarhus, Denmark, 2007
- *Fellow of the San Diego Supercomputer Center*, 2007
- *Fellow of the American Association for the Advancement of Science (AAAS)*, "for distinguished contributions to parallel and distributed algorithms for combinatorial and geometric problems, and excellence in teaching, academic and professional service, and textbook writing," 2007
- *Named as Chancellor's Professor*, for "demonstrated unusual academic merit and whose continued promise for scholarly achievement is unusually high," Univ. of California, Irvine, 2007
- *Fellow of the Institute of Electrical and Electronics Engineers (IEEE)*, "for contributions to parallel and distributed algorithms for combinatorial and geometric problems," 2009
- *Fellow of the ACM*, "for contributions to data structures and algorithms for combinatorial and geometric problems," 2009
- *ICS Dean's Award for Research*, "for contributions in the area of parallel and distributed algorithms," 2014
- *Chancellor's Award for Excellence in Fostering Undergraduate Research*, Univ. of California, Irvine, 2016
- *Faculty Mentor of the Month*, Undergraduate Research Opportunities Program (UROP), Univ. of California, Irvine, April 2016
- *Elected as a foreign member*, Royal Danish Academy of Sciences and Letters, April 2018
- *Named as Distinguished Professor*, for achieving "the highest levels of scholarship" over the course of a career and having "earned national and international level distinctions and honors of the highest level," Univ. of California, Irvine, 2019
- *Recipient, Alejandro López-Ortiz Best Paper Award*, for "Zip-zip Trees: Making Zip Trees More Balanced, Biased, Compact, or Persistent," 18th Algorithms and Data Structures Symposium, 2023.
- *Recipient, SIGMOD Research Highlight Award*, for "History-Independent Dynamic Partitioning: Operation-Order Privacy in Ordered Data Structures," 2024. This award recognizes research projects that exemplify core database research and that address an important problem, represent a definitive milestone in solving the problem, and have the potential of significant impact.
- *Distinguished Science Alumni Award*, Purdue University, 2025.

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- Total citations: over 18,500
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C-251. Suzanna Caroppo, Giordano Da Lozzo, Giuseppe Di Battista, Michael T. Goodrich, and Martin Nöllenburg, "Quantum Speedups for Polynomial-Time Dynamic Programming Algorithms," *19th Algorithms and Data Structures Symp.* (WADS), 14:1–14:22, 2025.

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C-255. David Eppstein, Michael T. Goodrich, Abraham M. Illickan, and Claire To, "Entropy-Bounded Computational Geometry Made Easier and Sensitive to Sortedness," *37th Canadian Conf. on Computational Geometry* (CCCG), 2025.

C-256. Ofek Gila, Michael T. Goodrich, Zahra Hadizadeh, Daniel S. Hirschberg, Shayan Taherijam, "The Marco Polo Problem: A Combinatorial Approach to Geometric Localization," *37th Canadian Conf. on Computational Geometry* (CCCG), 2025.

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C-258. Gerth S. Brodal, Michael T. Goodrich, John Iacono, Jared Lo, Ulrich Meyer, Victor Pagan, Nodari Sitchinava and Rolf Svenning, "External-Memory Priority Queues with Optimal Insertions," *European Symposium on Algorithms* (ESA), 2025.

C-259. David Eppstein, Michael T. Goodrich, Songyu Liu, "Bandwidth vs BFS Width in Matrix Reordering, Graph Reconstruction, and Graph Drawing," *European Symposium on Algorithms* (ESA), 2025.

C-260. Alvin Chiu, Thomas Depian, David Eppstein, Michael T. Goodrich, and Martin Nöllenburg, "Visualizing Treewidth," *33nd Int. Symp. on Graph Drawing and Network Visualization* (GD), 2025.

C-261. Tarlan Bahadori, Alvin Chiu, Ahmed Eldawy, and Michael T. Goodrich, "SGV: Scalable Geospatial Graph Visualization," *33rd ACM SIGSPATIAL Int. Conf. on Advances in Geographic Information Systems* (SIGSPATIAL), 2025.

C-262. Michael T. Goodrich, Yan Gu, Ryuto Kitagawa, Yihan Sun, "Parallel Joinable B-Trees in the Fork-Join I/O Model," *36th Int. Symp. on Algorithms and Computation* (ISAAC), 2025.

Other Publications:

O-1. Michael T. Goodrich, "Guest Editor's Introduction," *Int. Journal of Computational Geometry & Applications*, **2**(2), 1992, 113–116.

O-2. Michael T. Goodrich, "Parallel Algorithms Column 1: Models of Computation," *SIGACT News*, **24**(4), 1993, 16–21.

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O-4. Roberto Tamassia, Pankaj K. Agarwal, Nancy Amato, Danny Z. Chen, David Dobkin, Robert L. Scot Drysdale, Steven Fortune, Michael T. Goodrich, John Hershberger, Joseph O'Rourke, Franco P. Preparata, Jörg-R. Sack, Subhash Suri, Ionnis G. Tollis, Jeffrey S. Vitter, and Sue Whitesides, "Strategic Directions in Computational Geometry Working Group Report," *ACM Computing Surveys*, **28A**(4), December 1996.

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O-6. Thomas H. Cormen and Michael T. Goodrich, "A Bridging Model for Parallel Computation, Communication, and I/O," *ACM Computing Surveys*, **28A**(4), December 1996.

O-7. Michael T. Goodrich, "Computer Science Issues in the National Virtual Observatory," in *Virtual Observatories of the Future*, ASP Conf. Series, vol. 225, R.J. Brunner, S.G. Djorgovski, and A.S. Szalay, eds., 329–332, 2001.

O-8. Michael T. Goodrich, "Guest Editor's Foreword," *Algorithmica*, **33**(3), 271, 2002.

O-9. Michael T. Goodrich, Michael Shin, Christian D. Straub, and Roberto Tamassia, "Distributed Data Authentication (System Demonstration)," *DARPA Information Survivability Conf. and Exposition*, IEEE Press, Volume 2, 58–59, 2003.

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O-11. Michael T. Goodrich, "Simulating Parallel Algorithms in the MapReduce Framework with Applications to Parallel Computational Geometry," Second Workshop on Massive Data Algorithmics (MASSIVE), 2010. Available as *arXiv* preprint, 1004.4708, 2010.

O-12. David Eppstein, Michael T. Goodrich, and Pierre Baldi, "Privacy-Enhanced Methods for Comparing Compressed DNA Sequences," *arXiv* preprint, 1107.3593, 2011.

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News Releases, Reviews, Interviews, and Media Mentions:

N-1. H. Masum, "Review of *Data Structures and Algorithms in Java* (2nd ed)," *ACM SIGACT News*, **32**(1), 3–5, 2001.

N-2. H. Masum, "Book Review: *Algorithm Design: Foundations, Analysis, and Examples*," *ACM SIGACT News*, **35**(2), 14–16, 2004.

N-3. "Domain Integrity: Brown Licenses Internet ID Verification Technology to Startup Firm," *Brown Univ. News Service*, https://www.brown.edu/Administration/News_Bureau/2005-06/05-031.html, September 20, 2005.

N-4. "Computer scientist elected to Royal Danish Academy of Sciences & Letters," *UCI News*, https://news.uci.edu/2018/04/24/uci-computer-scientist-elected-to-royal-danish-academy-of-sciences-letters/, April 24, 2018.

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N-9. S. Pappas, "Mystery of Orb in a Record-Breaking Leonardo Da Vinci Painting Deepens," *LiveScience*, https://www.livescience.com/da-vinci-light-orb-mystery.html, January 13, 2020.

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PROFESSIONAL SERVICE

Guest Editor:

Int. Journal of Computational Geometry & Applications, **2**(2), 1992
Journal of Computer & System Sciences, **52**(1), 1996
Computational Geometry: Theory and Applications, **12(1–2)**, 1999.
Algorithmica, **33**(3), 2002.

Editorial Board Membership:

Computational Geometry: Theory and Applications, 2006–2015
Journal of Computer & System Sciences, 1994–2011
Journal of Graph Algorithms and Applications, 1996–2011

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Int. Journal of Computational Geometry & Applications, 1993–2010
Information Processing Letters, 1995–1997

Journal Advisory Board Membership:

Int. Journal of Computational Geometry & Applications, 2010–
Journal of Graph Algorithms and Applications, 2011–

Program Committee Service:

7th ACM Symp. on Computational Geometry (SoCG), 1991
1991 Workshop on Algorithms and Data Structures (WADS)
8th ACM Symp. on Computational Geometry (SoCG), 1992
25th ACM Symp. on Theory of Computing (STOC), 1993
Chair, 26th ACM Symp. on Theory of Computing (STOC), 1994
11th ACM Symp. on Computational Geometry (SoCG), 1995
DAGS '95 Conf. on Electronic Publishing and the Information Superhighway
1996 SIAM Discrete Mathematics Conference
1997 Workshop on Algorithms and Data Structures (WADS)
Int. Symp. on Graph Drawing (GD), 1997
1999 Workshop on Algorithms and Data Structures (WADS)
Co-chair, Workshop on Algorithm Engineering and Experimentation (ALENEX), 1999
Int. Symp. on Graph Drawing (GD), 2000
2000 Workshop on Algorithm Engineering (WAE)
41st IEEE Symp. on Foundations of Computer Science (FOCS), 2000
2001 Workshop on Algorithms and Data Structures (WADS)
Int. Symp. on Graph Drawing (GD), 2001
Workshop on Algorithm Engineering and Experimentation (ALENEX), 2002
18th ACM Symp. on Computational Geometry (SoCG), 2002
13th ACM-SIAM Symp. on Discrete Algorithms (SODA), 2002
Co-Chair, Graph Drawing 2002
Int. Symp. on Graph Drawing (GD), 2003
16th ACM-SIAM Symp. on Discrete Algorithms (SODA), 2005
32nd Int. Colloq. on Automata, Languages and Programming (ICALP), 2005
12th Int. Computing and Combinatorics Conference (COCOON), 2006
13th ACM Conf. on Computer and Communication Security (CCS), 2006
15th European Symp. on Algorithms (ESA), 2007
5th Int. Conference on Applied Cryptography and Network Security (ACNS), 2007
21st IEEE Int. Parallel & Distributed Processing Symp. (IPDPS), 2007
19th ACM Symp. on Parallelism in Algorithms and Architectures (SPAA), 2007
5th Workshop on Algorithms and Models for the Web-Graph (WAW), 2007
7th Int. Workshop on Experimental Algorithms (WEA), 2008
Second Int. Frontiers of Algorithmics Workshop (FAW), 2008
16th ACM SIGSPATIAL Int. Symp. on Adv. in Geographic Information Systems (GIS), 2008
17th ACM SIGSPATIAL Int. Symp. on Adv. in Geographic Information Systems (GIS), 2009
31st IEEE Symp. on Security and Privacy (S&P), 2010
18th Int. Symp. on Graph Drawing (GD), 2010
2011 Workshop on Analytic Algorithmics and Combinatorics (ANALCO)
8th Workshop on Algorithms and Models for the Web Graph (WAW), 2011
19th Int. Symp. on Graph Drawing (GD), 2011
24th ACM Symp. on Parallelism in Algorithms and Architectures (SPAA), 2012
20th European Symp. on Algorithms (ESA), 2012
2013 IEEE Int. Conf. on Big Data (BigData), 2013

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30th IEEE Int. Conf. on Data Engineering (ICDE), 2014
21st ACM Conf. on Computer and Communication Security (CCS), 2014
Symp. on Algorithms and Data Structures (WADS), 2015
ACM Cloud Computing Security Workshop (CCSW), 2015
Int. Symp. on Graph Drawing (GD), 2015
co-chair, 2016 Workshop on Algorithm Engineering and Experiments (ALENEX)
2016 Workshop on Massive Data Algorithmics (MASSIVE)
2016 Int. Symp. on Algorithms and Computation (ISAAC)
29th ACM Symp. on Parallelism in Algorithms and Architectures (SPAA), 2017
25th ACM SIGSPATIAL Int. Conf. on Adv. in Geographic Information Systems (GIS), 2017
26th European Symp. on Algorithms (ESA), 2018
26th ACM SIGSPATIAL Int. Conf. on Adv. in Geographic Information Systems (GIS), 2018
2nd SIAM Symp. on Simplicity in Algorithms (SOSA), 2019
ACM SIGSPATIAL Int. Workshop on Spatial Gems, 2019
2021 SIAM Symp. on Applied Computational & Discrete Algorithms (ACDA)
2023 SIAM Symp. on Algorithm Engineering and Experimentation (ALENEX)
35th ACM Symp. on Parallelism in Algorithms and Architectures (SPAA), 2023
7th SIAM Symp. on Simplicity in Algorithms (SOSA), 2024
37th ACM Symp. on Parallelism in Algorithms and Architectures (SPAA), 2025

Conference/Workshop Committee Service:

Conference chair, 12th ACM Symp. on Computational Geometry, 1996
Organizer, 1st CGC Workshop on Computational Geometry, 1996
Co-chair, 1999 Dagstuhl Workshop on Computational Geometry, 1999
Conference chair, Graph Drawing, 2002
Co-organizer, Hawaiian Workshop on Parallel Algorithms, 2017, 2019
Member, Symp. on Theory of Computing (STOC) Test of Time Award Committee, 2024

Steering Committee and Executive Committee Service:

Member at large, ACM SIG on Algorithms & Comp. Theory (SIGACT) Exec. Comm., 1993–97
Member, Exec. comm. for 1996 Federated Computing Research Conference (FCRC)
co-Founder and member, Steering Comm. for Workshop on Algorithm Engineering and Experimentation (ALENEX), 1999–2017 (chair, 2014–16)
co-Chair, Steering Comm. for ACM Symp. on Computational Geometry, 1999–2001
Member, Steering Comm. for Graph Drawing Conference, 2000–03, 2014–16
Conference Chair, ACM SIG on Algorithms & Comp. Theory (SIGACT), 2005–09

Center and Institute Affiliations:

Algorithms, Combinatorics and Optimization Center, UCI
Center for Algorithms and Theory of Computation, UCI
Center for Embedded and Cyber-physical Systems, UCI
Center for Machine Learning and Intelligent Systems, UCI
The Institute for Virtual Environments and Computer Games (IVECG), UCI
Secure Computing & Networking Center, UCI

Postdoctoral Fellows:

1. Timothy Chan, Johns Hopkins, 1996. (Now at Univ. of Illinois)
2. Gill Barequet, Johns Hopkins, 1996-98. (Now at Technion)
3. Pawel Gajer, Johns Hopkins, 2000. (Now at Univ. of Maryland)
4. Amitabh Chaudhary, UC-Irvine, 2002-2004. (Now at U. Chicago)
5. Amitabha Bagchi, UC-Irvine, 2002-2004. (Now at IIT-Dehli)

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6. Martin Nöllenburg, UC-Irvine, 2010, mentored jointly with David Eppstein. (Now at TU Wien)
7. Maarten Löffler, UC-Irvine, 2010-2011, mentored jointly with David Eppstein. (Now at Utrecht University)
8. Md. Jawaherul Alam, UC-Irvine, 2015-16. (Now at Amazon)
9. Giordano Da Lozzo, UC-Irvine, 2016-2017, mentored jointly with David Eppstein. (Now at "Roma Tre" University)

Ph.D. Students:

1. Mujtaba Ghouse, "Randomized Parallel Computational Geometry in Theory and Practice," Johns Hopkins Univ., May 1993.
2. Paul Tanenbaum, "On Geometric Representations of Partially Ordered Sets," Johns Hopkins Univ., May 1995 (co-advised with Edward Scheinerman).
3. Mark Orletsky, "Practical Methods for Geometric Searching Problems with Experimental Validation," Johns Hopkins Univ., May 1996.
4. Kumar Ramaiyer, "Geometric Data Structures and Applications," Johns Hopkins Univ., Aug. 1996.
5. Christian A. Duncan, "Balanced Aspect Ratio Trees," Johns Hopkins Univ., Aug. 1999.
6. Christopher Wagner, "Graph Visualization and Network Routing," Johns Hopkins Univ., Oct. 1999 (co-advised with Prof. Lenore Cowen).
7. Stephen Kobourov, "Algorithms for Drawing Large Graphs," Johns Hopkins Univ., May 2000.
8. Amitabha Bagchi, "Efficient Strategies for Topics in Internet Algorithmics," Johns Hopkins Univ., Oct. 2002.
9. Amitabh Chaudhary, "Applied Spatial Data Structures for Large Data Sets," Johns Hopkins Univ., Oct. 2002.
10. Breno De Medeiros, "New Cryptographic Primitives with Applications to Information Privacy and Corporate Confidentiality," Johns Hopkins Univ., May 2004 (co-advised with Giuseppe Ateniese).
11. "Jeremy" Yu Meng, "Confluent Graph Drawing," UC-Irvine, June 2006.
12. Jonathan Zheng Sun, "Algorithms for Hierarchical Structures, with Applications to Security and Geometry," UC-Irvine, Aug. 2006.
13. Nodari Sitchinava, "Parallel External Memory Model—A Parallel Model for Multi-core Architectures," UC-Irvine, Sep. 2009.
14. Darren Strash, "Algorithms for Sparse Geometric Graphs and Social Networks," UC-Irvine, May 2011 (co-advised with with David Eppstein).
15. Lowell Trott, "Geometric Algorithms for Social Network Analysis," UC-Irvine, May 2013.
16. Joseph Simons, "New Dynamics in Geometric Data Structures," UC-Irvine, May 2014.
17. Pawel Pszona, "Practical Algorithms for Sparse Graphs," UC-Irvine, May 2014.
18. William E. Devanny, "An Assortment of Sorts: Three Modern Variations on the Classic Sorting Problem," UC-Irvine, July 2017 (co-advised with David Eppstein).
19. Siddharth Gupta, "Topological Algorithms for Geographic and Geometric Graphs," UC-Irvine, Aug. 2018 (co-advised with with David Eppstein).
20. Timothy Johnson, "Graph Drawing Representations and Metrics with Applications," UC-Irvine, Aug. 2018.
21. Juan Besa, "Optimization Problems in Directed Graph Visualization," UC-Irvine, Aug. 2019.

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22. Nil Mamano Grande, "New Applications of the Nearest-Neighbor Chain Algorithm," UC-Irvine, Sep. 2019 (co-advised with David Eppstein).
23. Pedro Matias, "Exact Learning of Sequences from Queries and Trackers," UC-Irvine, May 2021
24. Martha Osegueda, "Constructing, Counting and Matching Combinatorial and Geometric Shapes," UC-Irvine, May 2022
25. Ramtin Afshar, "Exact Learning of Graphs Using Queries," UC-Irvine, Feb. 2023
26. Evrim Ozel, "Efficient Algorithms for Road Networks and Noisy Sorting: an Experimental and Theoretical Perspective," UC-Irvine, May 2024

Ph.D. Committee Service:

John Augustine	UC-Irvine	Advancement to candidacy, September 2003
Nikos Triandopoulos	Brown U.	Thesis prelim., February 2004
Einar Mykletun	UC-Irvine	Advancement to candidacy, March 2004
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John Augustine	UC-Irvine	Thesis defense, July 2006
Maithili Narasimha	UC-Irvine	Thesis defense, August, 2006
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Josiah Carlson	UC-Irvine	Thesis defense, December 2007
Michael Nelson	UC-Irvine	Advancement to candidacy, chair, March 2008
Minas Gjoka	UC-Irvine	Advancement to candidacy, June 2008
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Ali Zandi	UC-Irvine	Advancement to candidacy, September 2008
Jihye Kim	UC-Irvine	Thesis defense, September 2008
Darren Strash	UC-Irvine	Advancement to candidacy, December 2008
Kevin Wortman	UC-Irvine	Topic defense, January 2009
Nodari Sitchinava	UC-Irvine	Topic defense, chair, June 2009
Fabio Soldo	UC-Irvine	Advancement to candidacy, July 2009
Emil De Cristofaro	UC-Irvine	Advancement to candidacy, July 2009
Di Ma	UC-Irvine	Thesis defense, August 2009
Yanbin Lu	UC-Irvine	Advancement to candidacy, December 2009
Anh Le	UC-Irvine	Advancement to candidacy, April 2010
Lowell Trott	UC-Irvine	Advancement to candidacy, June 2010
Xiaomin Liu	UC-Irvine	Thesis defense, August 2010
Josh Olsen	UC-Irvine	Advancement to candidacy, September 2010
Yasser Altowim	UC-Irvine	Advancement to candidacy, December 2010
Angela Wong	UC-Irvine	Advancement to candidacy, May 2011

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Joshua Hill	UC-Irvine	Advancement to candidacy, September 2011
Alex Abatzoglou	UC-Irvine	Advancement to candidacy, September 2011
Michael Wolfe	UC-Irvine	Masters Thesis defense, October 2011
Olya Ohrimenko	Brown Univ.	PhD Thesis proposal, October 2011
Yanbin Lu	UC-Irvine	PhD Thesis defense, November 2011
Chun Meng	UC-Irvine	Advancement to candidacy, December 2011
Abinesh Ramakrishnan	UC-Irvine	Advancement to candidacy, March 2012
Pegah Sattari	UC-Irvine	PhD Thesis defense, April 2012
Michael Bannister	UC-Irvine	PhD Thesis defense, May 2015
Yingyi Bu	UC-Irvine	PhD Thesis defense, August 2015
Jenny Lam	UC-Irvine	PhD Thesis defense, November 2015
Timothy Johnson	UC-Irvine	Advancement to candidacy, chair, June 2016
Jiayu Xu	UC-Irvine	Advancement to candidacy, November 2016
Sky Faber	UC-Irvine	PhD Thesis defense, November 2016
Juan Jose Besa Vial	UC-Irvine	Advancement to candidacy, chair, March 2017
William Devanny	UC-Irvine	PhD Thesis defense, co-chair, July 2017
Ingo van Duijn	Aarhus Univ.	PhD Thesis defense, September 2017
Siddharth Gupta	UC-Irvine	Advancement to candidacy, January 2018
Boyang Wei	UC-Irvine	PhD Thesis defense, August 2018
Timothy Johnson	UC-Irvine	PhD Thesis defense, chair, August 2018
Siddharth Gupta	UC-Irvine	PhD Thesis defense, August 2018
Pedro Matias	UC-Irvine	Advancement to candidacy, chair, May 2019
Juan Jose Besa Vial	UC-Irvine	PhD Thesis defense, chair, August 2019
Sameera Chayyur	UC-Irvine	Advancement to candidacy, September 2019
Nil Mamano Grande	UC-Irvine	PhD Thesis defense, co-chair, September 2019
Yihan Sun	CMU	PhD Thesis defense, October 2019
Martha Osegueda	UC-Irvine	Advancement to candidacy, chair, June 2020
Tatiana Bradley	UC-Irvine	PhD Thesis defense, December 2020
Julius Ceasar Aguma	UC-Irvine	Advancement to candidacy, December 2020
Ramtin Afshar	UC-Irvine	Advancement to candidacy, chair, March 2021
Pedro Matias	UC-Irvine	PhD Thesis defense, chair, May 2021
Elham Havvaei	UC-Irvine	PhD Thesis defense, May 2021
Daniel Frishberg	UC-Irvine	Advancement to candidacy, May 2021
Hadi Khodabandeh	UC-Irvine	Advancement to candidacy, July 2021
Sameera Ghayyur	UC-Irvine	PhD topic defense, February 2022
Evrim Ozel	UC-Irvine	Advancement to candidacy, chair, May 2022
Rohith Gangam	UC-Irvine	Advancement to candidacy, May 2022
Martha Osegueda	UC-Irvine	PhD Thesis defense, chair, May 2022
Yanqi Gu	UC-Irvine	Advancement to candidacy, June 2022
Sameera Ghayyur	UC-Irvine	PhD Thesis defense, August 2022
Rasmus K. Petersen	Aarhus Univ.	PhD Thesis defense, Sept. 2022
Zihan Yu	UC-Irvine	Advancement to candidacy, Nov. 2022
Ramtin Afshar	UC-Irvine	PhD Thesis defense, chair, Feb. 2023
Shanshan Han	UC-Irvine	Advancement to candidacy, Feb. 2023
Zhanhang (Marco) Liang	UC-Irvine	Advancement to candidacy, Mar. 2023
Shion Fukuzawa	UC-Irvine	Advancement to candidacy, co-chair, Mar. 2023
Ryuto Kitagawa	UC-Irvine	Advancement to candidacy, chair, May 2024
Ofek Gila	UC-Irvine	Advancement to candidacy, chair, May 2024

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Po-Chu Hsu	UC-Irvine	Advancement to candidacy, May 2024
Yanqi Gu	UC-Irvine	PhD Thesis defense, May 2024
Evrim Ozel	UC-Irvine	PhD Thesis defense, chair, May 2024
Hadi Khodabandeh	UC-Irvine	PhD Thesis defense, June 2024
Alfred (Songyu) Liu	UC-Irvine	Advancement to candidacy, chair, Nov. 2024
Parnian Shahkar	UC-Irvine	Advancement to candidacy, Nov. 2024
Stelios Stavroukakis	UC-Irvine	Advancement to candidacy, Nov. 2024
Zhiqian Zhou	UC-Irvine	Advancement to candidacy, Feb. 2025
Apurva Rai	UC-Irvine	Advancement to candidacy, Mar. 2025
Phillip Nazarian	UC-Irvine	Advancement to candidacy, June 2025

University Service:

Ph.D. Requirements Committee, Dept. of Computer Science, chair: 1987–89
Graduate Admissions Committee, Dept. of Computer Science, 1991–1993 (chair: 1992)
Faculty Recruiting Committee, Dept. of Computer Science, 1993,95,96 (chair: 1996)
Steering Committee, Whiting School of Engineering, 1990–93 (chair, 1993)
Johns Hopkins Homewood Academic Computing Oversight Committee, 1990–93
Curriculum Committee, Whiting School of Engineering, 1994–96
Strategic Planning Committee, Whiting School of Engineering, 1999–00
Graduate Policy Committee, UCI Dept. of Information & Computer Science (ICS), 2001–02
Faculty Search Committee in Cryptography, UCI Dept. of ICS, 2001–03
School of Info. and Computer Science Executive Committee, 2002–04
UCI Committee on Educational Policy (CEP), 2002–03, 2004–06
UCI Change of Major Criteria Committee, 2002–03
UCI CEP Policy Subcommittee, 2002–2003
Distinguished Faculty Search Committee, Bren School of ICS, 2004–11 (chair, 2007–08)
Equity Advisor, Bren School of ICS, 2005–09
Dean's Advisory Council, Bren School of ICS, 2007–13
Associate Dean for Faculty Development, Bren School of ICS, 2006–12
Chair, Department of Computer Science, Bren School of ICS, 2012–13
Master of Computer Science Development Committee, Bren School of ICS, 2013–16
Stragic Planning Committee, Dept. of Computer Science, Bren School of ICS, 2015–16
Executive Committee, Bren School of ICS, 2017–18
UC-Irvine Senate Committee on Scholarly Honors & Awards, 2017–20
UC-Irvine Special Research Program Review Committee for CalIT2, 2018–19
UC-Irvine Year of Scholarly Values Advisory Committee, 2024–
Master of Computer Science Steering/Admissions Comm., Bren School of ICS, 2016–22, 2024–

Courses Taught and Developed:

Advanced Parallel Computing (developed and taught at Johns Hopkins)
Cyber-Puzzlers (designed and taught at UCI)
Computer Literacy (taught at Purdue, developed at Johns Hopkins)
Computer Programming for Scientists and Engineers (taught at Purdue)
Computer Security Algorithms (developed and taught at UCI)
Computational Models (revised and taught at Johns Hopkins)
Computational Geometry (revised and taught at Johns Hopkins and UCI)
Compiler Theory and Design (revised and taught at Johns Hopkins)
Computer Graphics (taught at Johns Hopkins)
Cyber-Fraud Detection and Prevention (designed and taught at UCI)

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Data Structures (revised and taught at Johns Hopkins and UCI)
Graph Algorithms (revised and taught at UCI)
Formal Languages and Automata Theory (revised and taught at UCI)
Fundamentals of Algorithms with Applications (revised and taught at UCI)
Introduction to Algorithms (developed and taught at Johns Hopkins and UCI)
Internet Algorithmics (developed and taught at Johns Hopkins, Brown, and UCI)
Design and Analysis of Algorithms (revised and taught at Johns Hopkins and UCI)
Parallel Algorithms (developed and taught at Johns Hopkins and Univ. of Illinois)
Project in Algorithms and Data Structures (revised and taught at UCI)
Text Processing and Pattern Matching (developed and taught at UCI)

Consulting:

Army Research Laboratory, Fort Belvior, 1995
Battelle Research Triangle, Columbus Division, 1996
AT&T, 1998
Univ. of Miami, 1999
Algomagic Technologies, Inc., 2000–2005
Brown University, 2000–2007
Purdue University, 2002
APAC Security, Inc., 2005
Walt Disney Animation Studios, 2009
Technical expert and expert witness, 2012–
3M, 2015

GRANTS AND CONTRACTS

1. PI, "Research Initiation Award: Parallel and Sequential Computational Geometry," National Science Foundation (NSF Grant CCR-8810568), $32,914, 1988–90.
2. co-PI, "Paradigms for Parallel Algorithm Design," NSF and DARPA (as NSF Grant CCR-8908092), $523,837, 1989–93 (with S. Rao Kosaraju (PI), S. Kasif, and G. Sullivan).
3. PI, "Parallel Computation and Computational Geometry," NSF (Grant CCR-9003299), $67,436, 1990–93.
4. co-PI, "A Facility for Experimental Validation," NSF (Grant CDA-9015667), $1,476,147, 1991–96 (with G. Masson (PI), J.K. Johnstone, S. Kasif, S. Rao Kosaraju, S. Salzberg, S. Smith, G. Sullivan, L. Wolff, and A. Zwarico).
5. PI, "Parallel Network Algorithms for Cell Suppression," The Bureau of the Census (JSA 91-23), $14,998 1991–92.
6. PI, "A Geometric Framework for the Exploration & Analysis of Astrophysical Data," NSF (Grant IRI-9116843), $535,553, 1991–96 (with S. Salzberg and H. Ford (from Physics and Astronomy Dept.)).
7. PI, "Research Experiences for Undergraduates supplement to IRI-9116843," NSF, $4,000, 1993–94 (with S. Salzberg and H. Ford).
8. PI, "Constructing, Maintaining, and Searching Geometric Structures," NSF (Grant CCR-9300079), $134,976, 1993–96.
9. co-PI, "Robust and Applicable Geometric Computing," Army Research Office (ARO MURI Grant DAAH04-96-1-0013), $4,500,000, 1996–2000 (with F. Preparata (PI, Brown U.), Roberto Tamassia (Brown U.), S. Rao Kosaraju, J. Vitter (Duke U.), and P. Agarwal (Duke U.)). Subaward size: $1,466,640.

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10. PI, "Application-Motivated Geometric Algorithm Design," NSF (Grant CCR-9625289), $107,389, 1996-98.
11. co-PI, "vBNS Connectivity for the Johns Hopkins University," NSF, $350,000, 1997–99 (with T.O. Poehler (PI), D.J. Binko, J.G. Neal, and A.S. Szalay).
12. co-PI, "Product Donation, Technology for Education Program," Intel Corporation, $480,071, 1997–2001 (with T.O. Poehler (PI), J.H. Anderson, A.S. Szalay, and M. Robbins).
13. co-PI, "A Networked Computing Environment for the Manipulation & Visualization of Geometric Data" (Research Infrastructure), NSF, $1,638,785, 1997–2003 (with L.B. Wolff (PI), Y. Amir, S.R. Kosaraju, S. Kumar, Roberto Tamassia (Brown U.), R.H. Taylor, and D. Yarowsky).
14. PI, "Geometric Algorithm Design and Implementation," NSF, Grant CCR-9732300, $224,982, 1998–2002.
15. PI, "Certification Management Infrastructure – Certificate Revocation," $52,023, 1998, NSA LUCITE grant.
16. PI, "Software Engineering Data Loading, Analysis, and Reporting," $41,614, 1998, NSA LUCITE grant.
17. PI, "Establishing a LUCITE Collaboration Environment," $10,018, 1998, NSA LUCITE grant.
18. PI, "In Support of a Secure Multilingual Collabortive Computing Environment," $51,471, 1999-2000, NSA LUCITE grant.
19. PI, "Accessing Large Distributed Archives in Astronomy and Particle Physics," $199,981. subcontract to UCI from Johns Hopkins Univ. on NSF Grant PHY-9980044 (total budget, $2,500,000), 1999–2004.
20. PI, "Efficient and Scalable Infrastructure Support for Dynamic Coalitions," $1,495,000, DARPA Grant F30602-00-2-0509, 2000-2003 (with Robert Cohen and Roberto Tamassia), including $227,893 subaward to UCI (with Gene Tsudik).
21. PI, "Graph Visualization and Geometric Algorithm Design," $400,000, NSF Grant CCR-0098068, 2001-2004 (with Roberto Tamssia).
22. PI, "Collaborative Research: Teaching Data Structures to the Millennium Generation," $125,00, NSF Grant DUE-0231467, 2003–2005.
23. PI, "Collaborative Research: An Algorithmic Approach to Cyber-Security," $100,000, NSF Grant CCR-0311720, 2003–2006.
24. PI, "The OptIPuter," $900,000, subcontract from UCSD on NSF ITR grant CCR-0225642 (total budget, $13.5 million), 2002–2007 (with Padhraic Smyth and Kane Kim).
25. PI, "ITR: Algorithms for the Technology of Trust," $300,000, NSF Grant CCR-0312760, 2003–2009.
26. co-PI, "SDCI Data New: Trust Management for Open Collaborative Information Repositories: The CalSWIM Cyberinfrastructure," NSF grant OCI-0724806, $1,103,590, 2007–2012.
27. co-PI, "Support for Machine Learning Techniques for Cyber-Fraud Detection," Experian Corporation, $200,000 gift, 2008.
28. PI, "IPS: Collaborative Research: Privacy Management, Measurement, and Visualization in Distributed Environments," NSF Grant IIS-0713046, $224,851, 2007–2009.
29. PI, "Collaborative Research: Algorithms for Graphs on Surfaces," $400,000, NSF Grant CCR-0830403, 2008–2011.
30. PI, "ROA Supplement: IPS: Collaborative Research: Privacy Management, Measurement, and Visualization in Distributed Environments," NSF Grant IIS-0847968, $25,000, 2008–2009.

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31. co-investigator, "Scalable Methods for the Analysis of Network-Based Data," Office of Naval Research: Multidisciplinary University Research Initiative (MURI) Award, number N00014-08-1-1015, $529,152, 2008–2014.
32. PI, "EAGER: Usable Location Privacy for Mobile Devices," NSF Grant 0953071, $300,000, 2009–2011.
33. PI, "TC:Large:Collaborative Research: Towards Trustworthy Interactions in the Cloud," NSF Grant 1011840, $500,000, 2010-2015.
34. PI, "TWC: Medium: Collaborative: Privacy-Preserving Distributed Storage and Computation," NSF Grant 1228639, $390,738, 2012-2018.
35. PI, "Support for Research on Geometric Motion Planning," 3M Corporation, $40,000 gift, 2014.
36. PI, "A4V: Automated Analysis of Algorithm Attack Vulnerabilities," subcontract 10036982-UCI from University of Utah for DARPA agreement no. AFRL FA8750-15-2-0092, $980,000, 2015–2019.
37. PI, "TWC: Small: Collaborative: Practical Security Protocols via Advanced Data Structures," NSF Grant 1526631, $166,638, 2015–2018.
38. PI, "NSF-BSF: AF: Small: Geometric Realizations and Evolving Data," NSF Grant 1815073, $474,392, 2018–2022.
39. PI, "Collaborative Research: AF: Medium: Algorithms for Geometric Graphs," NSF Grant 2212129, $799,800, 2022–2026.

SELECTED INVITED TALKS

- "Probabilistic Packet Marking for Large-Scale IP Traceback," Purdue Univ., 2003
- "Algorithms for Data Authentication," Harvey Mudd College, 2003
- "Efficient Tree-Based Revocation in Groups of Low-State Devices," Univ. of Arizona, 2004
- "Leap-Frog Packet Linking and Diverse Key Distributions for Improved Integrity in Network Broadcasts," Southern California Security and Cryptography Workshop, 2005
- "Is Your Business Privacy Protected?," NEXT Connections, 2005
- "Distributed Peer-to-peer Data Structures," Harvard Univ., 2006
- "Balancing Life with an Academic Research Career," Grace Hopper Conference, 2006
- "Computer Security in the Large," Univ. Texas, San Antonio, 2006
- "Inspirations in Parallelism and Computational Geometry," Brown Univ., 2006
- "Efficiency and Security Issues for Distributed Data Structures," Computer Science Distinguished Lecture Series, Johns Hopkins Univ., 2006
- "Efficiency and Security Issues for Distributed Data Structures," UCLA, 2006
- "Efficiency and Security Issues for Distributed Data Structures," Edison Distinguished Lecturer Series, Univ. of Notre Dame, 2006
- "Efficiency and Security Issues for Distributed Data Structures," Computer Science Distinguished Lecturer Series, Texas A & M Univ., 2006
- "Algorithms for Secure Computing and Searching with Applications to Medical Informatics," Purdue Univ., 2006
- "Blood on the Computer: How Algorithms for Testing Blood Samples can be Used for DNA Sequencing, Wireless Broadcasting, and Network Security," Univ. of Southern California, 2007
- "Blood on the Computer: How Algorithms for Testing Blood Samples can be Used for DNA Sequencing, Wireless Broadcasting, and Network Security," Univ. California, San Diego, 2007

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- "Blood on the Computer: How Algorithms for Testing Blood Samples can be Used for DNA Sequencing, Wireless Broadcasting, and Network Security," Univ. Minnesota, 2007
- "Blood on the Database: How Algorithms for Testing Blood Samples can be Used for Database Integrity," Invited Keynote, 21st Annual IFIP WG 11.3 Working Conference on Data and Applications Security (DBSec), 2007
- "Space-Efficient Straggler Identification," ALCOM Seminar, Univ. of Aarhus, 2007
- "Blood on the Computer: How Algorithms for Testing Blood Samples can be used in Modern Applications," ALCOM Seminar, Univ. of Aarhus, 2007
- "Studying Road Networks Through an Algorithmic Lens," ALCOM Seminar, Univ. of Aarhus, 2008
- "Studying Geometric Graph Properties of Road Networks Through an Algorithmic Lens," Int. Workshop on Computing: from Theory to Practice, 2009
- "Randomized Shellsort: A Simple Oblivious Sorting Algorithm," Distinguished Lecture Series, Department of Computer Science, Brown University, 2009
- "Simulating Parallel Algorithms in the MapReduce Framework with Applications to Parallel Computational Geometry," MASSIVE 2010
- "Data Cloning Attacks for Nearest-Neighbor Searching based on Retroactive Data Structures," Department of Computer Science, UCSB, 2011
- "Turning Privacy Leaks into Floods: Surreptitious Discovery of Social Network Friendships and Other Sensitve Binary Attribute Vectors," Department of Computer Science Distinguished Lecturer Series, Univ. of Illinois, Chicago, 2011
- "Turning Privacy Leaks into Floods: Surreptitious Discovery of Social Network Friendships and Other Sensitve Binary Attribute Vectors," Department of Computer Science, Purdue Univ., 2011
- "Spin-the-bottle Sort and Annealing Sort: Oblivious Sorting via Round-robin Random Comparisons," Department of Computer Science, Brown Univ., 2012
- "Using Data-Oblivious Algorithms for Private Cloud Storage Access," Qatar University, 2013
- "Using Data-Oblivious Algorithms for Private Cloud Storage Access," Department of Computer Science and Engineering Distinguished Speaker Series, University of Buffalo, 2013
- "Force-Directed Graph Drawing Using Social Gravity and Scaling," invited talk, ICERM Workshop on Stochastic Graph Models, Providence, RI, 2014
- "Invertible Bloom Lookup Tables and Their Applications in Large-Scale Data Analysis," invited key-note speaker, Algorithms for Big Data, Frankfurt, Germany, 2014
- "Invertible Bloom Lookup Tables and Their Applications in Large-Scale Data Analysis," Brown University, Providence, RI, 2014
- "Studying Road Networks Through an Algorithmic Lens," Bold Aspirations Visitor and Lecture, University of Kansas, 2015
- "Learning Character Strings via Mastermind Queries, with Case Studies," Invited Lecture, Workshop on Pattern Matching, Data Structures and Compression, Bar-Ilan University, Tel Aviv, Israel, 2016
- "Invertible Bloom Lookup Tables and Their Applications in Data Analysis," University of Hawaii, 2016
- "Invertible Bloom Lookup Tables," Purdue University, 2016
- "Combinatorial Pair Testing: Distinguishing Workers from Slackers," Calvin Univ., 2016
- "Invertible Bloom Lookup Tables," University of California, Riverside, 2016

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- "2-3 Cuckoo Filters for Faster Triangle Listing and Set Intersection," Technion, Israel Institute of Technology, Haifa, Israel, 2017
- "2-3 Cuckoo Filters for Faster Triangle Listing and Set Intersection," University of Arizona, 2017
- "Parallel Computational Geometry," First Hawaii Workshop on Parallel Algorithms and Data Structures, University of Hawaii, 2017
- "Fighting Gerrymandering with Algorithmic Fairness," Calvin University, 2019
- "Fighting Gerrymandering with Algorithmic Fairness," Carnegie Mellon University, 2019
- "Sorting Evolving Data in Parallel," Second Hawaii Workshop on Parallel Algorithms and Data Structures, University of Hawaii, 2019
- "Dealing with Big Data via External Memory Algorithms and Data Structures," Aarhus University, Denmark, 2021
- "Dealing with Big Data via External Memory Algorithms and Data Structures," Royal Danish Academy of Sciences and Letters, 2021
- "Augmenting Networks for Greedy Routing," Dept. of Electrical and Computer Engineering, Distinguished Lecturer Series, Iowa State University, 2023
- "Augmenting Networks for Greedy Routing," Dept. of Computer Science, University of California, Riverside, 2024
- "Exact Matching Algorithms," Dept. of Computer Science, University of Hawaii, 2024
- "When Algorithms and Architectures Meet," Dept. of Computer Science, Purdue University, 2025
- "Computational Geometry with Probabilistically Noisy Primitive Errors," Schloss Dagstuhl – Leibniz Center for Informatics, Germany, 2025

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TECHNICAL EXPERT CONSULTING SUMMARY
(LAST FIVE YEARS)

Michael T. Goodrich, PhD

Dept. of Computer Science
Bren School of Info. & Computer Sciences
University of California, Irvine
Irvine, CA 92697-3435

http://www.ics.uci.edu/~goodrich/
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TECHNICAL EXPERT CONSULTING

The following is a listing of prior and current expert consulting since 2020, but it may not include confidential information, as per written agreements.

1. Apr. 2016 to Sep. 2024, Technical expert and deponent, retained through Kramer Levin LLP on behalf of Acceleration Bay LLC, in IPR proceedings and patent litigation, Acceleration Bay LLC v. Activision Bizzard, Inc., Electronic Arts Inc., Take-Two Interactive Software, Inc., Rockstar Games, Inc., and 2K Sports, Inc. Civil Actions No. 1:16-cv-00453-RGA, No. 1:16-cv-00454-RGA, No. 1:16-cv-00455-RGA (D. Del.), IPR2015-01951, IPR2015-01953, IPR2015-01964, IPR2015-01970, IPR2015-01972, IPR2015-01996, IPR2016-00724, and IPR2016-00747 (PTAB).

2. May 2016 to Apr. 2023, Technical expert and deponent, retained through Kramer Levin LLP (transferred to Fish & Richardson) on behalf of Finjan, Inc., in PTO proceedings and patent litigations, Finjan, Inc. v. Blue Coat, Finjan, Inc. v. ESET, LLC, Finjan, Inc. v. Juniper Networks, Inc., Finjan, Inc. v. Cisco Systems, Inc., Finjan, Inc. v. Qualys, Inc., Finjan, Inc. v. Rapid7, Inc., and Finjan, Inc. v. SonicWall, Inc., IPR2015-01974, IPR2015-01979, IPR2016-00478, IPR2016-00159 (PTAB), 5:15-cv-03295-BLF-PSG (N.D. Cal.), 3:17-cv-05659-WHA (N.D. Cal.), 3:17-cv-0183-CAB-BGS (S.D. Cal.), 17-cv-0072-BLF-SVK (N.D. Cal.), 4:18-cv-07229-YGR (N.D. Cal.), 1:18cv-01519-MN (Del.), and 5:17-cv-04467-BLF (N.D. Cal.).

3. Jan. 2017 to Jan. 2021, Technical expert and deponent, retained by Fitzpatrick, Cella, Harper & Scinto, Venable LLP, on behalf of Koninklijke Philips N.V. and U.S. Philips Corp., in patent litigation, Philips v. Acer Inc., ASUSTeK Computer, Double Power Tech., HTC, Southern Telecom, Visual Land, Zowee Marketing Co., Ltd., Shenzen Zowee Technology Co., Ltd., YiFang USA, Inc. d/b/a EFun, Inc., and Intervenor/Counterclaim Defendant Microsoft Corporation. Civil Actions No. 15-1125-GMS, No. 15-1126-GMS, No. 15-1127-GMS, No. 15-1128-GMS, No. 15-1130-GMS, No. 15-1131-GMS, No. 15-1170-GMS (D. Del.), and 4:18-cv-01885-HSG (N.D. Cal., Oakland Div.).

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4. Jun. 2018 to present, Technical expert, declarant, deponent, and testifying trial expert witness, retained through Kramer Levin LLP (now HSF Kramer) on behalf of Centripetal Networks, Inc., in IPRs and patent litigation, Centripetal Networks, Inc. v. Keysight Technologies, Inc., Ixia, and Cisco. Civil Actions No. 2:17-cv-00383/HCM-LRL and 2:18-cv-00094-HCM-LRL (E.D. Virginia), 2:22-cv-00002 (E.D. Virginia), IPR2018-01386, IPR2018-01443, IPR2018-01444, IPR2018-01512, IPR2018-01513, IPR2022-01525, IPR2023-00445, IPR2023-00446, IPR2023-00448 (PTAB), and Inv. No. 337-TA-1314 (ITC).

5. Feb. 2019 to present, Technical expert, declarant, deponent, and testifying trial expert witness, retained through Reichman Jorgensen LLP on behalf of Kove IO, Inc., in patent litigation, Kove IO, Inc. v. Amazon Web Services, Inc., Civil Action No. 1:18-cv-08175 (N.D. Illinois, Eastern Div.).

6. Jun. 2019 to Jun. 2023, Technical expert, declarant, and deponent, retained through Kramer Levin LLP on behalf of CUPP Cybersecurity LLC, in patent litigation, CUPP Cybersecurity LLC, et al., v. Trend Micro, Inc. IPR2021-00813, IPR2021-01236, IPR2021-01237 (PTAB), Civil Action no. 3:18-cv-01251-M, 3:20-cv-03206-M (N.D. Texas).

7. Jul. 2020 to Feb. 2021, Technical expert and declarant, retained through Goodwin Procter LLP on behalf of MobileIron, Inc., in patent litigation, MobileIron, Inc. v. BlackBerry Corp. IPR2020-01741 (PTAB).

8. Aug. 2020 to present, Technical expert and declarant, retained through Thompson & Knight LLP (now Holland & Knight) on behalf of Broadcom Corp., in patent litigation, Broadcom Corp. and Avago Technologies International Sales PTE. Limited v. Netflix, Inc. Civil actions no. 8:20-cv-529 (C.D. Cal.), 3:20-cv-04677-JD (N.D. Cal.).

9. Nov. 2020 to Dec. 2021, Technical expert and deponent, retained through Kramer Levin LLP on behalf of Midwest Athletics and Sports Alliance LLC (MASA), in patent litigation, Midwest Athletics and Sports Alliance LLC v. RICOH USA, Inc., and Midwest Athletics and Sports Alliance LLC v. Xerox Corp. Civil Action Nos. 19-CV-00514 (E.D. Penn.) and 6:19-CV-06036-EAW-JFW (W.D. New York).

10. Mar. 2021 to Feb. 2024, Technical expert, declarant, and deponent, retained through Nix Patterson LLP on behalf of Ikorongo Technology LLC, in patent litigation, Ikorongo v. Samsung, LG, Lyft, Uber, and Bumble Trading, Civil Action Nos. 6:20-cv-00256-ADA, 6:20-cv-00257-ADA, 6:20-cv-00258-ADA, 6:20-cv-00259-ADA, 6:20-cv-00843-ADA (W.D. Texas, Waco), and IPR2021-00204 (PTAB).

11. May 2021 to Aug. 2024, Technical expert, declarant, and deponent, retained by McKool Smith on behalf of SEVEN Networks LLC in patent litigation, SEVEN Networks, LLC v. Motorola Mobility LLC. Civil Action Nos. 2:21-cv-88 (E.D. Texas) and 3:21-cv-1036 (N.D. Texas).

12. Aug. 2021 to present, Technical expert, declarant, and deponent, retained through Holland & Knight LLP on behalf of CA, Inc., in patent litigation, CA, Inc. and Avago Technologies International Sales PTE. Limited v. Netflix, Inc. Civil action no. 2:21-cv-00080-JRG-RSP (E.D. Texas).

13. Aug. 2021 to present, Technical expert, declarant, deponent, and testifying trial expert witness, retained through Kramer Levin LLP (now HSF Kramer) on behalf of Centripetal Networks, Inc., in patent litigation and IPRs, Centripetal Networks, Inc. v. Palo Alto Networks,

Inc. Civil Action No. 2:21-cv-00137 (E.D. Virginia, Norfolk Div.), IPR2021-01149, IPR2021-01150, IPR2021-01152, IPR2021-01157, IPR2022-00182 (PTAB).

14. Jul. 2022 to May 2024, Technical expert, deponant, and declarant, retained through McKool Smith on behalf of the State of Texas, in litigation State of Texas v. Meta Platforms, Inc., Cause No. 22-0121.

15. Aug. 2022 to present, Technical expert and declarant, retained through Stamoulis & Weinblatt LLC on behalf of Ameranth, Inc., in a patent-related matter.

16. Sep. 2022 to present, Technical expert, deponent, and declarant, retained through Reichman Jorgensen Lehman & Feldberg LLP on behalf of VideoLabs, Inc., in patent-related matters, VideoLabs v. Netflix, and Starz Entertainment, LLC, et al. v. VL Collective IP, LLC and VideoLabs, Inc., Civil Action No. 21-cv-1448-JLH (D. Del.), IPR2022-01086, IPR2023-00628, IPR2023-00630, IPR2023-00891.

17. Nov. 2022 to Jun. 2023, Technical expert and declarant, retained through McKool Smith on behalf of American Airlines, Inc., in a patent-related litigation, R2 Solutions LLC v. American Airlines, Inc., Civil Action No.4:22-cv-00353 (E.D. Tex.).

18. Feb. 2023 to Nov. 2023, Technical expert and declarant, retained through Kirkland and Ellis LLP on behalf of Forcepoint LLC in a patent-related litigation, Webroot, Inc. et al. v. Forcepoint LLC, Case No. 6:22-cv-00341-ADA (W.D. Tex.).

19. Feb. 2023 to Dec. 2023, Technical expert and declarant, retained through Holland & Knight LLP on behalf of MDSave Shared Services, Inc., in a patent-related litigation.

20. Aug. 2023 to Sep. 2024, Technical expert, declarant, and deponent, retained though Kramer Levin LLP on behalf of Acceleration Bay LLC in patent-related litigation, Acceleration Bay LLC v. Amazon Web Services, Inc., Case No. 1:22-cv-904 (D. Del.).

21. Feb. 2024 to May 2024, Technical expert and declarant, retained through McKool Smith on behalf of AlphaSense, Inc., in patent litigation, AlphaSense, Oy and AlphaSense, Inc. v. Tegus, Inc. and Bamsec, LLC, Case No. cv-23-1030-MN (D. Del.).

22. Mar. 2024 to present, Technical expert, retained through Holland & Knight LLP on behalf of Cellular South, Inc., d/b/a C Spire, Inc. in patent-related litigation.

23. May 2024 to Jan. 2025, Technical expert and declarant, retained through Reichman Jorgensen Lehman & Feldberg LLP on behalf of Kove IO, Inc., in patent litigation, Kove IO, Inc. v. Google, LLC, No. 1:23-cv-04244 (N.D. Ill.).

24. May 2024 to present, Technical expert, retained through Reichman Jorgensen Lehman & Feldberg LLP on behalf of Malikie Innovations Limited and Key Patent Innovations Limited, in patent litigation.

25. July 2024 to present, Technical expert, declarant, and deponent, retained through McKool Smith on behalf of Carbyne Biometrics, LLC, in patent litigation, Apple, Inc., Petitioner v. Carbyne Biometrics, LLC, Patent Owner in Case: (1) IPR2024-00329, U.S. Patent No. 9,972,010; (2) IPR2024-00330, U.S. Patent No. 10,713,656; (3) IPR2024-00331, U.S. Patent No. 11,526,886; (4) IPR2024-00332, U.S. Patent No. 10,929,512; (5) IPR2024-00333, U.S. Patent No. 11,475,105; (6) IPR2024-00334, U.S. Patent No. 11,514,138; and (7) IPR2024-00507, U.S. Patent No. 11,475,105.

26. Oct. 2024 to present, Technical expert, declarant, and deponent, retained through Kramer Levin LLP (now HSF Kramer) on behalf of Cyandia, Inc., in patent litigation Cyandia, Inc. v. SAP America, Inc., and SAP SE, Case No. 2:22-cv-00096-JRG.

27. Nov. 2024 to present, Technical expert and declarant, Kramer Levin LLP (now HSF Kramer) on behalf of NTECH Properties, Inc. in patent litigation NTECH Properties, Inc. in v. ByteDance LTD., ByteDance PTE. LTD, TikTok PTE. LTD., and TikTok Inc., Case No. 2:24-cv-00130-JRG and IPR2024-01340, IPR2024-01341, IPR2024-01342, and IPR2024-01343.

28. Dec. 2024 to present, Technical expert, retained through Kramer Levin LLP (now HSF Kramer) and Noerr Partnerschaftsgesellschaft mbB on behalf of Centripetal Networks, Inc., in UPC proceedings between Centripetal and Keysight Technologies, Inc. at Mannheim Local Division, case no. 414/2024.

29. Dec. 2024 to present, Technical expert, retained through McKool Smith on behalf of American Airlines, Inc., in patent-related litigation, Intellectual Ventures I LLC et al. v. American Airlines, Inc., No. 4:24-cv-980 (E.D. Tex.).

30. Apr. 2025 to present, Technical expert, retained through Reichman Jorgensen on behalf of Corent Technology, Inc., in patent-related litigation.

31. Apr. 2025 to present, Technical expert, retained through Reichman Jorgensen on behalf of Xtone, Inc., in patent-related litigation, Xtone, Inc. v. Amazon.com, Inc., Amazon Web Services, Inc. and Amazon.com Services, LLC.

32. Apr. 2025 to present, Technical expert, retained through McKool Smith on behalf of AT&T Corp., in patent-related litigation, Headwater Research, LLC v. AT&T Corp. *et al.*, Case No. 2:25-cv-00215.

33. May 2025 to Aug. 2025, Technical expert, retained through Reichman Jorgensen Lehman & Feldberg LLP on behalf of VideoLabs, Inc., in patent-related matters, VideoLabs v. Meta Platforms, Inc., et al., Civil Action No. 22-cv-00680 (D. Del.).

34. May 2025 to present, Technical expert, declarant, and deponent, retained through Reichman Jorgensen Lehman & Feldberg LLP on behalf of CardWare, Inc., in patent-related matters, CardWare Inc. v. Apple Inc., WDTX-1-25-cv-00446-ADA, CardWare Inc. v. Google LLC, WDTX-7-24-cv-00278 (W.D. Tex.).

35. June 2025 to present, Technical expert, retained through Reichman Jorgensen Lehman & Feldberg LLP on behalf of Droplets, Inc., in patent-related matters, Droplets, Inc. v. Ford Motor Company, 2:24-cv-00968 (E.D. Tex.); Droplets, Inc. v. Walmart Inc., 2:24-cv-00970 (E.D. Tex.); Droplets, Inc. v. The Home Depot, Inc. et al., 2:24-cv-00969 (E.D. Tex.).

36. July 2025 to present, Technical expert, retained through Reichman Jorgensen Lehman & Feldberg LLP on behalf of Primos Storage, LLC, in patent-related matters, Primos Storage v. Amazon Litigation.

37. July 2025 to present, Technical expert, retained through McKool Smith on behalf of NovaCloud Licensing LLC, in patent-related litigation, NovaCloud v. Meta.

38. July 2025 to present, Technical expert, retained through HSF Kramer on behalf Cleveland Medical Devices, Inc., in patent-related litigation, IPR2025-00157-160, IPR2025-00246-247.