

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

UNIFIED PATENTS, LLC,

Petitioner

v.

VL COLLECTIVE IP LLC,

Patent Owner

IPR2022-01086
U.S. Patent 8,605,794

DECLARATION OF DR. MICHAEL T. GOODRICH

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I, Dr. Michael T. Goodrich, hereby declare as follows:

I. INTRODUCTION

1. I have been asked by Patent Owner VL Collective IP LLC (“Patent Owner”) to offer my expert opinions in the above-captioned matter. In particular, I have been asked to provide analysis related to how the person of ordinary skill in the art would understand a certain term in the claims of U.S. Patent No. 8,605,794 (“the ’794 patent”). I have also been asked to analyze the anticipation and obviousness analysis based on U.S. Patent No. 5,627,656 (“Sonohara”) that is set forth in Petitioner Unified Patents’ (“Petitioner”) petition for *inter partes* review of the ’794 patent (“Petition”) and the supporting declaration of Dr. Immanuel Freedman.

II. MATERIALS CONSIDERED

2. In providing my expert opinions in this matter, I have reviewed the Petition, the ’794 patent, the file history for the ’794 patent, Sonohara, Dr. Freedman’s declaration, the transcript for the deposition of Dr. Freedman, U.S. Patent No. 7,428,696 (“Shin”), U.S. Patent No. 5,598,352 (“Rosenau”), and any materials cited or referenced herein.

III. BACKGROUND AND QUALIFICATIONS

3. Attached hereto as Appendix A is a true and correct copy of my Curriculum Vitae (“CV”). I received a Bachelor of Arts degree in Mathematics and Computer Science from Calvin University in 1983, a Master of Science in Computer

Science from Purdue University in 1985, and a Ph.D. in Computer Science from Purdue University in 1987.

4. 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 at University of California, Irvine is a campus-level distinction reserved for above-scale faculty who have achieved the highest levels of scholarship over the course of their careers and have earned national and international distinctions and honors of the highest level. I was a professor in the Department of Computer Science at Johns Hopkins University from 1987-2001.

5. I have authored and coauthored over 350 publications, including several widely adopted books, such as *Introduction to Computer Security* and *Algorithm Design and Applications*. My research includes contributions to data structures and algorithms, information security and privacy, networking, graph algorithms, computational geometry, distributed and parallel algorithms, and cloud security. For example, I have published research articles on topics in cloud computing and storage, hashing, data structures, and network and distributed computing. Using the indexing scheme of my CV, examples of such publications include P-3, P-5, B-1, B-3 through B-14, Ch-4, Ch-7, Ch-8, Ch-10, Ch-12, J-7, J-26, J-36, J-38, J-41, J-45, J-56, J-60, J-69, J-72, J-78, J-83, J-84, C-41, C-43, C-51, C-53, C-62, C-63, C-64, C-72, C-77, C-78, C-85, C-104, C-105, C-107, C-111, C-122,

C-125, C-133, C-147, C-151, C-152, C-153, C-155, C-156, C-159, C-161, C-162, C-163, C-165, C-167, C-168, C-171, C-172, C-174, C-180, C-182, C-193, C-199, C-200, C-202, C-207, C-209, and C-210. Further, I have published research articles on topics in audio and video creation, encoding, and distribution, as well as authoring research videos, including publications P-5, B-14, J-20, J-37, J-65, J-66, J-68, J-72, C-36, C-38, C-54, C-64, C-74, C-112, C-120, C-123, and C-159.

6. In addition, I have consulting experience in matters involving algorithms, cryptography, machine learning, digital rights management, computer security, networking, software, video distribution, and storage technologies.

7. I am a Fellow of the American Association for the Advancement of Science (AAAS), a Fulbright Scholar, a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), and a Fellow of the Association for Computing Machinery (ACM). I am a foreign member of the Royal Danish Academy of Science and Letters. I am also a recipient of the IEEE Computer Society Technical Achievement Award and the Pond Award for Excellence in Undergraduate Teaching.

8. My research has been supported by the Defense Advanced Research Projects Agency (DARPA), the National Science Foundation (NSF), the Office of Naval Research (ONR), the Army Research Office (ARO), and the National Security Agency (NSA). For example, I was co-principle investigator on an approximately

\$700K NSF grant funding (grants 6 and 19 in my CV) to build distributed data repositories and network query infrastructures for astrophysical data; a \$350K NSF grant to build out network connectivity and applications at Johns Hopkins University (CV, grant 11); a \$900K grant from NSF to study high-bandwidth distributed computing (CV, grant 24); an approximately \$500K grant from the ONR to study scalable methods for the analysis of network-based data (CV, grant 31); a \$500K grant from NSF to study trustworthy cloud computing (CV, grant 33); an approximately \$400K NSF grant to study privacy-preserving cloud computing (CV, grant 34); and an approximately \$150K grant from NSF to study security protocols for advanced data structures (CV, grant 37).

9. 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 based on cryptographic hash functions and digital signatures; 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; U.S. Patent No. 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, with applications to animated video creation; and 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 cryptographically verifiable search results that can be produced by a search engine.

10. 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, networking, algorithm engineering, computational geometry, computer graphics, and parallel processing. In addition, I have mentored 25 Ph.D. students over the years, who have written their Ph.D. theses on topics in algorithms, data structures, networking, parallel processing, and computer security and privacy.

11. 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, including 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 co-founded 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).

IV. LEGAL PRINCIPLES APPLIED IN THIS DECLARATION

12. Counsel for Patent Owner has informed me of the legal principles that apply for purposes of my declaration.

A. CLAIM CONSTRUCTION

13. I understand that the words of a claim are generally given their ordinary and customary meaning, which I understand is the meaning that the term would have to the person of ordinary skill in the art in question at the time of the invention. I understand that the person of ordinary skill in the art is deemed to read the claim

term not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the specification.

14. I understand that claim construction focuses on the “intrinsic evidence,” which consists of the claims themselves, the specification, and the prosecution history. I understand that the claims can provide helpful context for how the claim term is used. I understand that the specification is highly relevant to the claim construction analysis and usually dispositive concerning the meaning of a claim term. I further understand, however, that it is inappropriate to import limitations from preferred embodiments recited in the specification into the claim language.

15. I understand that “extrinsic evidence” may also be considered when determining the meaning of a claim. I understand that there are different sources of extrinsic evidence, including dictionaries, inventor testimony, expert testimony, and learned treatises. I understand that intrinsic evidence is generally favored over extrinsic evidence, and that extrinsic evidence may not be used to contradict the meaning of the claim term when read in light of the intrinsic evidence.

B. Patentability

16. While I am not an attorney, I have been informed that a patent is presumed valid, and that each claim of a patent (whether an independent or dependent claim) is presumed valid independently of the validity of other claims. I understand that the Patent Office will find a patent claim unpatentable in an *inter*

partes review if it concludes that it is more likely than not that the claim is unpatentable.

17. I understand that during an *inter partes* review proceeding, the standard for finding claims of an issued U.S. patent unpatentable is the “preponderance of the evidence standard.”

18. I understand that issues of patentability relating to the claims of the ’794 patent challenged in the Petition are to be considered under the relevant pre-AIA sections of Title 35 of the United States Code. I have been provided an understanding of those sections as noted below.

1. Anticipation

19. I understand for a claim to be unpatentable as anticipated under 35 U.S.C. § 102, every element and limitation of the claimed invention must be found in a single prior art reference, but also it must describe those elements arranged or combined as required in the claim. Although anticipation can be based on inherency, the missing disclosure must be necessarily present, not merely probably or possibly present, in the prior art.

2. Obviousness

20. I understand for a claim to be unpatentable as obvious under 35 U.S.C. § 103, the differences between the claimed invention and the prior art must be such that the claimed invention as a whole would have been obvious before the effective

filing date of the claimed invention to a person of ordinary skill in the art to which the claimed invention pertains.

21. I understand that in considering whether a claimed invention is obvious, one may consider whether there was a reason that would have prompted a person having ordinary skill in the art to which the claim invention pertains to combine known elements in a way the claimed invention does, taking into account such factors as: (1) whether the claimed invention was merely the predictable result of combining familiar prior art elements according to their known function(s); (2) whether the prior teaches or suggests the desirability of combining elements claimed in the invention; (3) whether prior art teaches away from combining elements in the claimed invention; and (4) whether a person having ordinary skill in the art had used a known technique to improve similar devices in the same way. I am informed that it is not sufficient to merely assert that it was obvious to try a combination of prior art elements in hindsight; knowledge of a problem and motivation to solve it are entirely different from a motivation to combine particular references.

22. I am informed that objective factors tending to show that a patent is not obvious include, among others: (1) evidence of copying the claimed invention(s); (2) long-felt but unmet need for the claimed invention(s); (3) commercial success of the claimed invention(s); (4) skepticism as to the solution; (5) industry acceptance of the claimed invention(s); and (6) praise by others for the claimed invention(s). I

understand all these factors may bear on whether a patent holder can overcome an initial impression of obviousness, subject to the requirement that the patent holder establish a nexus—in other words, a direct connection or link—between the adduced evidence and claimed invention's merits.

23. I understand that obviousness cannot be predicated on the mere identification in the prior art of individual components of claimed limitations. It is not appropriate to pick and choose among the individual elements of assorted prior art references to recreate the claimed invention. It is also not enough to show that the prior art references can be combined (i.e., are combinable). Rather, to prove obviousness, there must have been sufficient motivation at the time of the invention for a person of ordinary skill in the art to combine or modify the references in the manner proposed to arrive at the claimed invention. I also understand that motivation may not be gleaned from impermissible hindsight reasoning. For example, the reason to combine the prior art to arrive at the claimed invention cannot be based in whole or in part on what the patent in question teaches or discloses. I understand that the inquiry into secondary considerations is one way to test hindsight analysis.

24. I understand that it is Petitioner's burden to prove that a person of ordinary skill in the art would have been motivated to combine prior art references. I understand that the motivation to combine must be supported by evidence and

articulated explanation. When considering obviousness, I understand that it is insufficient to simply say that a skilled artisan, once presented with a combination of references, would have understood that they could be combined.

25. Rather, Petitioner must show that a person of ordinary skill in the art would have been motivated to combine or modify the prior art to arrive at the claimed invention. Conclusory statements alone are insufficient, and any obviousness analysis must be supported by a reasoned explanation as to why a person of ordinary skill in the art would have been motivated to combine the prior art. For example, “common sense” or “intuition” alone cannot support a motivation to combine without explaining why they would lead a person of ordinary skill in the art to solve the problem at hand with the particular elements of the claimed invention at the time of invention.

26. I understand that there is no motivation to combine references when a feature from one reference would be redundant or superfluous in the other reference. I further understand that obviousness cannot be found in an absence of a specific explanation as to why a particular combination is not redundant.

27. I understand that there is no motivation to combine when the combination would be inoperable and, thus, “teaches away” from the combination. To the extent that references teach away from the claimed invention, they cannot establish obviousness. Prior art teaches away from an invention when a person of

ordinary skill would be discouraged or diverted from following the path leading to the invention. I also understand that if a proposed combination would require modification of prior art and that modification would render the prior art unsatisfactory for its intended purpose, then there is no motivation to make the proposed combination and modification. I also understand that when prior art teaches away from combining prior art references, the discovery of a successful way to combine them is unlikely to be obvious.

28. I understand that to determine the scope and content of the prior art, one must consider whether the prior art was reasonably relevant to the particular problem the inventors faced in making the claimed invention.

29. To determine whether any material differences existed between the scope and content of the prior art and each asserted claim, one must consider the claimed invention as a whole to determine whether or not the claim would have been obvious in light of the prior art. If the prior art discloses all the elements in separate references, I must consider whether it would have been obvious to combine those references. I understand that a claim is not obvious just because all elements of a claim already existed.

30. I understand that a motivation to conduct further testing or research that may lead to the claimed invention does not necessarily render a claim obvious. I further understand that an invention is not necessarily rendered obvious simply

because a party asserts it was obvious to try a certain combination. Rather, the question is whether a person of ordinary skill would have had good reason to pursue the known options within his or her technical grasp, and whether such pursuit would have led to anticipated success. I understand that an invention would not have been obvious to try to a person of ordinary skill in the art if any of those findings cannot be made.

3. Prior Art

31. I understand that a product, patent, or other publication must first qualify as prior art before it can be used to challenge a patent claim. I further understand that in an *inter partes* review, petitions may only challenge the patentability of a claim on grounds that could be raised under § 102 or § 103 and only on the basis of prior art consisting of patents or printed publications.

32. For the purposes of this Declaration, I generally understand that prior art is the body of knowledge publicly available to a person skilled in the particular art or field of the invention at the time the invention was made or one year prior to the filing of the patent application for the asserted patent.

33. More particularly, I have been informed that prior art is defined as any reference that satisfies any of the pre-AIA § 102 subsections (a), (b), (e) and (g). I understand that Petitioner's grounds for petition pertain only to subsections (b) and (e).

34. Prior art under pre-AIA § 102 (b) includes an invention that was: (a) patented, or (b) described in a printed publication anywhere in the world, or (c) in public use in the United States, or (d) on sale in the United States more than one year before the application filing date to which the applicant is entitled to claim priority in the United States. For this purpose, the applicant is entitled to claim the benefit of the filing date of its earliest provisional or non-provisional application for which the disclosure of the application provides support for the claims at issue.

35. Prior art under pre-AIA § 102 (e) includes (1) published application for patent by another filed in the United States before the invention by the applicant for patent, or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent.

V. BACKGROUND

A. Overview of the '794 Patent

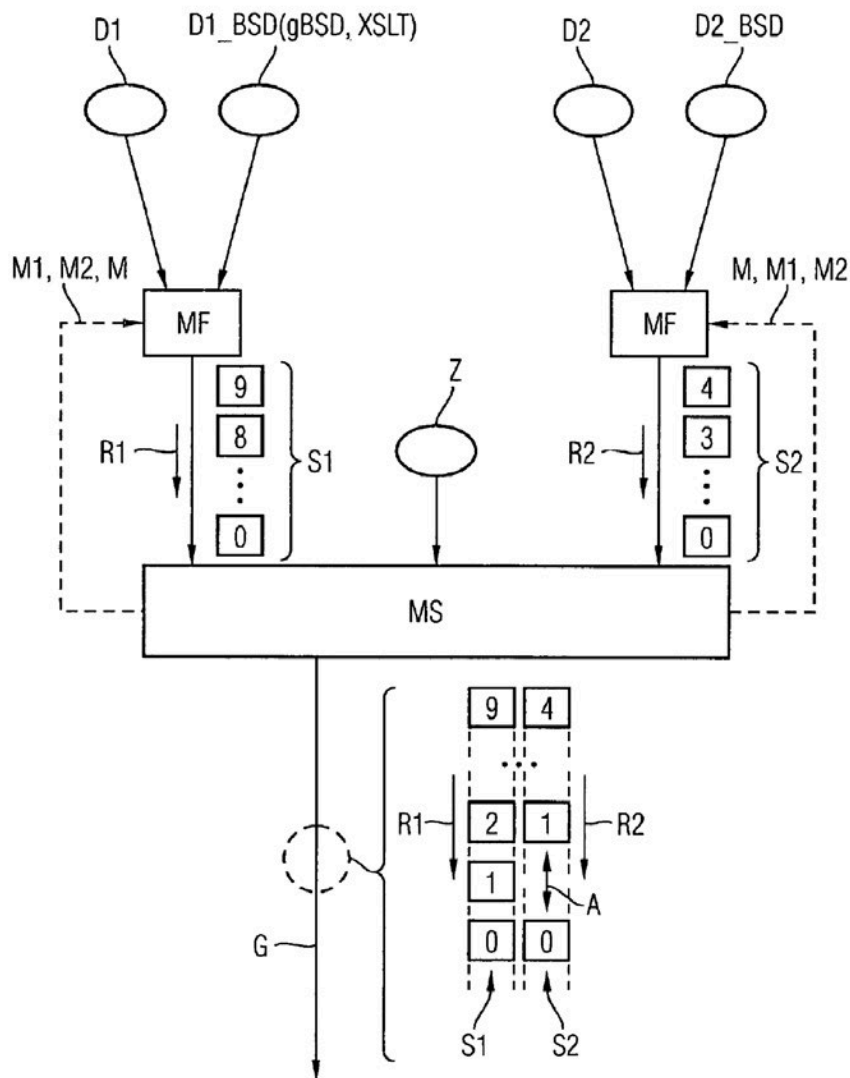
36. U.S. Patent No. 8,605,794 (the '794 patent) was filed March 16, 2006 and issued December 10, 2013. It lists Hermann Hellwagner, Jörg Heufr, Andreas Hutter, and Michael Ransburg as inventors. It claims priority to German Patent Application number DE 10 2005 016866, filed Apr. 12, 2005.

37. The '794 Patent discloses a method and a device for synchronizing content-dependent first data segments of a first data file and content-dependent second data segments of a second data file, the first and second data segments being

respectively output in sequence according to their chronological order in such a way that based on a pre-determinable assignment rule for the first and second data segments, each second data segment is output together with a corresponding first data segment. '794 Patent (EX1001) at Abstract.

38. This is illustrated in Fig. 1 of the '794 Patent, which I reproduce below:

FIG 1

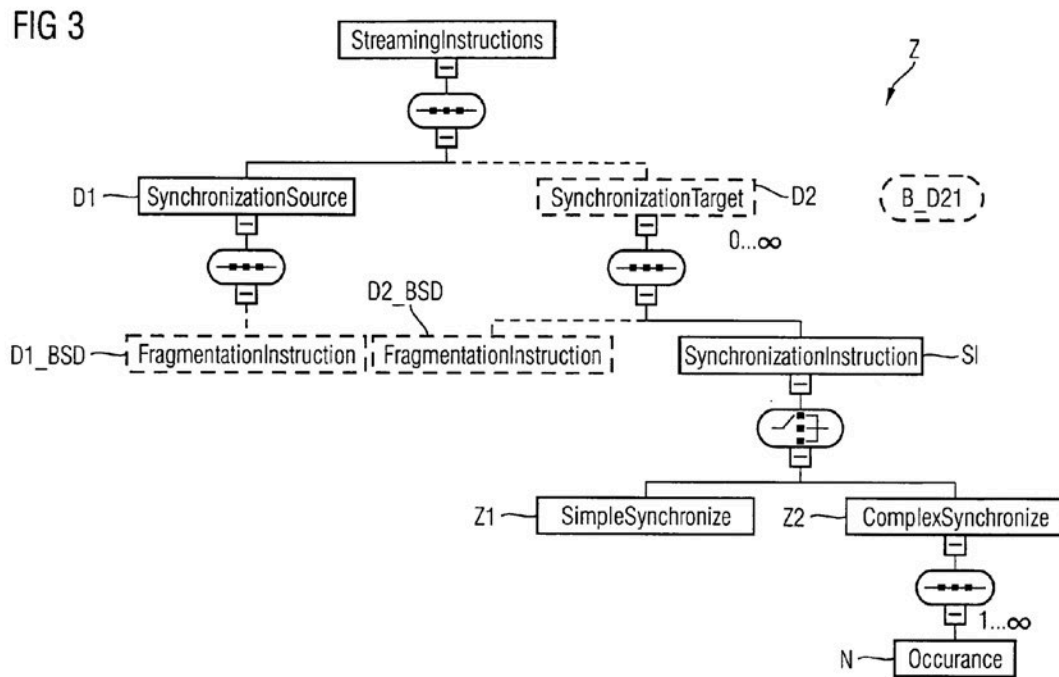


39. The '794 Patent discloses that this figure illustrates an example video data stream and audio data stream that are to be synchronized. The video data stream is identified as the first data file, D1. The audio data stream is identified as the second data file, D2. '794 Patent (EX1001) at 3:65-4:8. The '794 Patent further discloses that for each of these data files, there exists a fragmentation description file, which is named D1_BSD for D1 and D2_BSD for D2, respectively, and each file specifies how **content-related** first and second data segments S1 and S2 can be **obtained from** the respective data files, D1 and D2. '794 Patent (EX1001) at 4:9-14. The '794 Patent then goes on to disclose the following:

The term “**content-related**” is understood to **mean** that first and second data segments have a **syntactical meaning within the respective data file**, such as e.g. a plurality of succeeding second data segments represent the speech signal of a specific speaker within a dialog sequence. Furthermore, sections of the data file can also be understood thereby, such as e.g. individual images of a video sequence. In the following description data segments always refer to content-based data segments.

'794 Patent (EX1001) at 4:14-22, emphasis added.

40. Further, the '794 Patent discloses that the first and second data segments are synchronized on the bases of an assignment rule, as is visualized in Fig. 3, which I excerpt below:



41. For this embodiment, the '794 Patent discloses that the tree structure shows dependencies within an assignment rule indicated by means of dashed or unbroken connecting lines on the one hand and, on the other, keywords for using said assignment rule in the form of an XML-based description. '794 Patent (EX1001) at 5:15-20.

B. The Claims of the '794 Patent

42. The '794 patent claims methods and systems that simplify how audio and video data are synchronized before playback, resulting in faster rendering and lower overhead. Exemplary method claim 1 and system claim 9 are shown below:

1. A method for synchronizing content-related first data segments of a first data file and content-related second data segments of a second data file, the method comprising:

sequentially outputting, by a device for synchronizing content-related data, the content-related first data segments and the content-related second data segments according to their chronological sequence in such a way that each of the content-related second data segments is output together with an associated one of the content-related first data segments on the basis of an assignment rule for assigning each one of the content-related second data segments to one of the content-related first data segments.

9. A device for synchronizing content-related first data segments of a first data file and content-related second data segments of a second data file, comprising:

a synchronization device configured to output each of the content-related first data segments and the content-related second data

segments, sequentially, according to their chronological sequence, each of the content-related second data segments being output together with an associated one of the content-related first data segments based upon of an assignment rule for assigning each one of the content-related second data segments to each one of the content-related first data segment.

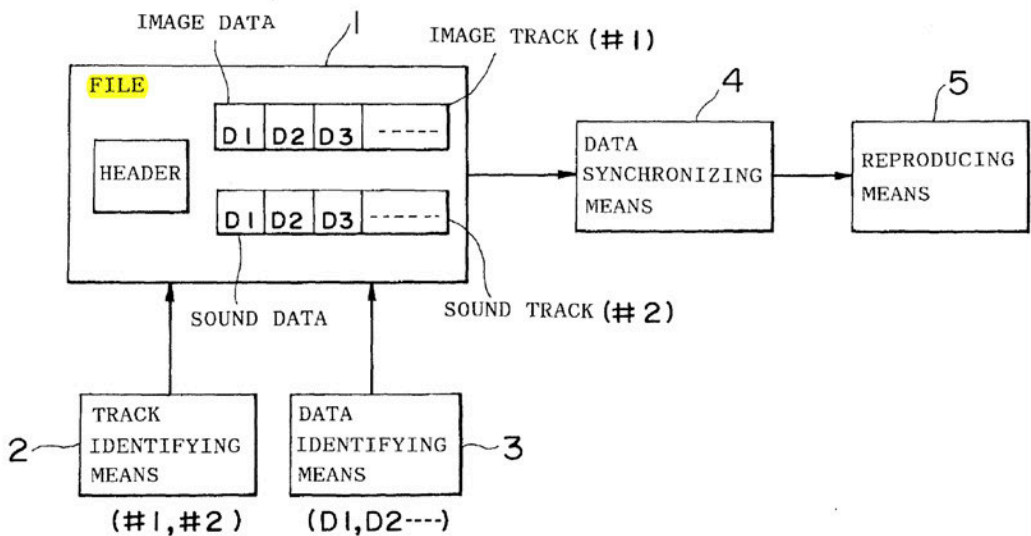
‘794 Patent (EX1001, claims 1, 9.)

C. Overview of Sonohara

43. Sonohara (EX1003) is U.S. Patent No. 5,627,656, which was filed August 12, 1996 and issued May 6, 1997.

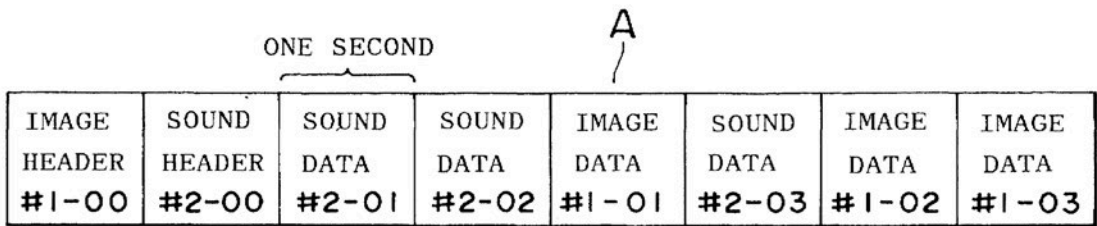
44. Sonohara discloses a single file that comprises image and sound data provided with track and data identifying numbers and having fixed time lengths, such as 1 second, which are then output in this stored order from the file. This is illustrated in Sonohara (EX1003) in Fig. 1, which I excerpt below (highlighting added; *see also*, Sonohara at 3:29, where Sonohara discloses this as a concept of the invention):

FIG.1



45. The time-length aspect of the video and audio data in Sonohara is further illustrated, e.g., in Fig. 7, which I excerpt below:

FIG.7



46. Sonohara discloses this as a view showing a format of the file 1 (shown above in Fig. 1). Sonohara (EX1003) at 5:44-46.

VI. PRIORITY DATE OF THE '794 PATENT

47. I understand that the priority date for the '794 Patent is as early as April 12, 2005, which is the foreign priority date of the '794 Patent, as I explain above. For my analysis, I assume this date as the priority date of the '794 Patent. My analysis would be the same, however, if it is determined that the '794 Patent has a slightly different priority date, including its U.S. filing date of March 16, 2006.

VII. LEVEL OF ORDINARY SKILL

48. I understand that the analysis of whether a patent is anticipated or obvious is performed from the perspective of the person of ordinary skill in the art (a "POSA" or "POSITA") at the time of the patented inventions. I further understand that the "person of ordinary skill in the art" is a hypothetical person who is presumed to be familiar with the relevant scientific field and its literature at the time of the invention. This hypothetical person is also a person of ordinary creativity capable of understanding the scientific principles applicable to the pertinent field.

49. I understand that the level of ordinary skill in the art may be determined by reference to certain factors, including (1) the type of problems encountered in the art, (2) prior art solutions to those problems, (3) the rapidity with which innovations are made, (4) the sophistication of the technology, and (5) the educational level of active workers in the field. I further understand that, in a given case, every factor may not be present, and one or more factors may predominate.

50. In my opinion, the appropriate level for one of ordinary skill in the art as of the date of the invention of the '794 Patent is an individual with at least a bachelor's degree in Computer Science or related area and two years of experience developing software tools and/or computer systems for use in the area of audio or video creation, encoding, and/or distribution. This description is approximate, and more work experience could compensate for less education or more education could compensate for less work experience. For example, the '794 Patent includes topics related to video creation, encoding, and distribution, as well as tree data structures and syntax and semantics for assignment rules, with examples in a version of Extensible Markup Language (XML).

51. Based on my training and experience, I believe that I am a person of greater-than-ordinary skill in the relevant art, and I have been since before the priority date for the '794 Patent. Further, in my capacity as a university professor, I have taught persons of ordinary skill in the art. Thus, I believe I can provide opinions about the qualifications of one of ordinary skill at the time of the invention.

52. I note that Dr. Freedman and Petitioner offer a slightly different definition of a POSITA, which is similar to my definition. EX1005 (Freedman Decl.) at ¶ 43 and Petition at 6. My opinions would not change were I to adopt the definition of POSITA offered by Petitioner.

VIII. CLAIM CONSTRUCTION

53. Dr. Freedman opines that claim terms should be understood according to their ordinary and customary meaning, which he states are “according to their plain and ordinary meaning as understood by a POSITA” and that he “considered any explicit definitions provided by the specification of the ’794 Patent, where applicable.” EX1005 (Freedman Decl.) at ¶ 46.

54. I understand that Patent Owner is offering the following constructions:

| Term | Patent Owner’s Proposed Construction |
|---|---|
| content-related . . . data segments (Claims 1, 9) | data segments ordered in a file such that they will present the file’s contents in their intended presentation order when rendered sequentially |
| Preambles (claims 1, 9) | The preambles are construed to be limiting. The first data file and the second data file are distinct from each other. |
| “assignment rule for assigning each one of the content-related second data segments to one of the content-related first data segments” / “assignment rule for assigning each one of the | assignment rule for assigning each one of the content-related second data segments to one of the content-related first data segments, wherein the assignment is not |

| | |
|--|---|
| content-related second data segments to each one of the content-related first data segments” (Claims 1, 9) | performed by using exact timing information for the data segments |
|--|---|

55. I agree with Patent Owner with respect to these constructions.

A. “content-related . . . data segments”

56. In my opinion, “content-related . . . data segments” should be construed as “data segments ordered in a file such that they will present the file’s contents in their intended presentation order when rendered sequentially.”

57. For example, the ’794 Patent states, “The term ‘content-related’ is understood to mean that first and second data segments have a syntactical meaning within the respective data file, such as e.g. a plurality of succeeding second data segments represent the speech signal of a specific speaker within a dialog sequence.” ’794 patent (EX1001) at 4:14-17. In my opinion, a POSITA would understand this to be an express definition of the phrase “content-related” in the context of “data segments.” A POSITA would understand that the “syntactic meaning” of data segments is to be ordered in a file such that they will present the file’s contents in their intended presentation order when rendered sequentially. *See, e.g.*, the ’794 Patent (EX1001) at 4:14-22, 4:49-60 (discussing synchronizing based on words, such as “Good” and “Morning”), and 5:35-6:3 (disclosing exemplary syntax for synchronizing data segments).

58. Further, this is consistent with Dr. Freedman’s testimony that “syntactic meaning” in the context of the ’794 Patent “is what determines what order [audio and video segments are] allowed to be in and what element of the information they represent.” Freedman Dep. Tr. (EX2008) at 33:2-6. For additional context, *see, e.g.*, Freedman Dep. Tr. (EX2008) at 32:13-34:21.

B. Preambles

59. In my opinion, a POSITA would understand the preambles of claims 1 and 9 to be limiting, in-part because they provide antecedent basis for “**the** content-related ... data segments.” That is, a POSITA would understand “the” in claim 1 reciting “the content-related first data segments” to be referring to “content-related first data segments of a first data file” and “the content-related second data segments” to be referring to “content-related first data segments of a second data file.” ’794 patent (EX1001) at claims 1 and 9. Thus, the preambles provide needed clarity about where the content-related data segments come from, and within which file the data segments have “syntactical meaning.” Moreover, a POSITA would additionally understand the preambles to claims 1 and 9 to provide antecedent basis for the first and second data segments, since, e.g., a POSITA would understand that a “segment” necessarily needs to be a portion of something, such as a file. Divorced from the specific language of the preambles, a POSITA would not understand where

the respective “content-related ... data segments” come from, as is required of a “segment” in the context of the ’794 Patent.

60. Further, given the teachings of the ’794 Patent, a POSITA would understand that synchronizing and sequentially outputting data segments from two *separate* files is key to the invention, which provides further evidence that a POSITA would understand the preambles to be limiting. For example, a POSITA would understand references to “the respective data file,” e.g., in the ’794 Patent (EX1001) at 4:9-22 as requiring separate data files. Moreover, the ’794 Patent gives these separate data files distinct names, D1 and D2, which a POSITA would further understand to be disclosing them to be separate. *See, e.g.,* ’794 Patent (EX1001) at Figs. 1-3 and at 3:65-7:20.

C. “Assignment Rule” Limitations

61. In my opinion, “assignment rule for assigning each one of the content-related second data segments to one of the content-related first data segments” / “assignment rule for assigning each one of the content-related second data segments to each one of the content-related first data segments” should be construed as “assignment rule for assigning each one of the content-related second data segments to one of the content-related first data segments, wherein the assignment is not performed by using exact timing information for the data segments.”

62. I understand that a patentee may provide statements of disclaimer during a patent's prosecution that may limit its meaning. Based on my reading of the File History for the '794 Patent, it is my opinion that patentee distinguished the invention of the '794 Patent with prior art reference U.S. Patent No. 7,428,696 ("Shin") on the basis that Shin requires content data and metadata each include time information for synchronization and that this is then used to determine "a relative time point" to "perform time synchronization for the content data and metadata" based on the determined time point. Shin (EX2011) at 2:42-45, 8:1-6.

63. Likewise, in my opinion, Patentee distinguished the invention of the '794 Patent from U.S. Patent No. 5,598,352 ("Rosenau") during prosecution for a similar reason. For example, Rosenau resynchronizes video and audio tracks when their respective timestamps differ by an amount of time greater than a threshold. *See, e.g.*, Rosenau (EX2012) at Figs. 3B, 3C, 5:65-6:59, 3:57-4:7, 5:8-10, 5:37-40.

64. Also, a POSITA would understand that the '794 Patent discloses an "assignment rule" that does not need to use timestamps. *See, e.g.*, the '794 Patent (EX1001) at 2:36-46.

65. I also note that, in my opinion, the above constructions are consistent with the claim construction methodology offered by Dr. Freedman to construe claim terms "according to their plain and ordinary meaning as understood by a POSITA"

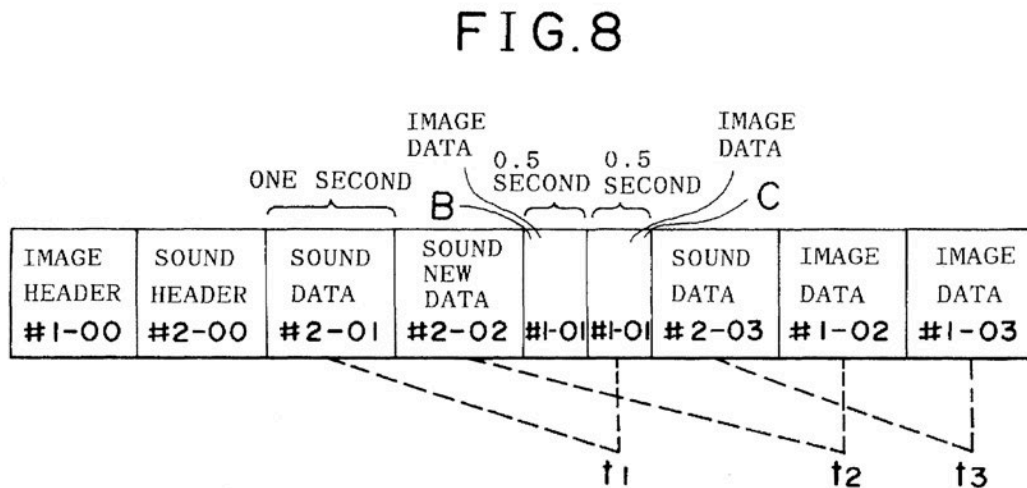
and to “consider[] any explicit definitions provided by the specification of the ’794 Patent where applicable.” EX1005 (Freedman Decl.) at ¶ 46. Therefore, my opinions would not change were I to apply the implied claim constructions of Dr. Freedman.

IX. ANTICIPATION AND OBVIOUSNESS ANALYSIS

A. Sonohara Does Not Teach Synchronizing Content-Related Data Segments From Two Distinct Data Files

66. Sonohara discloses that its apparatus “includes a file **1** into which image data of a moving object and audio data are stored, a file production processing device **7** for producing the file **1**, and a file reproduction processing device **8** for reproducing the video data and audio data of the file **1**.” Sonohara (EX1003) at 3:54-58. Further, Sonohara discloses, “The above-described file **1** is a file formed on a magneto-optical disc. As shown in FIG. **3**, the file **1** is schematically composed of a header **21** including control information for controlling the video data and audio data, an image track **22** on which the motion pictorial image data having a plurality of frames per unit time are recorded for a predetermined period of time, and a sound track **23** on which audio data are recorded for a predetermined period of time corresponding to the image data.” Sonohara (EX1003) at 3:66-4:7. Thus, a POSITA would understand Sonohara to be disclosing an encoding of video and audio data in the same file (file **1**) where each chunk of video data has a corresponding chunk of audio data of the same time period. This is illustrated, for example, in Fig. 7, excerpted

above, as well as Fig. 8, which shows an example file 1 after an edit has occurred to add corresponding video and audio chunks of the same time length (*see, e.g.*, EX1003 at 6:57-67):



67. A POSITA would understand this to mean that Sonohara expressly discloses that the video and audio fragments belong to a single file, file 1, not two files.

68. Further, I am using the plain and ordinary meaning of “file” here, such as that from the Microsoft Computer Dictionary, 5/e, 2002:

file *n.* A complete, named collection of information, such as a program, a set of data used by a program, or a user-created document. A file is the basic unit of storage that enables a computer to distinguish one set of information from another. A file is the “glue” that binds a

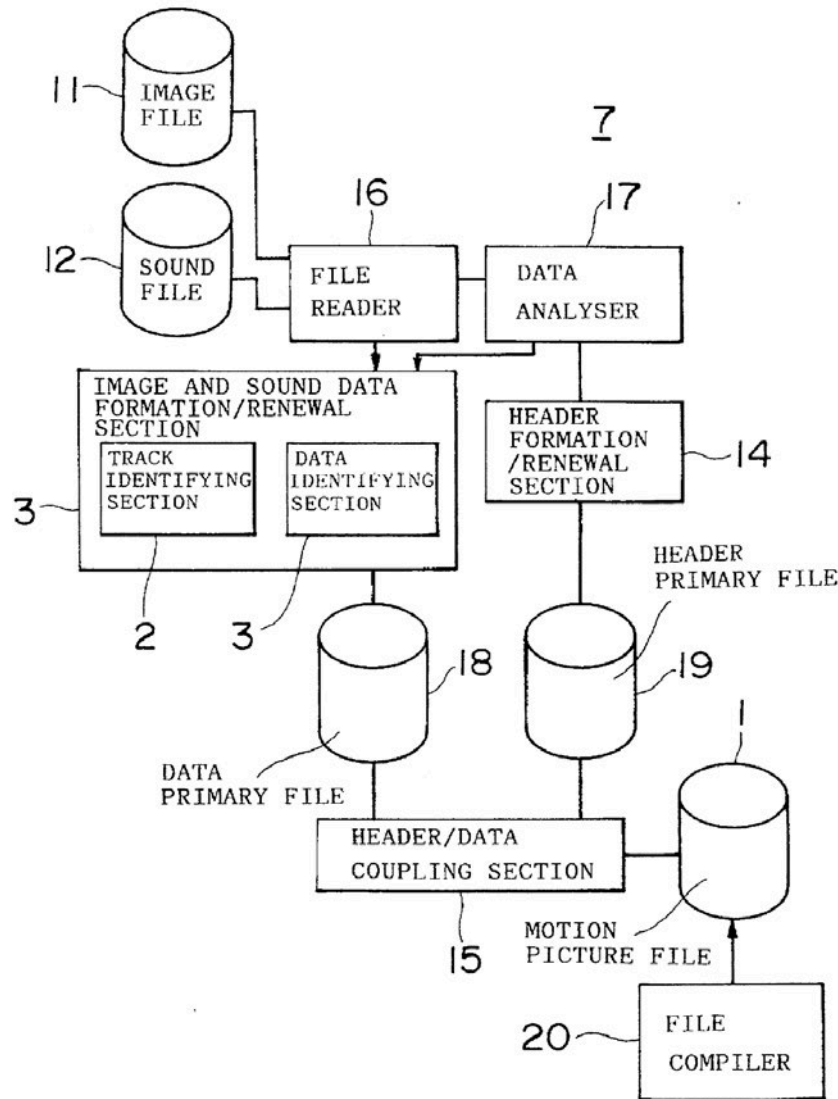
conglomeration of instructions, numbers, words, or images into a coherent unit that a user can retrieve, change, delete, save, or send to an output device.

Microsoft Computer Dictionary, 5/e, 2002 (EX2013), at 211.

69. Dr. Freedman identifies the video and audio frames from file 1 in Sonohara as the “first data segments” and “second data segments,” respectively, of the claim. But Dr. Freedman also respectively identifies the “first data file” and “second data file” as the image file 11 and sound file 12, respectively, of Sonohara. EX1005 (Freedman Decl.) at ¶¶ 125-132. I disagree.

70. A POSITA would understand instead that, as disclosed in Fig. 4 of Sonohara, the image file 11 and sound file 12 are the **inputs** to a separate process, which analyzes these files, performs several steps and transformations on this data, both in terms of its syntax (including headers) and structure (dividing it into frames), and ultimately produces the file 1 as an **output**. Sonohara (EX1003) at Fig. 4.

FIG. 4



71. For example, Sonohara discloses, “In FIG. 4, the apparatus is provided with an image file 11 onto which image data of motion picture having a plurality of frames per unit time have been recorded for a predetermined period of time, and a sound file 12 onto which audio data have been recorded for a predetermined period of time corresponding to the image data. The image file 11 and the sound file 12 are formed on a magneto-optical disc.” Sonohara (EX1003) at 4:13-20. Sonohara goes

on to disclose, “The image data and sound data formation/renewal section **13** renews and **forms the image data and sound data** from the file reader **16** on the basis of the analysis result of the data analyzer **17**, and includes a track identifying section **2** and a data identifying section **3**.” *Id.* at 4:30-34. Thus, a POSITA would understand that the alleged data segments in Sonohara are not of the original image file 11 and sound file 12, but instead are created during the processing of these files to create the output file 1 (which will then be a **single file** holding both types of alleged data segments). For instance, Sonohara goes on to disclose the following, disclosing that the resulting alleged (now transformed, numbered, and annotated) data segments are then put into file 1:

A data identifying section **3** gives data identifying numbers **01, 02, 03**, ... for representing the order of the data within the image track **22** or the sound track **23** to the image data and the sound data per unit time. In the apparatus, the same data identifying numbers are given to the image data and the sound data to be synchronized with the image data. Accordingly, **in the file 1**, the track identifying numbers and the data identifying numbers are imparted to the image data and the sound data per unit time by the track identifying section **2** and the data identifying section **3**.

Sonohara (EX1003) at 4:45-54, emphasis added.

72. Once file 1 is created, Sonohara teaches that “the device **8** has a reader **41** for reading, in order, the image data and sound data from the file **1**.” Sonohara (EX1003) at 5:10-13. Sonohara does not disclose or suggest going back to the original image file 11 or sound file 12. Instead, even to perform an update editing operation, Sonohara discloses performing this edit using file 1, not the original image file 11 or sound file 12. *See, e.g.*, Sonohara (EX1003) at 6:57-67.

73. Apparently, Petitioner is arguing that the first and second data file limitations can be met merely because some of the data comprising the alleged content-related data segments were stored in separate data files at any time in the past. A POSITA would not read the claims this way, however, for at least the reason that “content-related . . . data segments” must come from these files, not merely data that was later segmented and provided with “syntactical meaning” from a different single file (i.e., file 1 in Sonohara).

74. Based on the claim language, the data segments being synchronized must be from distinct data files. The alleged first and second data segments that are synchronized in Sonohara do not come from distinct data files, however; hence, this limitation is not disclosed or suggested by Sonohara.

75. The claims further require that the segments being synchronized be “content-related” data segments. Dr. Freedman does not address this limitation at

all, and instead seems to give no meaning to the “content-related” requirement for the data segments of the claims. *See, e.g.*, EX1005 (Freedman Decl.) at ¶¶ 125-156.

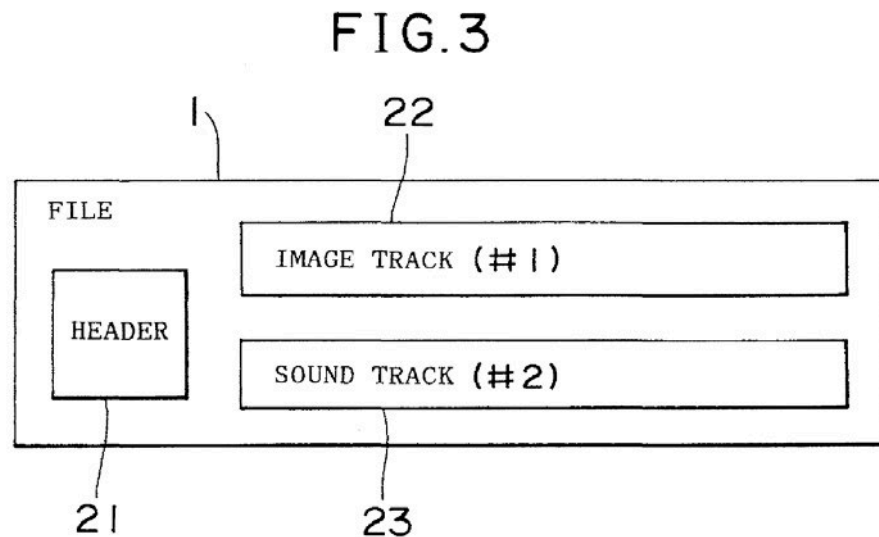
76. Instead, the ’794 Patent expressly teaches the following:

The term “content-related” is understood to mean that first and second data segments have a **syntactical meaning** within the respective data file, such as e.g. a plurality of succeeding second data segments represent the speech signal of a specific speaker within a dialog sequence.

’794 Patent (EX1001) at 4:14-19, emphasis added.

77. In spite of omitting any discussion of syntactical meaning in his declaration, in his deposition, Dr. Freedman testified that the above is a definition in the ’794 Patent and that it was consistent with his analysis that that this is consistent with the plain and ordinary meaning of those terms. Freedman Depo. Tr. (EX2008) at 30:7-31:21. Further, Dr. Freedman testified that “syntactical meaning” is “a meaning defined by syntax.” Freedman Depo. Tr. (EX2008) at 35:13-22. Nevertheless, as I already mentioned, Dr. Freedman does not address any alleged meaning defined by syntax for the alleged data segments in Sonohara. *See, e.g.*, EX1005 (Freedman Decl.) at ¶¶ 125-156. Indeed, his declaration does not contain the words “syntax” or “syntactical.”

78. Likewise, Sonohara does not contain the words “syntax” or “syntactical.” Sonohara does disclose a “format” for a data file, but this term is used exclusively for the file 1, not for the image file 11 or audio file 12. For example, Sonohara describes Fig. 3 as showing a format for file 1 (EX1003 at 3:32, 3:52-53):



79. Further, Sonohara likewise describes Figs. 7 and 8 as each showing a format for file 1 (EX1003 at 3:39-40, 5:43-46, 6:52-67. For example, Sonohara at 5:43-46 explains that its Fig. 6 shows a flowchart for forming the format of file 1; hence, a POSITA would understand that the image file 11 and audio file 12 do not have the format of file 1. Accordingly, a POSITA would understand that any syntax that is allegedly taught for file 1 in Sonohara does not apply to the image file 11 or audio file 12. Indeed, Dr. Freedman opined and testified that in Sonohara header data and/or frame numbering data is imparted (or “attached”) to video and/or audio

data after it is extracted from image file 11 and/or audio file 12. *See, e.g.*, EX1005 (Freedman Decl.) at ¶¶ 123, 127, 135, and Freedman Depo. Tr. (EX2008) at 95:16-97:16. Thus, a POSITA would understand that Sonohara does not disclose or suggest first and second data segments that have a **syntactical meaning** within the respective data files 11 and 12.

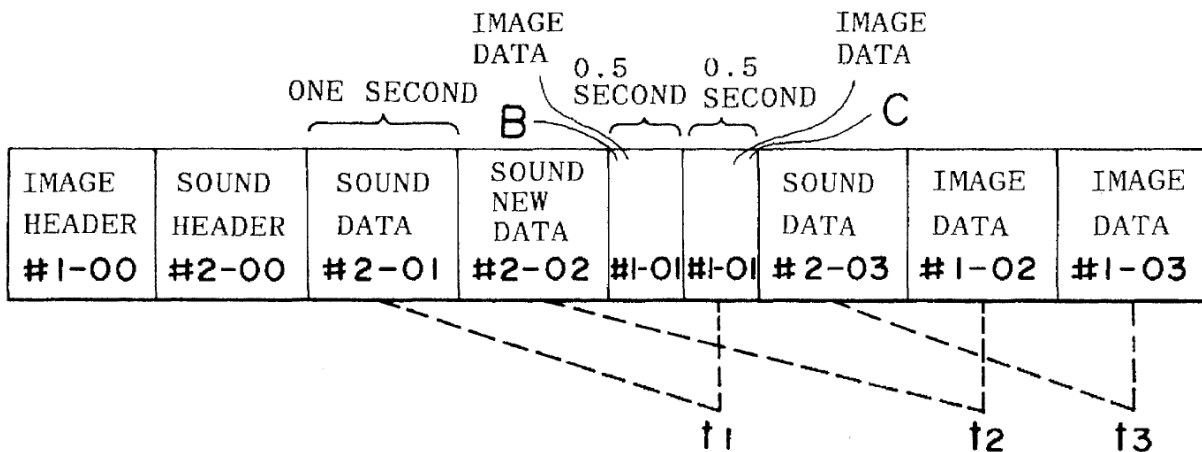
B. Sonohara Does Not Teach an “Assignment Rule”

80. Claims 1 and 9 of the '794 Patent further require an “assignment rule.” Further, as I explain above, in my opinion, “assignment rule for assigning each one of the content-related second data segments to one of the content-related first data segments” / “assignment rule for assigning each one of the content-related second data segments to each one of the content-related first data segments” should be construed as “assignment rule for assigning each one of the content-related second data segments to one of the content-related first data segments, wherein the assignment is not performed by using exact timing information for the data segments.”

81. In contrast, Sonohara teaches numbering frames of video and audio data by time durations that are the same for each video and audio frame. That is, the thing that is providing the synchronization in Sonohara is the pre-set time-duration and timing information for the video and audio data chunks, not an assignment rule.

82. Sonohara describes the reproduction of the audio and video unit times, at specific points in time, with reference to Figure 8 (reproduced below):

FIG. 8



Sonohara (EX1003), Fig. 8.

83. For example, Sonohara states:

At the time when the data identifying number of the image data is identified with the data identifying number of the sound data, the image data and sound data are read in synchronism from the region 42. For example, in the example shown in FIG. 8, **at the time t_1** , the sound data #2-01 for one second and the new image data #1-01 for 0.5 seconds and the image data #1-01 for 0.5 seconds are read in synchronism. . . .

Further, in the example shown in FIG. 8, **at time t_2** , the sound data #2-02 for one second and the image data #1-02 for one second are read in synchronism.

Sonohara (EX1003) at 7:29-51 emphases added.

84. That is, Sonohara discloses outputting corresponding unit times (**#1-02** and **#2-02**), which have a preset, fixed time duration (1 second), at specific, predetermined times (**t1** and **t2**). Therefore, contrary to the approach required by the claims of the '794 Patent, Sonohara relies on exact timing information (the duration of the unit times and the timestamps **t1** and **t2**) to assign the alleged content-related data segments to one another. In other words, Sonohara synchronizes unit times in the same manner as what is taught in Shin and Rosenau, which I discuss above; hence, Sonohara does not disclose or suggest an “assignment rule.”

85. Dr. Freedman points to a “header” “include[ing] control information” identified in claim 1 of Sonohara, as allegedly teaching an “assignment rule” as required by the claims of the '794 Patent. EX1005 (Freedman Decl.) at ¶¶ 148-149. I disagree.

86. First, Dr. Freedman is apparently ignoring the plain language of claim 1 in Sonohara, which recites, in part, “**a file** in a memory unit of the computer, including ... a header, including control information for controlling transfer of said image data and said sound data.” Thus, Dr. Freedman is apparently ignoring the disclosure that the “image track” and “sound track” track of claim 1 in Sonohara come from a single file, not two as required by the '794 Patent.

87. Second, the “control information” in Sonohara would not be seen as an “assignment rule” by a POSITA. Dr. Freedman points to a step shown in Fig. 6 of

Sonohara that creates the single file 1 where image and sound data are stored where “the sound data and image data are coupled with each other”. Freedman Decl. at ¶ 149, citing to Sonohara at Fig. 6 and 6:41-42. A POSITA would not consider this coupling as an assignment rule, however, and instead to simply be a numbering of the sections of corresponding sound data and image data, with a list of identifying numbers for the unit times. For example, as shown in Figs. 7 and 8 of Sonohara, the image track “#1-00” corresponds to the sound track “#2-00”, the image track “#1-01” corresponds to the sound track “#2-01”, image track “#1-02” corresponds to the sound track “#2-02”, and so on. But the identifying numbers, 00, 01, 02, and so on, in Sonohara are merely used to identify (and thus distinguish) the unit time tracks from one another, so that they can be reproduced at particular times. The same is true for the track numbers, #1 and #2, which simply distinguish between audio unit times and image unit times. Thus, a POSITA would understand that in the Sonohara system, when it comes to reproducing the audio and image data, the exact timing information of the unit times and when they are output is critical to the synchronization. That is, the system of Sonohara requires that the track sections are each of the same time length and that the numbers are simply for identifying whether they are for sound or images and which same-time section (00, 01, 02, ...) they correspond to. Thus, there is no assignment rule.

88. Therefore, the disclosures of Sonohara contrast with the assignment rule of the '794 patent, where the precise duration of the data segments or exact times at which they are output is not required. *See e.g.*, '794 Patent (EX1001) at 4:54-67.

89. Given the teachings in the '794 Patent, and the disclaimers from the File History, a POSITA would understand that the “assignment rule” of the '794 Patent achieves synchronization independent of timestamps, precise durations, or other exact timing information. Indeed, as I explain above, this aspect of assignment rules is central to the '794 patent, and is how references like Shin and Rosenau were overcome during prosecution. In my opinion, Sonohara is distinguishable from the '794 patent for the same reason.

90. Further, Dr. Freedman’s obviousness analysis is based on apparent hindsight, using the '794 patent as a guide. *See, e.g.*, Freedman Decl. (EX1005) at ¶¶ 150-152. For example, absent any teaching in Sonohara of an “assignment rule,” Dr. Freedman jumps to the conclusion that the numbers 00, 01, 02, 03, ..., are an “assignment rule” without any support. Instead, in the context of Sonohara (and divorced from using the '794 patent as a guide), a POSITA would understand the numbers 00, 01, 02, 03, ..., to be what they plainly are—numbers—not an assignment rule, even under Dr. Freedman’s definition of “rule” as “a **prescribed** guide for conduct or action.” For example, numbers, by themselves, are not a prescribed guide for anything. Thus, without using the '794 patent as a guide, a

POSITA has no rationale to go from Sonohara's exact timing information technique to the use of an assignment rule as taught in the '794 patent.

91. Accordingly, Sonohara does not disclose the assignment rule of the '794 Patent. *See, e.g.*, EX1003 (Sonohara) at Figs. 7 and 8, and at 6:52-67.

C. Sonohara Does Not Teach An “Assignment Rule” That Is Not Based on a Timestamp

92. As I explain above, the alleged “data segments” in Sonohara are always formed for an exact amount of time (e.g., 1 second). A POSITA would understand that the number and duration header information disclosed in Sonohara to correspond to a timestamp. *See, e.g.*, EX1003 (Sonohara) at 5:57-65, 6:53-67, 7:33-65 (“For example, in the example shown in FIG. 8, at the time *t*₁, the sound data #2-01 for one second and the new image data #1-01 for 0.5 seconds and the image data #1-01 for 0.5 seconds are read in synchronism.”) Accordingly, any alleged assignment rule disclosed or suggested in Sonohara is based on timestamps. Further, Dr. Freedman apparently agrees with this understanding of a POSITA with respect to timestamps, in that he states, “In the context of the '794 Patent, a *timestamp* or ‘time code’ would be understood to be an absolute time or time range.” EX1005 (Freedman Decl.) at ¶ 167 citations omitted. Accordingly, any alleged assignment rule in Sonohara is based on a time range, that is, it is based on timestamps.

93. Moreover, the unit times in Sonohara are also described as being output at precise times, **t1**, **t2**, **t3**, which a POSITA would understand to be timestamps, given the teachings in Sonohara that audio and video sections are each one second in the disclosed embodiments and the times, **t1**, **t2**, and **t3**, in Fig. 8 of Sonohara are named points in time, i.e., what a POSITA would understand to be timestamps.

94. In contrast, claims 20 and 21 of the '794 Patent require that “the assignment rule is **not** based on a timestamp.” '794 patent (EX1001), claims 20-21 (emphasis added). As explained above, Sonohara uses timestamps, and so does not meet this limitation.

X. CONCLUSION

95. I hereby declare, under penalty of perjury under the laws of the United States, that the foregoing is true and correct, and that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I understand that willful false statements are punishable by fine or imprisonment or both.

Executed on April 17, 2023, in Irvine, CA.



Michael T. Goodrich

Appendix A

CURRICULUM VITAE

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EDUCATION

| | | |
|-------|------|---|
| Ph.D. | 1987 | <i>Efficient Parallel Techniques for Computational Geometry</i> Computer Science, Purdue Univ. (M.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 |
| 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. |

RESEARCH INTERESTS

Algorithm and data structure design
Parallel and distributed computing
Information assurance, privacy, and security
Principles of database, machine learning, computer vision, and typesetting systems
Information visualization, computer graphics, and computational geometry

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 R. Tamassia, N. Triandopoulos, D. Yao, and D. Ellis), 2006
- *ACM Distinguished Scientist*, 2006
- *2006 IEEE Computer Society Technical Achievement Award*, “for outstanding contributions to the design of parallel and distributed algorithms for fundamental combinatorial and geometric problems”
- *Fulbright Scholar*, 2007, for senior specialist service to University of Aarhus, Denmark
- *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

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Google Scholar Citation Statistics:

- Total citations: over 16,800
- H-index (top H publications with at least H citations): 73

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- P-2. M.T. Goodrich and R. Tamassia, “Efficient Authenticated Dictionaries with Skip Lists and Commutative Hashing,” U.S. Patent 7,257,711, August 14, 2007.
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- B-2. M.T. Goodrich and C.C. McGeoch, eds., *Algorithm Engineering and Experimentation*, Lecture Notes in Computer Science (LNCS), Vol. 1619, Springer-Verlag, 1999.
- B-3. M.T. Goodrich and R. Tamassia, *Data Structures and Algorithms in Java, Second Edition*, John Wiley and Sons, Inc., 2001.
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- B-5. M.T. Goodrich and S.G. Kobourov, eds., *10th Int. Symp. on Graph Drawing (GD)*, Lecture Notes in Computer Science, Vol. 2528, Springer-Verlag, 2002.
- B-6. M.T. Goodrich, R. Tamassia, and D. Mount, *Data Structures and Algorithms in C++*, John Wiley and Sons, Inc., 2004.
- B-7. M.T. Goodrich and R. Tamassia, *Data Structures and Algorithms in Java, Third Edition*, John Wiley and Sons, Inc., 2004.
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- C-228. M.T. Goodrich, S. Gupta, H. Khodabandeh, and P. Matias, “How to Catch Marathon Cheaters: New Approximation Algorithms for Tracking Paths,” *17th Algorithms and Data Structures Symp.* (WADS), 442–456, 2021.
- C-229. R. Afshar, M.T. Goodrich, P. Matias, and M.C. Osegueda, “Mapping Networks via Parallel kth-Hop Traceroute Queries,” *39th Int. Symp. on Theoretical Aspects of Computer Science* (STACS), LIPIcs, Vol. 219, 4:1–4:21, 2022.
- C-230. R. Afshar, M.T. Goodrich, and E. Ozel, “Efficient Exact Learning Algorithms for Road Networks and Other Graphs with Bounded Clustering Degrees,” *20th Int. Symp. on Experimental Algorithms* (SEA), 9:1–9:18, 2022.
- C-231. G. Barequet, S. Fukuzawa, M.T. Goodrich, D. Mount, M. Osegueda, and E. Ozel, “Diamonds are Forever in the Blockchain: Geometric Polyhedral Point-Set Pattern Matching,” *34th Canadian Conf. on Computational Geometry* (CCCG), 16–23, 2022.
- C-232. R. Afshar and M.T. Goodrich, “Exact Learning of Multitrees and Almost-Trees Using Path Queries,” *15th Latin American Theoretical Informatics Symp.* (LATIN), 293–311, 2022.
- C-233. M.T. Goodrich and E. Ozel, “Modeling the Small-World Phenomenon with Road Networks,” *30th ACM SIGSPATIAL Int. Conf. on Advances in Geographic Information Systems* (GIS), 46:1–46:10, 2022. **Best Paper Runner Up Award.**
- C-234. M. Blanton, M.T. Goodrich, and C. Yuan, “Secure and Accurate Summation of Many Floating-Point Numbers,” *23rd Privacy Enhancing Technologies Symp.* (PETS), 2023.
- C-235. R. Jacob and M.T. Goodrich, “Optimal Parallel Sorting with Comparison Errors,” *35th ACM Symp. on Parallelism in Algorithms and Architectures* (SPAA), 2023.
- C-236. R. Afshar, M. Dillencourt, M.T. Goodrich, and E. Ozel “Noisy Sorting Without Searching: Data Oblivious Sorting with Comparison Errors,” *21st Symposium on Experimental Algorithms* (SEA), 2023.

Other Publications:

- O-1. M.T. Goodrich, “Guest Editor’s Introduction,” *Int. Journal of Computational Geometry & Applications*, **2**(2), 1992, 113–116.
- O-2. M.T. Goodrich, “Parallel Algorithms Column 1: Models of Computation,” *SIGACT News*, **24**(4), 1993, 16–21.
- O-3. M.T. Goodrich, V. Mirelli, M. Orletsky, and J. Salowe, “Decision tree construction in fixed dimensions: Being global is hard but local greed is good,” Technical Report TR-95-1, Johns Hopkins University, Department of Computer Science, Baltimore, MD 21218, May 1995.
- O-4. R. Tamassia, P.K. Agarwal, N. Amato, D.Z. Chen, D. Dobkin, R.L.S. Drysdale, S. Fortune, M.T. Goodrich, J. Hershberger, J. O’Rourke, F.P. Preparata, J.-R. Sack, S. Suri, I.G. Tollis, J.S. Vitter, and S. Whitesides, “Strategic Directions in Computational Geometry Working Group Report,” *ACM Computing Surveys*, **28A**(4), December 1996.
- O-5. G.A. Gibson, J.S. Vitter, and J. Wilkes, A. Choudhary, P. Corbett, T.H. Cormen, C.S. Ellis, M.T. Goodrich, P. Highnam, D. Kotz, K. Li, R. Muntz, J. Pasquale, M. Satyanarayanan, D.E. Vengroff, “Report of the Working Group on Storage I/O Issues in Large-Scale Computing,” *ACM Computing Surveys*, **28A**(4), December 1996.

- O-6. T.H. Cormen and M.T. Goodrich, “A Bridging Model for Parallel Computation, Communication, and I/O,” *ACM Computing Surveys*, **28A**(4), December 1996.
- O-7. M.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. M.T. Dickerson and M.T. Goodrich, “Matching Points to a Convex Polygonal Boundary,” Proceedings of the 13th Canadian Conf. on Computational Geometry (CCCG’01), 89–92, 2001.
- O-9. M.T. Goodrich, “Guest Editor’s Foreword,” *Algorithmica*, **33**(3), 271, 2002.
- O-10. M.T. Goodrich, M. Shin, C.D. Straub, and R. Tamassia, “Distributed Data Authentication (System Demonstration),” *DARPA Information Survivability Conf. and Exposition*, IEEE Press, Volume 2, 58–59, 2003.
- O-11. M.T. Goodrich and R. Tamassia, “Efficient and Scalable Infrastructure Support for Dynamic Coalitions,” *DARPA Information Survivability Conf. and Exposition*, IEEE Press, Volume 2, 246–251, 2003.
- O-12. E. Ghosh, M.T. Goodrich, O. Ohrimenko, and R. Tamassia, “Poster: Zero-Knowledge Authenticated Order Queries and Applications,” *IEEE Symp. on Security and Privacy*, 2015. (See also <https://eprint.iacr.org/2015/283>.)
- O-13. F. Bayatbabolghani, M. Blanton, M. Aliasgari, and M.T. Goodrich, “Poster: Secure Computations of Trigonometric and Inverse Trigonometric Functions,” *IEEE Symp. on Security and Privacy*, 2017.

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
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
 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

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

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)
6. Martin Nollenburg, 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 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 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 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.
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.

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 |
| Kartic Subr | UC-Irvine | Advancement to candidacy, September 2004 |
| S. Joshua Swamidass | UC-Irvine | Advancement to candidacy, April 2005 |
| Jeong Hyun Yi | UC-Irvine | Thesis defense, August, 2005 |
| Nodari Sitchinava | UC-Irvine | Advancement to candidacy, chair, December 2005 |
| John Augustine | UC-Irvine | Thesis defense, July 2006 |
| Maithili Narasimha | UC-Irvine | Thesis defense, August, 2006 |
| Josiah Carlson | UC-Irvine | Advancement to candidacy, August 2006 |

| | | |
|----------------------|--------------|---|
| Xiaomin Liu | UC-Irvine | Advancement to candidacy, September 2006 |
| Gabor Madl | UC-Irvine | Advancement to candidacy, September 2006 |
| Nikos Triandopoulos | Brown U. | Thesis defense, September 2006 |
| Rabia Nuray-Turan | UC-Irvine | Advancement to candidacy, May 2007 |
| S. Joshua Swamidass | UC-Irvine | Thesis defense, June 2007 |
| Michael Sirivianos | UC-Irvine | Advancement to candidacy, June 2007 |
| Kevin Wortman | UC-Irvine | Advancement to candidacy, August 2007 |
| Di Ma | UC-Irvine | Advancement to candidacy, December 2007 |
| 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 |
| Sara Javanmardi | UC-Irvine | Advancement to candidacy, June 2008 |
| 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 |
| 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 |

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|------------------------|--------------|--|
| 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 |
| Rohith Gangan | 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 |

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
 Strategic Planning Committee, Dept. of Computer Science, Bren School of ICS, 2015–16
 Master of Computer Science Steering/Admissions Comm., Bren School of ICS, 2016–22
 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

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)
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:

APAC Security, Inc., 2005
Algomagic Technologies, Inc., 2000–2005
Army Research Laboratory, Fort Belvoir, 1995
AT&T, 1998
Battelle Research Triangle, Columbus Division, 1996
Brown University, 2000–2007
3M, 2015
Purdue University, 2002
The National Science Foundation, 1990–2016
Univ. of Miami, 1999
Walt Disney Animation Studios, 2009
Technical expert and expert witness, retained for IP litigations, 2012–

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.R. 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. Johnstone, S. Kasif, S.R. 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.), R. Tamassia (Brown U.), S. Rao Kosaraju, J. Vitter (Duke U.), and P. Agarwal (Duke U.)). Subaward size: \$1,466,640.
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, R. 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 Collaborative 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 Tamassia).
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.
 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 (RECENT YEARS ONLY)

- “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
- “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 Sensitive 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 Sensitive 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
- “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