

UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

TESLA, INC.,
Petitioner,

v.

GRAPHITE CHARGING COMPANY, LLC,
Patent Owner

Case: IPR2024-00388

U.S. Patent No. 8,291,243

EXPERT DECLARATION OF DR. KIRK W. CAMERON
IN SUPPORT OF PATENT OWNER'S RESPONSE

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I. INTRODUCTION

1. My name is Dr. Kirk W. Cameron and I reside in Alexandria, Virginia. I have been retained as a technical expert by counsel for Patent Owner Graphite Charging Company, LLC (“Graphite Charging” or “Patent Owner”) to provide expert opinion testimony in the above-captioned matter.

2. I have been asked to render opinions on Petitioner’s unpatentability arguments regarding U.S. Patent No. 8,291,243 (“the ’243 Patent”) that have been identified in the Petition. Specifically, I have been asked to consider whether certain references disclose or suggest the features recited in claims 1–20 of the ’243 Patent.

3. This report contains statements of my opinions formed to date regarding these references and the ’243 Patent and the bases and reasons for those opinions. I may offer additional opinions based on further review of materials in this case, including opinions and/or testimony of other expert witnesses.

4. Based upon the materials that I have considered, and the arguments made by Petitioner and Dr. MacCarley, as explained below it is my opinion that Petitioner has failed to meet its burden to show that any challenged claim of the ’243 Patent is unpatentable.

II. QUALIFICATIONS

5. This is a summary of my background and qualifications. I set forth my background in more detail in my Curriculum Vitae (“CV”).

6. I graduated from the University of Florida with a Bachelor of Science degree in Mathematics in 1994. Subsequently, I attended Louisiana State University, where I earned a Doctor of Philosophy in Computer Science in 2000.

7. After earning my Ph.D., I taught Computer Science at the University of South Carolina for four years before moving to my current position at the Virginia Polytechnic Institute & State University (“Virginia Tech”) in 2005. At Virginia Tech, I am a tenured Professor of Computer Science as well as the inaugural faculty lead and Associate Vice President for Academic Affairs at Virginia Tech’s Innovation Campus in Alexandria, Virginia. My research focuses on issues related to improving power and performance efficiency in high performance computing (HPC) systems and applications.

8. From 2012-2022, I was Director of the stack@cs Center for Computer Systems (ranked #26 by US News in 2022). I was the inaugural Associate Department Head for Research and Engagement from 2018-2022. I was Associate Department Head and Graduate Program Director from 2014-2017. I held a Distinguished Visiting Fellowship at Queen’s University, Belfast and I was a

distinguished visitor to the U.K. Royal Academy of Engineering during the 2017-2018 academic year.

9. I am a Fellow of IEEE based on my contributions to measurement and management of energy in high-performance computing systems. The IEEE Grade of Fellow is conferred on members with extraordinary records of professional technical accomplishments. The total number of fellows selected world-wide in any one year does not exceed one-tenth of one percent of the total voting Institute membership.

10. I am a Distinguished Member of the ACM. Since 2015, I have served as an associate editor for the Journal of Parallel and Distributed Computing and I am currently the Associate Editor in Chief for IEEE Transactions on Parallel and Distributed Computing.

11. My work was initially funded by the prestigious National Science Foundation CAREER Award in 2004. The Faculty Early Career Development (CAREER) Program is a Foundation-wide activity that offers the National Science Foundation's most prestigious awards in support of early-career faculty who have the potential to serve as academic role models in research and education and to lead advances in the mission of their department or organization. As a result of this investment, my research findings pioneered the creation of energy measurement

and management technologies that, among other things, influenced the creation of the Energy Star program for compute servers.

12. I've been awarded over \$15M from external funding sources. These investments in my work resulted in over 100 publications in highly selective professional journals and conferences. Moreover, the work led to the issuance of U.S. Patent No. 8,918,657 ("the '657 patent"), entitled "Systems, Devices, and/or Methods for Managing Energy Usage," on which I am listed as a co-inventor.

13. The '657 patent formed the foundational technology used in the venture-backed startup company, MiserWare, that I co-founded in 2006. This patent describes power and energy management techniques that control power and energy use of various devices in deployments. The grano.la software was one commercial embodiment, a decision engine that measures and manages power and energy while guaranteeing performance. The grano.la software has been downloaded by about half a million users in more than 160 countries.

14. I also created the PowerPack power measurement software and hardware framework that provides scientifically sound fine-grain AC and DC power measurements of computer systems and their components. The PowerPack methodology influenced the design of the methodologies used today in the DOE Energy Star program for servers. Section 104 of the Energy Policy Act of 2005

requires federal government agencies to purchase ENERGY STAR-qualified systems when procuring compute servers. Though the exact figure is undisclosed for security and operational reasons, the number of U.S. government-owned compute servers is in the hundreds of thousands.

15. I am the recipient of numerous national and international awards for my work in power measurement and management. In addition to the National Science Foundation Career Award, in 2004 I was also awarded the prestigious Department of Energy Early Career Award. I was also awarded IBM and AMD Faculty Awards for my work with industry. For my corporate leadership as CEO and CTO of MiserWare, I was named Innovator of the Week by Bloomberg Businessweek Magazine.

16. My pioneering work led to an invitation to lead the NSF Technical Report “NSF Report on the Science of Power Management.” This report resulted in several programs that provided millions in funding to energy efficiency work in NSF programs. My work consistently appears in major news media and has appeared in venues as varied as SXSW and the Smithsonian National Museum of American History in Washington, D.C.

17. I have published chapters in nine different textbooks. I have also published over 40 refereed journal publications and over 60 referred conference

papers, a more complete list of which is included in my CV. In addition to my publications, I have given numerous tutorials, talks, presentations, and lectures, in both academic and corporate settings, on electrical energy management.

18. I regularly supervise B.S., M.S., and Ph.D. students that upon graduation work in top tech companies. I teach classes at the undergraduate and graduate levels at Virginia Tech, where I ran the graduate program for a number of years. I regularly teach courses on computer systems and networking, energy efficiency, computer architecture, and parallel computation at the introductory and advanced levels.

III. PRIOR TESTIMONY

19. I have provided technical consulting to several clients in the electrical energy management field in regards to litigation focused on the tools, technologies, decision engines, and various other techniques for in-band and out-of-band energy measurement and management of electrical devices at the systems level. These cases were dismissed or settled before trial.

20. A list of all such cases in which I have consulted can be found in my CV.

IV. COMPENSATION

21. I am being compensated for my services in this proceeding. This

compensation is not contingent upon my performance, the outcome of this case, or any issues involved in or related to this case. I have no financial interest in this matter.

V. MATERIALS CONSIDERED

22. My opinions are based on my experience in this field, and are necessarily formed by my own experiences, materials I have read over the years, and discussions I have had with colleagues during my career. I have also considered the understanding of a person of ordinary skill (“POSITA”) around the time of the invention of the ’243 Patent. In addition, I have reviewed and considered the following materials in forming my opinion:

- The ’243 Patent (Ex-1001);
- Prosecution History of the ’243 Patent (Ex-1002);
- Declaration of Expert, Dr. C. Arthur MacCarley, Ph.D., P.E. (Ex-1003);
- Curriculum Vitae of Dr. C. Arthur MacCarley, Ph.D., P.E. (Ex-1004);
- PCT Patent App. Pub. No. 2006/096854 to Wang *et al.* (“Wang”) (Ex-1005);
- Archived Copies of Published Data from the Alberta Electric Supply Operator (“AESO Report”) (Ex-1006)
- U.S. Patent No. 9,052,904 to Cooley *et al.* (“Cooley”) (Ex-1007);
- Order on Reexamination for Control No. 90/019,303 (Ex-1008);
- Federal Court Management Statistics – Profiles (Sept. 30, 2023) (Ex-

1009);

- District Court Complaint (Aug. 4, 2023) (Ex-1010);
- Motion for Extensions of Time (Jan. 26, 2024) (Ex-1011);
- Alberta Electrical Supply System Study (Oct. 2004) (Ex-1012);
- Alberta Electric Supply Operator – Help Page (Mar. 2007) (Ex-1013);
- RSS Article (Sept. 13, 2006) (Ex-1014);
- History of Power Article (Oct. 1, 2022) (Ex-1015);
- U.S. Patent No. 5,673,497 to St. Louis (“St. Louis”) (Ex-1016);
- Alliance Laundry Systems – Home Laundry Dryers Service Manual (Apr. 2002) (“Service Manual”) (Ex-1017);
- Internet Archive Affidavit (Feb. 7, 2024) (Ex-1018).

VI. UNDERSTANDING OF THE LAW

23. I am not an attorney. For the purposes of this declaration, Patent Owner’s counsel has informed me about certain aspects of the law that are relevant to my opinions. I have applied those legal principles in arriving at my conclusions expressed in this declaration.

A. Claim Construction

24. I understand that the first step in performing a validity analysis of the patent claims is to interpret the meaning and scope of the claims by construing the terms and phrases found in those claims. I understand that a determination of the meaning and scope of the claims is a matter of law.

25. I have been informed that to determine the meaning of the claims, courts consider the intrinsic evidence, which includes the patent's claims, written description, prosecution history, materials incorporated by reference in the patent, and prior art cited in the patent or its prosecution history. Courts give claim terms their ordinary and accustomed meaning as understood by one of ordinary skill in the art at the time of the invention in the content of the entire patent.

26. I have been informed that a patentee may also define his or her own terms to disavow claim scope. Normally, embodiments and examples appearing in the specification will not generally be read into the claims. However, the intrinsic record may resolve ambiguous claims terms where the ordinary and accustomed meaning of the words used in the claims lack sufficient clarity to permit the scope of the claim to be ascertained from the words alone. A term's context in the claims can also be helpful. Differences among the claim terms can also assist in understanding a term's meaning.

27. I have been informed that extrinsic evidence can also be useful in determining the meaning of claims, however, it is less significant than the intrinsic record. Technical dictionaries may be useful to show the way one skilled in the art might use claim terms, but technical dictionaries may provide definitions that are too broad or may not be indicative of how the term is used in the patent.

28. I understand that the claim terms of a patent are to be construed from the point of view of a hypothetical person of ordinary skill in the art (POSITA) in the time frame of the patent's priority date. At times I may refer to a person of skill in the art as simply "a skilled person".

B. Level of Ordinary Skill

29. For the purpose of assessing the level of ordinary skill of POSITA, I have considered the field of the invention, the prior art relevant to that field, and the level of education and expertise of active workers in the field.

30. I understand that Petitioner has taken the position that a POSITA at the time of the invention of the '243 Patent would have had a bachelor's degree in electrical engineering, computer science, or a related degree and would have also had at least two years training or experience with intelligent power-management techniques for electrical or electronic devices that use or control utility grid electricity and that additional advanced educational degrees could substitute for some years of experience, and vice versa.

31. In my opinion, a POSITA at the time of the invention of the '243 Patent would have had a bachelor's degree in electrical engineering, computer science, or a related degree, along with at least two years of professional experience working on techniques for managing the power consumption of

electrical or electronic devices connected to a power grid, with additional education substituting for professional experience and vice versa. My proposed definition is more consistent with the stated field of the invention of the '243 Patent to adapt power consumption of a computational device in response to environmental conditions, (Ex-1001 at 1:6-9), whereas Petitioner's definition introduces terms such as "intelligent" and concepts such as "control [of] utility grid electricity" that in my opinion are unnecessary and unclear.

32. Regardless, I meet either definition of a POSITA based upon my education and experience.

C. Legal Standards for Prior Art

33. I understand that a patent or other publication must first qualify as prior art before it can be used to invalidate a patent claim.

34. I understand that a U.S. or foreign patent qualifies as prior art to an asserted patent if the date of issuance of the patent is prior to the invention of the asserted patent. I further understand that a printed publication, such as an article published in a magazine or trade publication, qualifies as prior art to an asserted patent if the date of publication is prior to the invention of the asserted patent.

35. I understand that a U.S. or foreign patent also qualifies as prior art to an asserted patent if the date of issuance of the patent is more than one year before

the filing date of the asserted patent. I further understand that a printed publication, such as an article published in a magazine or trade publication, constitute prior art to an asserted patent if the publication occurs more than one year before the filing date of the asserted patent.

36. I understand that a U.S. patent qualifies as prior art to the asserted patent if the application for that patent was filed in the United States before the invention of the asserted patent.

D. Legal Standards for Anticipation

37. I have been informed by counsel and understand that to anticipate a patent claim, all of the requirements of that claim must be shown to be present in a single previous device or method that was known of, used, or described in a single previous printed publication or patent. Anticipation should be assessed on a claim-by-claim basis. I also understand that anticipation can occur when an undisclosed limitation is literally missing but is present because the prior art must necessarily function in accordance with, or include, the undisclosed limitation.

38. I have further been informed that only a single reference should be relied upon to anticipate a claim unless any further references are cited solely to:

- a. prove that the primary reference contains an “enabled disclosure;”

- b. explain the meaning of a term used in the primary reference; or
- c. show that a characteristic not disclosed in the reference is inherent.

39. I understand that to anticipate a claim, the prior art does not need to use the same words as the claim, but all the requirements of the claim must have been disclosed, either stated expressly or implied to a person having ordinary skill in the art in the technology of the invention.

40. I understand that for a reference to anticipate a patent claim, that reference must also enable one of ordinary skill in the art to make and use the full scope of the claimed invention without undue experimentation.

41. I understand that documents and materials that qualify as prior art can be used to invalidate a patent claim via anticipation or obviousness.

42. I understand that, once the claims of a patent have been properly construed, the second step in determining anticipation of a patent claim requires a comparison of the properly construed claim language to the prior art on a limitation-by-limitation basis.

43. I understand that a prior art reference “anticipates” an asserted claim, and thus renders the claim invalid, if all elements of the claim are disclosed in that prior art reference, either explicitly or inherently (i.e., necessarily present).

44. I understand that anticipation in an *inter partes* review must be shown by a preponderance of the evidence, which is a higher standard than the reasonable likelihood required to institute an *inter partes* review.

E. Legal Standard for Obviousness

45. I have been informed by counsel and understand that even if a patent is not anticipated, it is still invalid if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a person of ordinary skill in the art.

46. I understand that a person of ordinary skill in the art provides a reference point from which the prior art and claimed invention should be viewed. This reference point prevents one from using his (or her) own insight or hindsight in deciding whether a claim is obvious.

47. I also understand that an obviousness determination includes the consideration of various factors such as:

- a. the scope and content of the prior art,
- b. the differences between the prior art and the asserted claims,
- c. the level of ordinary skill in the pertinent art, and
- d. the existence of secondary considerations such as commercial

success, long-felt but unresolved needs, failure of others, etc.

48. I understand that an obviousness evaluation can be based on a combination of multiple prior art references. I understand that the prior art references themselves may provide a suggestion, motivation, or reason to combine, but other times the nexus linking two or more prior art references is just common sense. I further understand that obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that a motivation to combine references may be supplied by the direction of the marketplace.

49. I understand that if a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.

50. I also understand that practical and common-sense considerations should guide a proper obviousness analysis, because familiar items may have obvious uses beyond their primary purposes. I further understand that a person of ordinary skill in the art looking to overcome a problem will often be able to fit together the teachings of multiple publications. I understand that obviousness analysis therefore considers the inferences and creative steps that a person of

ordinary skill in the art would employ under the circumstances.

51. I understand that a particular combination may be proven obvious merely by showing that it was obvious to try the combination. For example, when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp because the result is likely the product not of innovation but of ordinary skill and common sense.

52. The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. When a work is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or a different one. If a person of ordinary skill can implement a predictable variation, the patent claim is likely obvious.

53. It is further my understanding that a proper obviousness analysis focuses on what was known or obvious to a person of ordinary skill in the art, not just the patentee. Accordingly, I understand that any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

54. I understand that a claim can be obvious through consideration of a single reference, without the need to combine references, if the elements of the claim that are not found explicitly or inherently in the reference can be supplied by the common sense of one of skill in the art.

55. Further, I understand that for an obviousness challenge based on a single reference in view of the knowledge and skill of a POSITA, there must be a motivation to make the combination and a reasonable expectation that such a combination would be successful, otherwise a skilled artisan would not arrive at the claimed combination. In other words, when a gap in a single prior art reference requires filling with, for example, the POSITA's knowledge, there must be a further showing that the POSITA would have arrived at the claimed invention.

56. I understand that contemporaneous and independent invention by others is another consideration supporting an obviousness determination.

57. In summation, my understanding is that prior art teachings are properly combined where a person of ordinary skill in the art having the understanding and knowledge reflected in the prior art and motivated by the general problem facing the inventor, would have been led to make the combination of elements recited in the claims. Under this analysis, the prior art references themselves, or any need or problem known in the field of endeavor at the time of

the invention, can provide a reason for combining the elements of multiple prior art references in the claimed manner.

58. I understand that obviousness in an *inter partes* review must be shown by a preponderance of the evidence, which is a higher standard than the reasonable likelihood standard for instituting *inter partes* review.

VII. CLAIM CONSTRUCTION

59. It is my understanding that Petitioner claims to have “applied plain and ordinary meanings to all terms” (Pet. at 11), without specifying what constitutes the plain and ordinary meaning of any term.

60. As explained in greater detail below, in my opinion, Petitioner’s arguments fail to give certain claim terms at issue their ordinary and customary meaning as understood by a POSITA.

61. In my opinion, with respect to the term “aggregate feed” in claim 8, Petitioner incorrectly claims that “the specification does not use the term.” (Pet. at 56.)

62. In my opinion, Petitioner assumes that the term “simply refers to a feed for delivery of the high demand indicator, as well as other information,” *id.*, and Petitioner subsequently reads any type of feed in Wang as an “aggregate feed,” *id.* at 57-59.

63. There are numerous references to an “aggregate feed” in the ’243 Patent. *See, e.g.*, 4:66-5:7 (“the module 200 further configured to aggregate a feed inclusive of high-demand indicators and publish the **aggregate feed** through a communication means 282”); 5:57-6:2 (“analysis . . . may indicate that one or more local, more environmentally-friendly (or ‘green’) energy producers are near capacity, resulting in issuance of a high-demand indicator through an **aggregated feed** . . . ”); 6:60-66 (“**[a]ggregated feed** publication to the computational device (for example at 108 of FIG. 1 above) is accomplished by a feed publisher logic component 208, which may publish the **aggregate feed** through pushing updated RSS data to registered computational devices 230 . . . ”); 7:8-12 (“computational device 230 memory 233 comprises an **aggregate feed** acquirer logic component 232 configured to acquire the **aggregated feed** from the feed publisher 208 through the communication means . . . ”); 7:16-33 (“The **aggregate feed** acquirer 232 may thus accept incoming data . . . ”); 7:41-50 (“ . . . service provider 284 performs the required feed 280 analysis and aggregate results into an **aggregate feed** with indicators . . . ”).

64. The ’243 Patent uses the terms “aggregate feed” and “aggregated feed” interchangeably. In my opinion, a POSITA reading the ’243 Patent would understand these terms to mean “a feed combining data from a plurality of other

feeds.”

65. In my opinion, the meaning of “aggregate feed” provided above is consistent with the way the term is used in the ’243 Patent, (*see* 4:66-5:7; 5:57-6:2; 6:60-66; 7:8-12; 7:16-33; 7:41-50), as well as the dictionary definition of the term “aggregate,” (EX2014 at 1 (“aggregate” defined as “formed by the collection of units or particles into a body, mass, or amount”))).

66. Petitioner fails to address the meaning of the term “current” in the limitation “automatically reducing a current amount of consumption of electric power from the power grid system” in independent claims 1, 11, 15, and 18. (Petition at 11.) In my opinion, a POSITA reading the ’243 Patent and, in particular, the examples of power reduction actions described therein, would understand the limitation “automatically reducing a current amount of consumption of electric power from the power grid system” to mean a reduction in power consumption that takes place in the present as opposed to some future time.

67. In my opinion, the meaning of “automatically reducing a current amount of consumption of electric power from the power grid system” provided above is consistent with the disclosure in the ’243 Patent, which includes numerous examples of power reductions that take place in the present (*see* Ex-1001 at 1:61-67; 2:66-3:7; 5:32-43; 6:21-33; 8:47-60) and one that takes place in the future (*see*

id. at 8:61-62), as well as the dictionary definition of the term “current,” (EX2015 at 1 (“current” defined as “occurring in or existing at the present time”)).

68. In my opinion, a POSITA would understand that by incorporating the term “current” in the claims, the Applicant clearly intended to cover power reductions that take place in the present.

69. Furthermore, in my opinion, if the Applicant wished to cover power reductions that take place in the future, it could have left the term “current” out of the claim.

VIII. OVERVIEW OF THE '243 PATENT

A. The '243 Patent

70. The '243 Patent is entitled “Adaptive Computing Responsive to Environmental Conditions,” has a priority date of October 24, 2008, and generally relates to products for adapting the power consumption of a computational device in response to environmental conditions. (Ex-1001 at 1:5-10.)

71. In its Background of the Invention, the '243 Patent recognizes that “[a]ll computer usage consumes energy, and depending on the energy source, such usage may also increase green-house gas emissions.” (*Id.* at 1:22-24.)

72. According to the 45 Patent, because of the large burden on the power grid imposed by computer systems, it is estimated “that the energy cost to run a

large computer system may exceed the cost of the system hardware over its useful life.” (*Id.* at 1:31-34.)

73. According to the ’245 Patent, to reduce the energy consumed by a computer system’s computational components, “manufacturers have developed numerous power-efficient technologies: for example, processor speeds and/or use can be adaptively reduced or stopped when the processor is not heavily used, monitors and peripherals can be put in a reduced power-consumption mode[.]” (*Id.* at 1:34-41.)

74. According to the ’245 Patent, these technologies were limited to operating “on a localized level, in response to local considerations, for example, manually triggered by a conscientious (or utility bill-paying) user or automatically by a hardware configuration or a software application running on the system (e.g., triggering a standby state after a given idle time, or in response to a heat monitor detecting a rise in an internal temperature associated with a powered computer component).” (*Id.* at 1:41-49.)

75. The ’243 Patent observes that such “processes may be nullified or insignificant when considered on an overall (e.g. annual) basis when energy used by the device in more-active or high-powered uses is acquired during peak energy demand times, thus utilizing the highest-cost or most environmentally-degrading

energy available to the device.” (*Id.* at 1:49-55.)

76. They “are limited in responsiveness to larger contextual conditions: no consideration is given to the present cost of power used, or to the sources of that power.” (*Id.* at 16-19.)

77. In the Detailed Description of the Invention, the ’243 Patent discloses embodiments of the “present invention.” (*Id.* at 4:65.)

78. For example, FIG 2 of the ’243 Patent discloses “a programmable device or module 200 and computational device 230 according to the present invention.” (*Id.* at 4:63-65.)

79. The ’245 Patent discloses a “module 200 that is configured to acquire feeds or other power-generating contextual, environmental or operating information and data from one or more feed/data providers 280, the module 200 further configured to aggregate a feed inclusive of high-demand indicators and publish the aggregate feed through a communication means 282 to the computational device 230, which may responsively select a power-reduced or relatively high powered configuration.” (*Id.* at 4:66-5:7.)

80. Also included are “[c]ommunication ports or network link/nodes 207/237” that enable network and other communications. (*Id.* at 5:25-5:31.)

81. In the module 200, a “data/feed acquirer logic component 202 [is]

configured to acquire information from a plurality of feed and/or sources 280.”

FIG 2 is reproduced below:

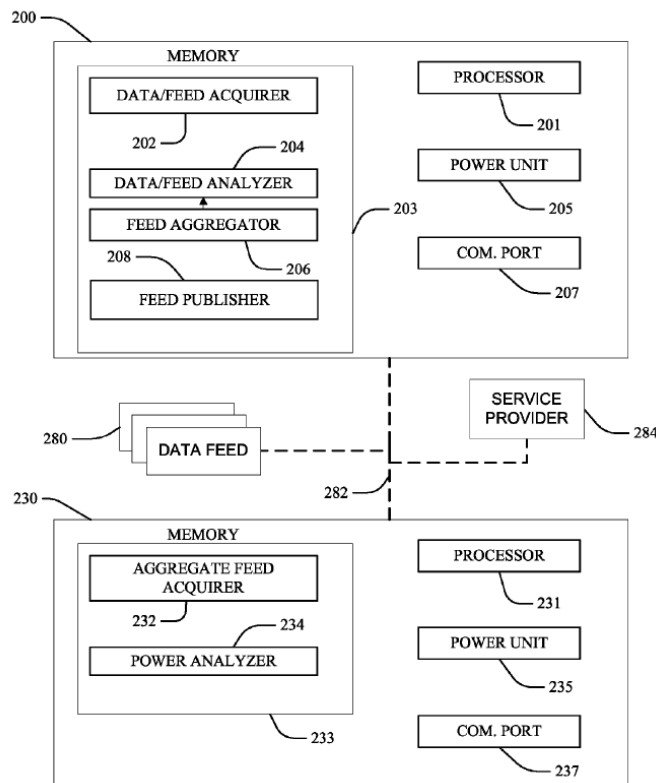


FIG 2

(Ex-1001, FIG 2.)

82. The '243 Patent explains that “[i]nformation data and files received through the feed 280 may be updated regularly, for example by a timer on a provider side or updates driven by changes in data, and the data acquisition component 202 may be configured to regularly check feed files for changes, and if changes are found or occur then download the changed data, update internal state tables with the new download data, then invoke a data/feed analyzer component

204. (*Id.* at 5:35-42.)

83. The data/feed analyzer component 204 is configured, for example, “with a weighted function comprising a linear combination of values obtained from a plurality of different sources or feeds 280 with appropriate weights, wherein if the linear combination is above a certain threshold power savings according to the present invention is triggered or ended.” (*Id.* at 6:27-33.)

84. The ’243 Patent discloses that the “feeds 280 may comprise a variety of feeds and sources.” (*Id.* at 5:57, 5:58 (“energy producer feed 280”), 6:3 (“weather feeds 280”).

85. The ’245 Patent discloses that, for example, “RSS feed embodiments and configurations enable a data acquisition entity (e.g. the programmable module 200 or a service provider) to automatically track energy information providers,” where “RSS generally refers to a family of internet web feed formats used to publish frequently updated content[.]” (*Id.* at 5:44-56.)

86. The ’245 Patent discloses that such feeds may be aggregated and that “the aggregate feed” may be communicated to the computational device. (*Id.* at 4:66-5:7; 5:57-6:2; 6:60-66; 7:8-12; 7:16-33; 7:41-50.)

87. The ’245 Patent uses the term “the aggregated feed” interchangeably with “the aggregate feed.” (*See, e.g., id.* at 6:60-66 (“**Aggregated feed** publication

to the computational device (for example at 108 of FIG. 1 above) is accomplished by a feed publisher logic component 208, which may publish the ***aggregate feed*** through pushing updated RSS data to registered computational devices 230, or by providing a method for the computational devices 230 to pull updated data from the feed publisher 208 or other service provider.”); *id.* at 7:8-12 (“The computational device 230 memory 233 comprises ***an aggregate feed*** acquirer logic component 232 configured to acquire ***the aggregated feed . . .***”).

88. The ’243 Patent further discloses that such “operating environmental condition data” is “analyzed to determine a high electric power demand indication” and, “if the analyzing determines a high electric power demand indication, then a computational device automatically reduces an amount of electric power consumption.” (*Id.* at 1:61-67; 2:66-3:7; 5:32-43; 6:21-33.)

89. The ’243 Patent provides the following examples of power reduction actions:

reducing a clock rate of the CPU 312; reducing a brightness of a monitor 328 of the computer system 304; reducing a waiting time before disks 316/332 of the computer system 304 are suspended; reducing a waiting time before the computer system 304 enters a hibernation or a standby mode; turning off one or more banks of memory 316/332 of the computer system 304; disabling one or more applications providing nonessential services (e.g., turning off the services that check for availability of software upgrades, turning off grid applications, etc.); consolidating loads from one or more computational devices 336 onto the single computer system 304 and turning off the other computational devices 336; scheduling

nonessential operations at a different time (e.g., nonessential software or hardware upgrades)

(*Id.* at 8:47-63)

IX. OPINION

A. THE CITED ART DOES NOT ANTICIPATE OR RENDER OBVIOUS THE CHALLENGED CLAIMS

1. Ground 1: Wang Does Not Render Obvious Claims 1-20

90. In my opinion, Petitioner has failed to show by a preponderance of evidence that it would have been obvious in view of Wang to perform the claimed steps of “analyzing operating environmental condition data to determine an indication of high demand for electric power from a power grid system” (Limitation 1[B]) and “a computational device automatically reducing a current amount of consumption of electric power from the power grid system by the computational device if the analyzing determines the high electric power demand indication” (Limitation 1[C]).

91. I understand that Petitioner alleges that Wang’s “smart appliances” have an “Appliance/Load Shed Application Processor” that “analyzes environmental condition data for relevant information (e.g., regarding power pricing)” and uses the information “to make determinations regarding demand for electric power.” (Pet. at 23-26.)

92. Petitioner doesn’t cite to any portion of Wang that explicitly describes

the smart appliances as analyzing the information to determine a high electric power demand indication as claimed. Instead, Petitioner cites an excerpt from Wang stating that the appliances are “configured to use such information in an autonomous manner” and “[are] capable of independent load-shedding decisions.” (Pet. at 23 (citing Ex-1005 at 15:13-27).)

93. Petitioner then argues that “[a]nalyzing operating environmental condition data is necessary for autonomous operation and independent load-shedding based on that data.” (Pet. at 23.)

94. In my opinion, however, these excerpts omit important information, and a POSITA viewing Wang as a whole would reach a different conclusion.

95. In my opinion, Petitioner mischaracterizes Wang by stating that the “appliances are configured to receive information from UMC transmitters (orange) and ‘use this information to regulate [their] usage . . . [and] minimize utility costs.’” (Pet. at 13.)

96. In my opinion, Petitioner’s intentional editing omits that it is the human user—not the appliance—that does any regulating subject to the needs not of the environment, but to the individual user’s life style choices: “Such appliances, in turn, use this information to regulate appliance usage in a manner to as to minimize utility costs subject to any constraints needed to accommodate

appliance user life style choices.” (Ex-1005 at 41:8-10.)

97. In Wang, “in a particular embodiment, such appliances provide the user with the ability to encode such cost/convenience trade-offs through a suitable man machine interface (MMI). This is illustrated, for example, by way of a programmable HVAC thermostat controller example disclosed below.” (Ex-1005 at 41:11-16.)

98. In my opinion, Wang does not “analyze the operating environmental condition data to determine an indication of a high demand for electric power from the power grid system,” and automatically reduce a current amount of consumption of electric power “if the analyzing determines the high electric power demand indication.” (Ex-1001 at 10:65-11:5.)

99. In my opinion, Wang discloses appliances that reduce consumption based on consumer preferences, and to the extent that any reduction in consumption is achieved, it is not done “automatically” nor is it done by “reducing a current amount of consumption,” because Wang is directed to appliances that prioritize individual consumer choices (*See e.g.*, Ex-1005, 15:13-20 (“In other embodiments, a decentralized system load sheds appliances ***in accordance with consumer lifestyle choices*** . . . In some embodiments, each such appliance is configured to use such information in an autonomous manner.”), 16:11-13 (“Radio

receivers directly embedded within appliances are operable to receive such IBOC or RDS/RBDS modulated tariff data. Load shedding is then performed ***based on consumer programming*** and power tariff rates in force.”)

100. In my opinion, the fact that an appliance may do something “autonomously” as repeated several times by Petitioner does not mean that the appliance is analyzing the data to determine an indication of high demand or automatically reducing a current amount of power consumed by the appliance.

101. In my opinion, there is no evidence that the Wang appliances have a decision engine that can analyze data and determine an indication of high demand.

102. In my opinion, tariffs are not always indicative of demand.

103. In my opinion, the evidence of the Wang displays is lacking as well.

104. For example, Petitioner cites to disclosure in Wang that the display may illuminate a symbol 202 “when the power grid is experiencing overloaded conditions” or “[c]an flash with an intensity . . . [indicative] of the extent to which the power grid is overloaded” as evidence that the display teaches or suggests “analyzing the operating environmental condition data . . . to determine an indication of a high demand for electric power from the power grid system.” (Pet. at 28-29.)

105. Petitioner also cites to a portion of Wang allegedly indicating that the

display can light up symbol 204 in cases where the power grid is in danger of becoming overloaded as further support. (Pet. at 28.)

106. However, in my opinion, there is no suggestion in Wang that the display performs any analysis of operating environmental condition data to determine an indication of a high demand for electric power from the power grid system.

107. In my opinion, a POSITA reading Wang would conclude that the display is **not** performing such an analysis.

108. For example, Wang discusses receiving “control signals to turn on lights 202, 204, and 206.” (Ex-1005 at 30:30-33.) This suggests that the display in Wang is not performing the analysis.

109. Furthermore, the AESO information in Wang characterized by Petitioner as operating environmental condition data is described in Wang as being “communicated using the systems and methods of the present invention to displays 200 so that utility customers can make informed decisions on when to use power.” (Ex-1005 at 36:13-15.) Again, this suggests that the display in Wang is not performing the analysis.

110. In my opinion, these teachings strongly suggest that the display is not intended to perform the claimed analysis, particularly because Wang teaches

against cutting human operators out of the loop. (Ex-1005 at 35:11-14.)

111. Wang states that one of the advantages of the invention “is the fact that no regulatory approval is required to implement the systems and methods of the present invention.” (Ex-1005 at 34:29-30.)

112. Wang goes on to explain that “[b]ecause the new receiver does not control the appliance directly, no electrical safety approvals will be required and there is no liability associated with the display device as the human operator is still “in the loop.”” (Ex-1005 at 35:11-14.)

113. In my opinion, a POSITA reading these statements would not be motivated to cause Wang’s appliances and/or displays to perform the claimed analysis and power reduction in a completely autonomous manner and, in fact, would be discouraged from doing so.

114. In my opinion, even if the display was incorporated into the appliance, this would simply be a distributed version of the same functionality in Wang that requires a human user to operate.

115. In my opinion, the tariff rate data in Wang is not a high electric power demand indication—it is data that may be used to determine a high electric power demand indication. The Petition assumes that tariff rate data is always a direct proxy for electric power demand. While tariff rate data may track with demand in

stable and predictable markets, tariff rate data is also influenced by several factors beyond demand, including supply, market dynamics, geopolitical events, regulations, and external shocks.

116. In my opinion, Petitioner's discussion of the use of tariff rate data in Wang is an implicit admission that Wang is not reducing power consumption based on a high electric power demand indication.

117. In each of the examples relied on by Petitioner, an interface such as a keypad or touch screen and a display unit is provided for the user to control the appliance. (*See, e.g.*, Ex-1005 at 41:8-16; 51:11-14, 19-25, 29-31; 52:3-5, 10-12; 53:33-54:2; 54:8-9; FIG. 8.) In my opinion, these examples further demonstrate the importance of keeping the user in the loop in Wang.

118. In my opinion, Wang teaches against cutting human operators out of the loop to avoid the need for electrical safety approvals and potential liability associated with having the receiver [of data] control the appliance.

119. In my opinion, a POSITA would not be motivated to configure Wang's appliances and/or displays to automatically reduce a current amount of power of consumption of the appliances based on a high electric power demand indication.

120. In my opinion, for at least the reasons discussed above, Petitioner has

failed to show by a preponderance of evidence that claim 1 would have been obvious in view of Wang.

121. It is my understanding that, since claim 2 depends from claim 1, claim 2 is not rendered obvious by Wang for at least all of the reasons discussed above with regard to claim 1.

122. I understand that Petitioner does not dispute the fact that Wang fails to disclose determining a high power demand indicator based on a small size fossil fuel plant coming on-line as recited in claim 2.

123. Instead, Petitioner argues that “[b]ased on the general knowledge of peaking plants and their relationship to grid demand, as well as Wang’s discussion of smart appliances receiving data regarding power producers, a POSA would have found it obvious to configure a smart appliance to receive and make power-consumption determinations based on data regarding peaking plants (i.e., small-size fossil fuel plants) coming online.” (Pet. at 36.)

124. In my opinion, a POSITA would understand that generic references to peaking plants does not imply that a fossil fuel plant is coming on-line.

125. It is my understanding that, since claim 3 depends from claim 1, claim 3 is not rendered obvious by Wang for at least all of the reasons discussed above with regard to claim 1.

126. It is my understanding that, since claim 4 depends from claim 1, claim 4 is not rendered obvious by Wang for at least all of the reasons discussed above with regard to claim 1.

127. I understand that Petitioner does not dispute the fact that Wang fails to disclose an RSS feed as set forth in claim 4.

128. I understand that Petitioner argues “[s]ince RSS is simply XML-formatted plain text, a POSA would have understood an RSS feed as one of a finite number of known protocols for communication of XML or HTML web server data.” (Pet. at 40.)

129. In my opinion, a POSITA would understand that a reference to XML does not imply that an RSS feed is being used because there are many uses of XML that do not require RSS, such as the format for .NET configuration files, data exchanges in SOAP (Simple Object Access Protocol), and for transmitting data in web services; other examples include industry-specific standards for data exchange in finance (XBRL) and healthcare (HL7), mathematical expressions such as MathML and scalable vector graphics, and XML is used in relational databases (e.g., SQL server; Oracle).

130. It is my understanding that, since claim 5 depends from claim 1, claim 5 is not rendered obvious by Wang for at least all of the reasons discussed above

with regard to claim 1.

131. I understand that Petitioner does not dispute the fact that Wang fails to disclose determining an indication of high demand for electric power if environmental condition data indicates an unusual weather condition.

132. I understand that Petitioner argues that “Wang describes operating environmental condition data that includes grid reliability and critical weather warnings (i.e. unusual weather conditions).” (Pet. at 41.)

133. In my opinion, Wang does not provide any disclosure that is related to determining a high power demand indicator based on unusual weather conditions, much less automatically reducing a current amount of power consumption based on unusual weather conditions.

134. In my opinion, a POSITA reading Wang would understand that the “critical weather warning” is merely sent to a display for the individual user’s benefit. (Ex-1005 at 39:25-29 (“Furthermore, critical weather warning . . . Display 200, because of its ongoing use for other utility purposes, is well suited to provide this emergency service and is best able to guarantee message delivery.”)).

135. It is my understanding that, since claim 6 depends from claim 1, claim 6 is not rendered obvious by Wang for at least all of the reasons discussed above with regard to claim 1.

136. It is my understanding that, since claim 7 depends from claim 1, claim 7 is not rendered obvious by Wang for at least all of the reasons discussed above with regard to claim 1.

137. I understand that Petitioner alleges that the additional limitations of claim 7 would have been obvious in view of Wang's disclosure that AESO publishes information (i.e., MCR and TNG) of individual renewable energy sources and, with that information, users are able to postpone energy consuming tasks to points in time when more renewable energy resources are used to generate power. (Pet. at 49-51.)

138. In my opinion, even if it were possible to use the AESO information to determine whether a relatively environmentally-friendly energy producer is near its output capacity, there is no teaching or suggestion in Wang of using such information to determine an indication of high demand for electric power from the power grid system, much less automatically reducing a current amount of power consumed by a computational device from the power grid system.

139. In my opinion, Wang merely discloses that the AESO information can be published to the user display 200 so that the user "can make informed decisions on when to use power." (*See* Ex-1005 at 36:13-15.)

140. In my opinion, even if Wang did determine a high demand indicator

(which it does not), Wang still leaves it up to the user to analyze the data and postpone energy consuming tasks.

141. It is my understanding that, since claim 8 depends from claim 1, claim 8 would not have been obvious for at least the same reasons as claim 1.

Furthermore, in my opinion, claim 8 should be found patentable because Petitioner has failed to show by a preponderance of evidence that the additional limitations of claim 8 would have been obvious in view of Wang.

142. I understand that Petitioner does not allege that Wang discloses the additional limitations of claim 8.

143. I understand, however, that Petitioner argues that the additional limitations would have been obvious because Wang allegedly discloses “values obtained from a plurality of different feeds,” and “a POSA would have been motivated to weigh the data and thereby make aggregated findings concerning power-grid demand.” (Pet. at 55.)

144. It is my understanding that Petitioner does not cite to any prior art in support of its allegation that a POSITA would have been motivated to weigh data from a plurality of feeds in a linear combination to determine an indication of high power demand.

145. It is my understanding that Petitioner instead relies on the unsupported

testimony of its expert, Dr. MacCarley, that I find are conclusory assertions.

146. I understand that Petitioner and Dr. MacCarley allege that the limitations of claim 8 that are missing from Wang would have been obvious because:

- (a) the limitations “would have furthered Wang’s stated goal of ‘allow[ing] customers to make informed choices with regard to energy consumption and load shedding[.]’” (Pet. at 55; Ex-1003, ¶145);
- (b) the limitations are “one of a finite number of known methods for correlating and analyzing data” and would therefore have been “obvious to try” (Pet. at 56; Ex-1003, ¶146); and
- (c) providing the limitations would have been motivated by Wang’s discussion of “user preferences for particular types of energy.” (Pet. at 56; Ex-1003, ¶147.)

147. In my opinion, with regard to Petitioner’s argument (a), a conclusory statement that the additional limitations of claim 8 would have furthered a stated goal of Wang, without any explanation how or why, is not enough to demonstrate obviousness of the additional limitations to a POSITA.

148. In my opinion, the additional limitations of claim 8 (determining an indicator of high power demand by applying a weighted function comprising a

linear combination of values obtained from a plurality of different feeds, and including the high demand indicator in an aggregate feed), would actually frustrate Wang's alleged goal of 'allow[ing] customers to make informed choices with regard to energy consumption and load shedding[],' by withholding the underlying information from the customer and instead providing an indicator in an aggregate feed that is used to automatically reduce power consumption, thereby taking the customer out of the loop.

149. With regard to Petitioner's argument (b), it is my opinion that Petitioner and its expert have not shown that Wang analyzes operating environmental condition data to determine a high electric power demand indication that is used to automatically reduce a computational device's current amount of consumption of electric power.

150. In my opinion, data such as tariffs, which Petitioner equates with the claimed operating environmental condition data, cannot also be the claimed high electric power demand indication.

151. In my opinion, Petitioner has not identified any analysis in Wang that determines a high electric power demand indication from such data, much less a high electric power demand indication that is used to automatically reduce a current amount of power consumed by a computational device.

152. In my opinion, even if Wang did disclose such an analysis, Petitioner provided no evidence (other than a conclusory statement) that the additional limitations are “one of a finite number of known methods for correlating and analyzing data.”

153. In my opinion, there were numerous possible alternatives for analyzing data at the time of the invention, such as other linear methods (e.g., linear regression methods, linear mixed models, stochastic gradient descent, Bayesian linear regression, matrix factorization techniques, etc.), non-linear methods (such as polynomial regression, quadratic programming, genetic algorithms, etc.), analysis of variants (ANOVA), matrix decomposition, principle component analysis, clustering methods (such as k-means clustering, k-nearest neighbors, etc.), neural networks, statistical classifiers, decision trees, random forest techniques or even providing the high demand indicator in separate feeds instead of an aggregate feed, as well as a great many others.

154. With regard to Petitioner’s argument (c), it is my opinion that the fact that a user may prefer to postpone energy consuming tasks to those points in time when more renewable energy sources are being used to generate power would not have motivated a POSA to weigh the information from various feeds to determine an indication of high electrical power demand that is used to automatically reduce

a computational device's current amount of power consumption.

155. It is my understanding that Petitioner has provided no evidence (other than unsupported expert testimony) linking a user's preference for particular types of energy with determining an indication of high electrical power demand or automatically reducing a computational device's current amount of power consumption based on such an indication.

156. I understand that Petitioner argues that a POSA would be motivated "to weigh the information from the various feeds to suit user preferences" (e.g., to postpone energy consuming tasks until more renewable energy sources are being used to generate power). (Pet. at 56.)

157. In my opinion, even if this were true, the result would not provide all the missing limitations of claim 8.

158. In my opinion, postponing energy consuming tasks does not involve reducing a **current** amount of power consumed by the computational device.

159. In my opinion, Petitioner has not shown that the alleged motivation to weigh information from various feeds to suit user preferences would involve a linear combination of values, determining a high electric power demand indication from the values, or including the indicator in an aggregate feed if the linear combination is above a certain threshold.

160. In my opinion, with regard to claim 8, a POSITA reading the '243 Patent would readily understand the term “the aggregate feed” to mean “a feed combining data from a plurality of other feeds.” In my opinion, a POSITA would conclude that the '243 Patent uses the term “the aggregate feed” and “the aggregated feed” interchangeably.

161. In my opinion, the meaning of “the aggregate feed” presented above is consistent with the disclosure of the '243 Patent and with the dictionary definition of the term “aggregate.”

162. In my opinion, Petitioner has provided no evidence that the feeds in Fig. 17 disclose the aggregate feed of claim 8, unless one ignores the word “aggregate” in the term.

163. In my opinion, when the term “the aggregate feed” is properly construed, it is clear that the various communication feeds between appliances 1720 and 1730 and meters 1502 in Fig. 17 of Wang do not disclose an aggregate feed, because none of the feeds are shown or described as combining data from a plurality of other feeds.

164. In my opinion, Petitioner has not shown by a preponderance of evidence that Wang combines a plurality of feeds into an aggregate feed, much less applying a weighted function comprising a linear combination of values obtained

from a plurality of different feeds and including a high demand indicator in such an aggregate feed.

165. In my opinion, even if it would have been obvious to determine a high power demand indicator by applying a weighted function comprising a linear combination of values obtained from a plurality of different feeds (which has not been demonstrated), Petitioner has not shown by a preponderance of evidence that it would have been obvious to include the high power demand indicator in an aggregate feed or to automatically reduce a current power consumption of a computational device if the analyzing determines a high power demand indicator.

166. It is my understanding that, since claim 9 depends from claim 1, claim 9 is not rendered obvious by Wang for at least all of the reasons discussed above with regard to claim 1.

167. With respect to the additional limitations recited in claim 9, it is my opinion that Petitioner has not shown by a preponderance of evidence that Wang teaches or suggests determining the high electric power demand indication in response to “a rate of change of a price of electricity.”

168. I understand that Petitioner alleges that while “Wang does not explicitly teach data regarding the rate of change of the price of electricity . . . Wang does describe real-time pricing data.” (Pet. at 60.)

169. In my opinion, the fact that Wang receives tariff information over time, and the fact that a rate of change may be calculated using tariff information over time, does not imply that it would have been obvious to modify Wang to calculate a rate of change of a price of electricity, much less to determine a high electric power demand indication based on calculating a rate of change. This is particularly true because tariff rate data is not always a direct proxy for electric power demand. While tariff rate data may track with demand in stable and predictable markets, tariff rate data is also influenced by several factors beyond demand, including supply, market dynamics, geopolitical events, regulations, and external shocks.

170. It is my understanding that, since claim 10 depends from claim 9, and claim 9 depends from claim 1, claim 10 is not rendered obvious by Wang for at least all of the reasons discussed above with regard to claim 1 and claim 9.

171. In my opinion, independent claim 11 recites essentially the same limitations that were discussed above with respect to claim 1 (e.g., 1[B] and 1[C]) that are not obvious in view Wang.

172. Therefore, for the same reasons as discussed above with respect to claim 1, it is my opinion that Wang does not render obvious claim 11.

173. It is my understanding that, since claim 12 depends from claim 11,

claim 12 is not rendered obvious by Wang for at least all of the reasons discussed above with regard to claim 11. Furthermore, since claim 12 includes essentially the same limitations as claim 2, it is my opinion that claim 12 is not obvious in view of Wang for the same reasons as claim 2.

174. It is my understanding that, since claim 13 depends from claim 12, claim 13 is not rendered obvious by Wang for at least all of the reasons discussed above with regard to claim 12. Furthermore, since claim 13 includes essentially the same limitations as claim 5, claim 13 is also not obvious in view of Wang for the same reasons as claim 5.

175. It is my understanding that, since claim 14 depends from claim 12, claim 14 is not rendered obvious by Wang for at least all of the reasons discussed above with regard to claim 12. Furthermore, since claim 14 includes essentially the same limitations as claim 9, claim 14 is also not obvious in view of Wang for the same reasons as claim 9.

176. In my opinion, with regard to claims 9 and 14, Petitioner has not shown by a preponderance of evidence that Wang teaches or suggests determining the high electric power demand indication in response to “a rate of change of a price of electricity.”

177. I understand that Petitioner alleges that while “Wang does not

explicitly teach data regarding the rate of change of the price of electricity . . .

Wang does describe real-time pricing data.” (Pet. at 60, 68 (Claims 12-14 “are otherwise analogous to Claims 2, 5, and 9, respectively, and are obvious for similar reasons.”).)

178. In my opinion, the fact that Wang receives tariff information over time, and the fact that a rate of change may be calculated using tariff information over time, does not necessarily lead to the conclusion that it would have been obvious to modify Wang to calculate a rate of change of a price of electricity, much less to determine a high electric power demand indication based on calculating a rate of change.

179. In my opinion, claim 15 includes essentially the same limitations as claim 1 and, therefore, Wang does not render obvious claim 15 for the same reasons as discussed above with respect to claim 1.

180. It is my understanding that, since claim 16 depends from claim 15, claim 16 is not rendered obvious by Wang for at least all of the reasons discussed above with regard to claim 15.

181. It is my understanding that, since claim 17 depends from claim 15, claim 17 is not rendered obvious by Wang for at least all of the reasons discussed above with regard to claim 15. Furthermore, since claim 17 includes essentially

the same limitations as claim 7, it is my opinion that claim 17 is also not obvious in view of Wang for the same reasons as claim 7.

182. In my opinion, claim 18 includes essentially the same limitations as claims 1, 11, and 15. Therefore, claim 18 is not rendered obvious by Wang for at least all of the reasons discussed above with respect to claims 1, 11, and 15.

183. It is my understand that, since claim 19 depends from claim 18, claim 19 is not rendered obvious by Wang for at least all of the reasons discussed above with regard to claim 18.

184. It is my understanding that, since claim 20 depends from claim 18, claim 20 is not rendered obvious by Wang for at least all of the reasons discussed above with regard to claim 18.

2. Ground 2: Wang-AESO Does Not Render Obvious Claims 2, 12-14, and 20

185. Furthermore, AESO does not provide any disclosure that is related to a small-size fossil fuel plant *coming on-line*. In my opinion, mere existence of a coal plant is not enough. Therefore, AESO would not have motivated a POSITA to determine a high power demand indicator if a small-size fossil fuel plant comes online.

3. Ground 3: Cooley Does Not Anticipate Claims 1, 3, 11, 15, and 18

186. In my opinion, with respect to claim 1, Petitioner has failed to show by a preponderance of evidence that Cooley discloses “a computational device automatically reducing a current amount of consumption of electric power from the power grid system by the computational device if the analyzing determines the high electric power demand indication” (Limitation 1[C]).

187. In my opinion, a POSITA would understand that the ’243 Patent gives examples of two different types of power reduction actions—those that reduce a current amount of consumption of electrical power and those that reduce an amount of consumption at some later time. (Ex-1001 at 8:49-63.)

188. In my opinion, examples of power reduction actions that reduce a current amount of consumption of electric power include: “reducing a clock rate of the CPU 312; reducing a brightness of a monitor 328 of the computer system 304; reducing a waiting time before disks 316/332 of the computer system 304 are suspended; reducing a waiting time before the computer system 304 enters a hibernation or a standby mode; turning off one or more banks of memory 316/332 of the computer system 304; disabling one or more applications providing nonessential services (e.g., turning off the services that check for availability of software upgrades, turning off grid applications, etc.); consolidating loads from

one or more computational devices 336 on the single computer system 304 and turning off the other computational devices 336.” (Ex-1001 at 8:49-60.)

189. In my opinion, an example of a power reduction action that does not reduce a current amount of consumption of electric power is scheduling nonessential operations at a different time (e.g., nonessential software or hardware upgrades). (Ex-1001 at 8:61-62.)

190. In my opinion, Petitioner has not even attempted to show that Cooley automatically reduces a current amount of consumption of electric power.

191. I understand that Petitioner relies on scheduling for this limitation, which does not affect the current amount of consumption of electric power. (See Pet. at 91 (“one or more modules . . . determine whether to reschedule tasks on computing devices based on power-availability information for a power grid.”))

192. I understand that the Petition describes Cooley as allowing “computing devices to reschedule tasks based on power-availability information for a power grid.” (Pet. at 84; see Pet. at 89 (“In Cooley, ‘the system may determine whether to reschedule the task on the computing device based on the power-availability information received in step 320 [green].’”), Pet. at 92 (“For example, ‘after determining that there is not sufficient power available to execute the task, the task permit may be postponed,’ and ‘may remain postponed until there

is sufficient power available on the power grid, as determined by power-availability module 106.”)

193. In my opinion, a POSITA would understand that Cooley’s disclosure of rescheduling or postponing task permits does not result in a computational device automatically reducing a current amount of consumption of electric power from the power grid.

194. In my opinion, Cooley’s task permits that are rescheduled or postponed is directed to future tasks that are in the system’s regular schedule—as opposed to claim 1 of the ’243 Patent that is directed to automatic reduction of a current amount of consumption.

195. I understand that Cooley discloses that “[c]omputing devices often execute various tasks, such as automatic disk defragmentation and anti-virus scans, on regularly scheduled bases. Unfortunately, when a sufficient number of computing devices execute such tasks simultaneously, the collective activity of the computing devices may contribute to spikes on a power grid.” (Ex-1007 at 1:10-15.)

196. In my opinion, rescheduling or postponing tasks so as to avoid predicted spikes on a power grid is not the same as, and not similar to, claim 1 of the ’243 Patent that requires automatic reduction of current electrical power

consumption.

197. As such, in my opinion, Petitioner has failed to show by a preponderance of evidence that Cooley anticipates claim 1 of the '243 Patent.

198. In my opinion, since claim 3 depends from claim 1, claim 3 is not anticipated by Cooley for at least all of the reasons discussed above with regard to claim 1.

199. In my opinion, since claim 11 includes essentially the same limitations as claim 1, claim 11 is not anticipated by Cooley for at least all of the reasons discussed above with regard to claim 1.

200. In my opinion, since claim 15 includes essentially the same limitations as claim 1, claim 15 is not anticipated by Cooley for at least all of the reasons discussed above with regard to claim 1.

201. In my opinion, since claim 18 includes essentially the same limitations as claim 1, claim 18 is not anticipated by Cooley for at least all of the reasons discussed above with regard to claim 1.

X. CONCLUSIONS

202. I reserve the right to revise, supplement, and/or amend my opinions in this declaration based on future positions taken by Petitioner and/or their experts, additional documents, testimony, or other information provided by Petitioner or its

witnesses, any orders from the Court, or as I may otherwise find necessary and to offer rebuttal analyses and/or opinions to any such positions of the Petitioner.

203. I expect to continue to develop my opinions discussed in this report. I also reserve the right to supplement my opinions based on information obtained from additional discovery or from Petitioner's experts, as indicated above.

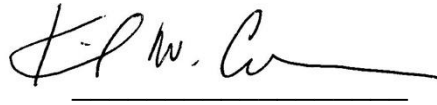
204. When called upon to do so, I will offer testimony at trial or otherwise regarding these opinions and will offer rebuttal testimony as appropriate throughout the remainder of this proceeding.

205. I currently hold the opinions expressed in this declaration, but my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

206. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both under Section 1001 of Title 18 of the United States Code and that any such willful false statements may jeopardize the validity of the patent at issue in this proceeding.

Case IPR2024-00388
Patent No. 8,291,243
Declaration of Dr. Kirk W. Cameron

Dated: November 27, 2024

A handwritten signature in black ink, appearing to read "K. W. Cameron", written over a horizontal line.

Dr. Kirk W. Cameron

Kirk W. Cameron, Ph.D.

<http://www.cs.vt.edu/~cameron> +1.540.557.7452 (M) kirk.w.cameron@gmail.com

ACADEMIC EXPERIENCE	VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY	<i>August 2005-Present</i>
	Associate Vice President for Academic Affairs, Innovation Campus	<i>August 2023-Present</i>
	Faculty Lead, Innovation Campus	<i>August 2022-Present</i>
	Founder and Executive Director, cs/root	<i>August 2022-Present</i>
	Founder and Executive Director, BURGs	<i>August 2018-Present</i>
	Assoc. Dept. Head for Research and Engagement (5 direct reports)	<i>August 2018-2022</i>
	QUEENS UNIVERSITY BELFAST World Leading Researcher Fellow	<i>August 2017-May 2018</i>
	BRITISH ROYAL ACADEMY Distinguished Visitor Fellowship	<i>August 2017-May 2018</i>
	Assoc. Dept. Head for Graduate Studies	<i>August 2014-2017</i>
	Director, stack@cs Center for Computer Systems	<i>June 2013-2023</i>
	Professor of Computer Science	<i>June 2012-Present</i>
	Faculty Fellow, College of Engineering	<i>May 2007-Present</i>
	Associate Professor of Computer Science	<i>Aug 2005-May 2012</i>
	Founder and Director, Scalable Performance Laboratory (SCAPE)	<i>August 2001-Present</i>
CORPORATE EXPERIENCE	UNIVERSITY OF SOUTH CAROLINA Asst. Prof. of CSE	<i>August 2001-August 2005</i>
	FLORIDA INSTITUTE OF TECHNOLOGY Asst. Prof. of CS	<i>August 2000-July 2001</i>
	MISERWARE, INC.	<i>August 2007-2014</i>
	Founder, CEO, and CTO	
	Venture-backed VT Spinout Company; Raised over \$3M in venture capital funding.	
	INTEL CORPORATION	<i>May 1996-January 1997</i>
	Engineer: 82450 NX Multiprocessor Chipset Design Team	
	LABORATORY EXPERIENCE	
	LOS ALAMOS NATIONAL LABORATORY CIC DIVISION	<i>January 1998-August 2000</i>
	Research Assistant: Parallel Architecture Laboratory, ASCI (Accelerated Strategic Computing Initiative)	
	SELECT ACADEMIC HONORS	
	IEEE FELLOW For contributions to measurement and management of energy in high-performance computing systems	<i>January 2021</i>
	DEAN'S AWARD FOR EXCELLENCE IN SERVICE	<i>April 2024</i>
	DEAN'S AWARD FOR EXCELLENCE IN RESEARCH	<i>September 2020</i>
	INFOCOMP 2018 Best Paper Award	<i>September 2018</i>
	ACM Distinguished Scientist for "Contributions to Computing"	<i>November 2017</i>
	LLNL Deputy Director's Science/Tech Excellence Award	<i>September 2017</i>
	U.K. ROYAL ACADEMY OF ENGR. Distinguished Visiting Fellowship	<i>August 2017-May 2018</i>
	ACM HPDC 2017 – Karsten Schwan Memorial Best Paper Award	<i>July 2017</i>
	MAGPI MAGAZINE -- #2 RPI PROJECT OF ALL TIME LIST (SeeMore)	<i>September 2016</i>
	OUTSTANDING SERVICE – IPDPS 2016 (also CCGRID 2014)	<i>May 2016</i>
	INT'L MAKERS FAIRE 2015 – 3 Editor's Choice Awards (SeeMore)	<i>September 2015</i>
	AMD FACULTY AWARD	<i>May 2014</i>
	NAE FRONTIERS SYMPOSIUM Organizer, (also Invitee 2008, 2010)	<i>May 2014</i>
	VT SCHOLAR OF THE WEEK	<i>October 2010</i>
	MICROSOFT FACULTY SUMMIT (also 2007)	<i>June 2009</i>
	IBM FACULTY AWARD	<i>July 2007</i>
	VT COE FACULTY FELLOW	<i>May 2007</i>
	IEEE/ACM SUPERCOMPUTING Best Paper Finalist	<i>November 2006</i>
	USC COEIT Young Investigator Research Award	<i>May 2005</i>
	DEPARTMENT OF ENERGY CAREER AWARD	<i>August 2004</i>
	NATIONAL SCIENCE FOUNDATION CAREER AWARD	<i>January 2004</i>
SELECT CORPORATE	ROANOKE-BLACKSBURG TECH COUNCIL Rising Star Award	<i>May 2013</i>
	BLOOMBERG BUSINESSWEEK MAGAZINE Innovator of the Week	<i>October 2011</i>

HONORS	PC MAGAZINE – TOP 20 FREE UTILITY APP (GRANO.LA) TIME MAGAZINE – TOP 20 GREEN TECH IDEA (GRANO.LA) MINDSHARE NETWORK – CEO Networking and Mentoring Program	<i>February 2011</i> <i>December 2010</i> <i>December 2009</i>
GREEN IT EXPERIENCE	GRANO.LA SOFTWARE Over 500K users in 160+ countries. SPEC POWER BENCHMARK Founding subcommittee member. ENERGY STAR FOR SERVERS (DOE) Consulting member. IEEE COMPUTER Green IT columnist, associate editor. THE GREEN500 LIST (GREEN500.ORG) Founder THE UPTIME INSTITUTE Fellow	<i>April 2010 – March 2014</i> <i>June 2005 – Present</i> <i>August 2005 – Present</i> <i>January 2009 – January 2017</i> <i>January 2006 – Present</i> <i>August 2008 – Present</i>
EDUCATION	LOUISIANA STATE UNIVERSITY , Baton Rouge, LA Doctor of Philosophy in Computer Science UNIVERSITY OF FLORIDA , Gainesville, FL Bachelor of Science in Mathematics	<i>August 2000</i> <i>April 1994</i>

NOTABLE ADMINISTRATIVE ACCOMPLISHMENTS

Associate Vice President for Academic Affairs, Innovation Campus, Virginia Tech (2023-Present). Oversee all academics at the Innovations campus including faculty affairs, student affairs, professional degree program design and implementation, outreach, establishing community, etc. Lead role in management, hiring, and development of experiential learning pedagogy for (at scale) 700 M.Eng. graduates per year across 2 degree programs.

Founding Faculty Lead, Innovation Campus, Virginia Tech (2022-Present). Lead faculty, or department head equivalent, with 12 Tenured faculty and 5 Collegiate Faculty spanning Computer Science and Computer Engineering (as of 8/23). Grow faculty to 50 total at full buildout (5-7 years).

Creation of CS/root Entrepreneurial Hub, Virginia Tech (2022-Present). PI and co-founder of cs/root, an entrepreneurial hub that brings together VT CS alumni and friends that are technical founders to mentor Region 2 would-be entrepreneurs coming from a technical background. This hub was inspired by my struggles as a technical-founder entrepreneur.

Creation of Associate Department Head for Research and Engagement (2018-2022): Recruited by DH (Cal Ribbens) to create position to manage CS Research, Marketing, Communications, Alumni relations, Corporate relations, Economic development

- ◆ Recruited and hired 4 AP/faculty personnel and 1 staff to handle aspects of research and engagement mission
- ◆ Responsible for working with companies to identify research opportunities
- ◆ Rebranded CS|Source corporate membership program and doubled revenue twice
- ◆ Via CS|Source provided \$100k/year in undergraduate merit-based scholarships since 2019 to CS students
- ◆ PI for \$500k Go-Virginia Economic Development Grant for department-led blockchain entrepreneurial activities
- ◆ Contributed to **CS Grad Ranking US News (from #40 to #38)**. Now tied with: NYU, Rutgers, Texas A&M, UC Boulder.

Research Leadership (2013-2022): Recruited by DH (Barbara Ryder) to direct Center for High-End Computing Systems (CHECS)

- ◆ Rebranded and broadened to stack@cs Center for Computer Systems (~1 dozen faculty in systems and security)
- ◆ Doubled external grant funding (\$1M→\$2M annually) over 5 years (2013-2018); on track to double again by 2023
- ◆ Designed protocols for hiring and mentoring systems faculty for 4 years – 5 NSF and 1 DoD Early Career awards
- ◆ Led center to first-ever ranking in **US News Computer Systems Programs (#26 in 2022)**. Tied with USC, UChicago, Rice.

Graduate Program Leadership (2014-2017): Recruited by DH (Barbara Ryder) to direct the CS MS/PhD graduate program

- ◆ Responsible for matriculation of ~250 graduate students per year (~60% PhD, ~40% MS)
- ◆ Created Draft Day event for unification and quality control of graduate recruitment; adopted permanently by department
- ◆ Increased substantially the departments campus-wide competitiveness for graduate scholarships and fellowships
- ◆ Led development and broad adoption of automated software for annual student performance and faculty evaluations

Broadening Participation Leadership (2014-Present):

- ◆ Led innovative broadening participation plan to increase student participation from underrepresented groups
- ◆ Fostered pipeline from CS systems intro courses into the BS/MS, MS and PhD programs

- ◆ Increased research participation (2x) above department norms for women (50%) and African Americans (20%).
- ◆ Scaling effort to create Broadening Undergraduate Research Group for Systems (BURGS).
- ◆ Demonstrated SeeMore kinetic sculpture to 100k+ science and technology faire attendees (tens of thousands K-12)
- ◆ Demonstrated LACE kinetic sculpture to 30k+ visitors at Smithsonian National Museum of American History.

Entrepreneurial Leadership (2006-2014):

- ◆ Founder, CEO, CTO of energy measurement and management startup based on externally funded research
- ◆ Raised >\$3M in venture capital and grew company to 10 employees
- ◆ Mindshare DC-area executive startup management course (by invitation only) and membership Class of 2009
- ◆ Released commercial software and grew user base to 500k users in 160+ countries

Other Relevant Leadership:

- ◆ Elected (by CS faculty) and appointed chair (by dean) of 5-year department head performance review (2020-2021)
- ◆ Elected (by CS faculty) to Tenure and Promotion (Personnel) committee for multiple 3-year terms (Chair: 2015-2016)
- ◆ Appointed (by CS DH) to Faculty Innovation Campus Advisory Board (Chair: Lance Collins, Director Innovation Campus)
- ◆ Initiated many aspects of CS mentoring program for new faculty (mock CAREER panels, mentor structure, etc.)

SELECT FUNDING (Total External Funding as PI: ~\$13M, Total External Funding: ~\$16M)

- [LLNL] Lawrence Livermore National Laboratory, “Automating AI/ML-based Tuning for High-performance Computing,” **\$98,978**, 12/6/22 – 5/31/24. Kirk W. Cameron (PI). [Department of Energy, Office of Science.]
- [COSTAR] CoStar Group, “Systems Capstone: Emergent Computing for apartments.com,” **\$25,000**, 1/1/23 – 5/14/23. Kirk W. Cameron (PI).
- [GOVA] Growth and Opportunity Virginia Grant, “cs/root entrepreneurial hub,” **\$250,000**, 10/15/2022-10/14/2023. Kirk W. Cameron (**VT Lead**). I am the lead on this economic development project related to entrepreneur training and education.
- [NSF] National Science Foundation, “CSR: Large: VarSys: Managing variability in high-performance computing systems,” **\$1,200,000**, 8/15/19 – 8/14/23. Kirk W. Cameron (**PI**), Danfeng Yao (co-PI), Layne T. Watson (co-PI), Ali Butt (co-PI), Yili Hong (co-PI), Godmar Back (SP). [NSF CNS #1838271]
- [NSF] National Science Foundation, “CNS: CORE: Small: iLORE: Computer Systems Performance Integrated Lineage Repository,” **\$500,000**, 10/01/2019 - 9/30/2023. Kirk W. Cameron (**PI**), Margaret Ellis (co-PI), Godmar Back (co-PI). [NSF CNS #1939076]
- [NSF] National Science Foundation, “SPX: Collaborative Research: Cross-stack Memory Optimizations for Boosting I/O Performance of Deep Learning HPC Applications,” **\$1,200,000**, 10/01/2019 - 9/30/2022. Ali Butt (VT PI), Xun Jian (VT co-PI), Kirk W. Cameron (**VT co-PI**), Yue Cheng (GMU PI). [NSF CCF #1919113]
- [VT] VT ICAT and VT ICTAS, SEAD Program, “Ada: Understanding Decentralized, Distributed Computing and Blockchains through Kinetic Sculpture,” **\$75,000**, 9/1/20 – 8/31/22. Sam Blanchard, Kirk W. Cameron.
- [B1] Block.One, “VT Blockchain Virtual Laboratory,” **\$50,000**, 11/1/2018-6/1/2020. Kirk W. Cameron (**PI**). This is a grant to support research, development, and training on blockchain technologies in Capstone courses.
- [GOVA] Growth and Opportunity Virginia Grant, “Blockchain Ecosystem Catalyst,” **\$500,000**, 10/15/2019-10/14/2021. Kirk W. Cameron (**VT Lead**). I am the lead on this economic development project related to blockchain training and education.
- [RAE] Royal Academy of Engineering Distinguished Visiting Fellowship, “Co-design of hardware and software for variability in high-performance computing systems,” **£3,300 (\$4,573)**, 2017-2018. Kirk W. Cameron (**PI**), Dimitrios Nikolopoulos (QUB Host). Personal Share: \$4,573. [UK-wide, highly competitive]
- [QUB] “World Leading Researcher” Faculty Fellowship, The Queen’s University – Belfast, “Co-design of hardware and software for variability in high-performance computing systems,” **£108,269 (\$150,000)**, 2017-2018. Kirk W. Cameron (**PI**). Personal Share: \$150,000. [world-wide, highly competitive]
- [NSF] National Science Foundation, “CSR: Large: VarSys: Managing variability in high-performance computing systems,” **\$1,200,000**, 8/15/16 – 8/14/19. Kirk W. Cameron (**PI**), Danfeng Yao (co-PI), Layne T. Watson (co-PI), Ali Butt (co-PI), Yili Hong (co-PI), Godmar Back (SP). [NSF CNS #1565314]

[MITRE] Mitre Corporation, “Enhancement of Senior Capstone Projects with Mitre,” **\$25,000**, 8/22/16 – 12/15/16. Kirk W. Cameron (PI). Personal Share: \$25,000.

[NSF] National Science Foundation, “Exploiting slowdowns for speedup in power-scalable HPC systems,” **\$500,000**, 8/1/14 – 7/31/17. Kirk W. Cameron (PI), Ali Butt (co-PI). Personal Share: \$250,000. [NSF #1422788]

[NSF] National Science Foundation, “Collaborative: Application-aware Energy Modeling and Power Management for Parallel and High Performance Computing,” **\$500,000**, 8/1/14 – 7/31/17. PIs: Kirk W. Cameron (VT), Yonghong Yan (UHouston). Personal Share: \$250,000. [NSF #1422712]

[AMD] Advanced Micro Devices, “Power and energy measurement of mobile devices,” **\$75,000**, 5/1/14 – 4/30/15. Kirk W. Cameron (PI). Personal Share: \$75,000.

[NSF] National Science Foundation, “Kinetic Computing Sculpture: A functional parallel cluster of Raspberry Pi computers that inspire computational thinking,” **\$181,395**, 9/23/13 – 9/23/14. Kirk W. Cameron (PI), Aditya Johri (co-PI), Sam Blanchard (Senior Personnel). Personal Share: \$131,395. [NSF # 1355955]

[VT] VT Institute for Creativity, Arts, and Technology, SEAD Program, “A kinetic sculpture and functional parallel cluster of Raspberry Pi computers,” **\$25,000**, 7/1/13 – 7/1/14. Sam Blanchard, Kirk W. Cameron, Ali Butt.

[NSF] National Science Foundation, “SBIR Phase II: Intelligent Software Power Management for Windows-based Systems,” **\$350,000**, 9/15/10 – 9/14/12. Awarded to MiserWare, Inc. (Kirk W. Cameron, CEO)

[NSF] National Science Foundation, “CSR: Large: Collaborative Research: Multi-core Applications Modeling Infrastructure (MuMI),” **\$2,400,000**, 9/1/09 – 8/31/14. PIs: Kirk W. Cameron (VT), Shirley Moore (Utenn), Valerie Taylor (TAMU). Personal share: \$800,000.

[NSF] National Science Foundation, “CSR: Medium: Collaborative Research: GridPac: A Resource Management System for Energy and Performance Optimization on Computational Grids,” **\$1,100,000**, 9/1/09 – 8/31/13. PIs: Kirk W. Cameron, Jack Dongarra (Utenn), Ishfaq Ahmad (UTSA), Sanjay Ranka (UF). Personal share: \$180,000.

[NSF] National Science Foundation, “SBIR Phase I: Intelligent Software Power Management on Multicore Systems,” **\$100,000**, 5/1/10 – 9/15/10. Awarded to MiserWare, Inc. (Kirk W. Cameron, CEO)

[NSF] National Science Foundation, “Metrics And Methodologies for High Performance System Energy Benchmarking,” **\$200,000**, 7/31/08 -7/30/09. Kirk W. Cameron (PI), Wu-Chun Feng (co-PI). Personal share: \$100,000

[NSF] National Science Foundation, “CSR-AES: Thermal Conductors: Runtime Software Support for Proactive Heat Management in Advanced Execution Systems,” **\$350,000**, 7/30/07-7/29/10. Kirk W. Cameron (PI), Dimitris Nikolopoulos (co-PI). Personal share: \$175,000.

[NSF] National Science Foundation, “CRI: MISER: A High-Performance Power-Aware Cluster,” **\$500,000**, 9/18/07-9/17/10. Kirk W. Cameron (PI), Dimitris Nikolopoulos (co-PI), Adrian Sandu (co-PI). Personal share: \$200,000.

[NSF] National Science Foundation, “High-Performance Power-Aware Computing Workshop,” **\$5,000**, 9/21/07-1/3/09. Kirk W. Cameron (PI). Personal share: \$5,000.

[IBM] IBM Faculty Award, “Building the Tree of Life using IBM BlueGene/L and Cell Broadband Engine Technologies”, **\$38,000**, 7/1/07 – 6/30/08. Kirk W. Cameron (PI). Personal share: \$38,000

[ML] Merrill Lynch & Co. Inc, “Integrating PowerPack technologies in the Virtual Server Switch,” **\$55,000**, 7/1/07 – 6/30/08. Kirk W. Cameron (PI). Personal share: \$55,000.

[CS] Crucial Security, “Study of Parallel I/O,” **\$25,000**, 1 semester. 9/1/06-12/15/06. Kirk W. Cameron (PI). Personal share: \$25,000.

[NSF] National Science Foundation, “CCF: REU Supplement for high-performance, power-aware, distributed computing,” **\$12,000**, 1 year. 5/15/06-5/14/07. Kirk W. Cameron (PI). Personal share: \$12,000.

[NSF] National Science Foundation, “Collaborative Research: CSR(SMA): Scalable performance modeling and analysis framework,” **\$50,000**, 1 year. 9/1/05-8/31/06. Kirk W. Cameron (PI, VT), Xian-He Sun (PI, IIT). Personal share: \$25,000.

[DOE] Department of Energy, Office of Science, Early Career Principal Investigator Program. “Ultra-scale memory analysis for high-end computing”, **\$300,004**, 3 years. 9/1/04-8/31/07. Kirk W. Cameron (PI). Personal share: \$300,004

- [NSF] National Science Foundation, “CCF: REU Supplement for high-performance, power-aware, distributed computing,” **\$17,500**, 1 year. 5/15/04-5/14/05. Kirk W. Cameron (PI). Personal share: \$17,500.
- [NSF] National Science Foundation, “CAREER: High-performance, power-aware distributed computing,” **\$402,203**, 5 years. 2/1/04-1/31/09. Kirk W. Cameron (PI). Personal share: \$402,203.
- [USC] USC Office of Research Equipment Grant, “The SC Grid Initiative.” **\$45,000**, 1 year. 04/04/03 – 06/30/04. Kirk W. Cameron (PI), John Rose (co-PI). Personal share: \$22,500.
- [INTEL] Intel Corporation, “Telecommunication softswitch hardware.” **\$4,000**. Equipment. Permanent beginning 2/1/03. Kirk W. Cameron (PI). Personal share: \$4,000.
- [IXIA] Ixia Corporation, “Utilization of Aggregate Network Load Modules for High-Performance Computing Applications.” **\$301,204** (\$250,000 in hardware, \$51,204 direct+indirect). 9 months. 1/1/03-08/31/03. Kirk W. Cameron (PI), Duncan Buell (co-PI). Personal share: \$225,000 in hardware, \$48,083 research expenditures.
- [IXIA] Ixia University Partnership Program (IxUPP), “Ixia Network Performance Monitoring System.” **\$106,950**. Equipment. Ixia 1600 Chassis (\$26950) and IxExplorer (\$80000). Permanent donation 10/1/02. Kirk W. Cameron (PI), Srihari Nelakuditi (co-PI). Personal share: \$96,255
- [USC] USC Office of Research VPR Opportunity Fund. “Benchmarking Telecommunication Workloads for the Next Generation Network”, **\$71,194**, (\$35,597 + 1:1 match), 1 year. 7/1/02-6/30/03. Kirk W. Cameron (PI). Personal share: \$71,194.
- [DOE] Department of Energy, Laboratory Directed R&D (DOE-LDRD) Computer Science and Software “Dynamic Adaptive Superscalar Microprocessor Architecture” **\$110,000** per year, 3 years. 9/1/99-8/31/02 Yong Luo (PI), Maya Gokhale (PI), Kirk W. Cameron (Senior Personnel). Personal share: none.

SELECT VENTURE-BACKED CAPITAL FUND RAISING (Total Funding as CEO: ~\$3M)

- [VC] Valhalla Partners, Virginia Center for Innovative Technologies, Dark Angels. “Product Development”, \$622,500, December 2007, Kirk W. Cameron (CEO). [Series A]
- [VC] Valhalla Partners, Virginia Center for Innovative Technologies, Dark Angels. “Non-recurrent Engineering”, \$175,000, November 2009, Kirk W. Cameron (CEO). [Series A Bridge]
- [VC] Valhalla Partners. “Non-recurrent Engineering”, \$100,000, March 2010, Kirk W. Cameron (CEO). [Series A Bridge]
- [VC] InQTel. “Non-recurrent Engineering”, \$500,000, March 2010, Kirk W. Cameron (CEO). [Series A Bridge]
- [VC] Valhalla Partners. “Non-recurrent Engineering”, \$400,000, July 2011, Kirk W. Cameron (CEO). [Series A Bridge]
- [VC] Virginia Center for Innovative Technologies. “Non-recurrent Engineering”, \$200,000, February 2012, Kirk W. Cameron (CEO). [Series A Bridge]

PATENTS/DISCLOSURES

- [1] K.W. Cameron and J. Turner, “Systems, devices, and/or methods for managing energy usage”, [United States Patent: 8,918,657] [UK Patent: #GB2476606B]
- [2] K.W. Cameron and J. Turner, “Portable methods for reducing component energy while guaranteeing performance in computer systems”, VTIP Disclosure Number 08.109
- [3] R. Ge, X. Feng, and K.W. Cameron, “Automatic, systemic, performance-constrained techniques for reducing power consumption in computer systems”, VTIP Disclosure Number 07.029
- [4] K.W. Cameron, X. Feng, and H.K. Pyla, “Method and system for correlation and analysis of performance and sensor data in computer systems”, VTIP Disclosure Number 07.019.
- [5] M. Tolentino, J. Turner, and K.W. Cameron, “Performance-centric runtime system minimizing energy consumption in power-scalable cluster architectures”, VTIP Disclosure Number 06.079.
- [6] K.W. Cameron, M.A. Cameron, and J.A. Turner, “Method and System for Classification, Analysis, and Presentation of Spatial-Temporal Risk-of-Incidents During Travel”, VTIP Disclosure Number 06.060.

PUBLICATIONS

REFEREED JOURNALS (*=students or former students, +supervised post doc or researcher)

Note: These are full publications in peer-reviewed, archived journals that require full manuscript submission (10-15 pages) and provide 3-6 full-length reviews. Thompson-Reuters ISI impact factors listed where available.

- [TC] Wang, Y., Furman, S., Hardy, N., Ellis, M., Back, G., Hong, Y. and Cameron, K.W.: A Detailed Historical and Statistical Analysis of the Influence of Hardware Artifacts on SPEC Integer Benchmark Performance. *IEEE Transactions on Computers*, 15 pages. (To appear: 2024)
- [JRSS] Xu, L., Hong, Y., Morris, M. D., and Cameron, K.W.: Prediction for Distributional Outcomes in High-Performance Computing I/O Variability, *Journal of the Royal Statistical Society*. (To appear: 2024)
- [JCST] Cameron, K.W. Adventures Beyond Amdahl's Law: How Power-Performance Measurement and Modeling at Scale Drive Server and Supercomputer Design. *J. Comput. Sci. Technol.* 38(1): 80-86 (2023).
- [TPDS] *Dichev, K. De Sensi, D., Nikolopoulos, D., Cameron, K.W., & Spence, I., Power Log'n'Roll: Power-Efficient Localized Rollback for MPI Applications Using Message, *IEEE Transactions on Parallel and Distributed Systems*, 33(6): 1276-1288 (2022) **ISI Impact factor: 2.6 (2019)]**
- [JQT] Wang, Y., Xu, L., Hong, Y., Pan, R., Chang, T., Lux, T., & Cameron, K. (2022). Design strategies and approximation methods for high-performance computing variability management. *JOURNAL OF QUALITY TECHNOLOGY*, 16 pages. doi:10.1080/00224065.2022.2035285
- [NA] *Lux, T., Watson, *L., Chang, T., Hong, Y., & Cameron, K.W., Interpolation of sparse high-dimensional data, *Numerical Algorithms*, 88(1): 281-313 (2021). **[ISI Impact factor: 2.064 (2019)]**
- [QENG] *Xu, L., *Lux, T., *Chang, T., *Li, B., Hong, Y., Watson, L., Butt, A., Yao, D., & Cameron, K.W., Prediction of high-performance computing input/output variability and its application to optimization for system configurations, *Quality Engineering*, Taylor & Francis Group, In press (2021). DOI: [10.1080/08982112.2020.1866203](https://doi.org/10.1080/08982112.2020.1866203) **[ISI Impact factor: 1.902 (2020)]**
- [JPDC] *Xu, L., *Wang, Y., *Lux, T.C.H., *Chang, T.H., *Bernard, J., *Li, B., *Hong, Y., Cameron, K.W., Watson, L.T., Modeling I/O performance variability in high-performance computing systems using mixture distributions. *Journal of Parallel and Distributed Computing*, 139: 87-98 (2020). **[ISI Impact factor: 2.296 (2019)]**
- [TOMS] *Chang, T.H., Watson, L.T., *Lux, T.C.H., Butt, A.R., Cameron, K.W. Hong, Y., Algorithm 1012: DELAUNAYSPARSE: Interpolation via a Sparse Subset of the Delaunay Triangulation in Medium to High Dimensions. *ACM Transactions on Mathematical Software*, 46(4): 38:1-38:20 (2020). **[ISI Impact factor: 2.33 (2019)]**
- [TPDS] Cameron, K.W., *Anwar, A., *Cheng, Y., *Xu, L., Li, B., *Ananth, U., Lux, T., Hong, Y., Watson, L.T., Butt, A. R. (2019). MOANA: Modeling and Analyzing I/O Variability in Parallel System Experimental Design. *IEEE Transactions on Parallel and Distributed Systems*, 30(8): 1843-1856 (2019). **[ISI Impact factor: 2.173 (2013)]**
- [JPDC] *Umar, M., Moore, S. V., Meredith, J. S., Vetter, J. S., & Cameron, K.W. (2018), Aspen-Based Performance and Energy Modeling Frameworks. *Journal of Parallel and Distributed Computing*, 120: 222-236. **[Impact factor: 1.930 (2016)]**
- [JPDC] *Li, B., *Mooring, J., Blanchard, S., Johri, A., Leko, M., & Cameron, K. W. (2017). SeeMore: A kinetic parallel computer sculpture for educating broad audiences on parallel computation. *Journal of Parallel and Distributed Computing*, 105(C), 183-199. doi: [j.jpdc.2017.01.017](https://doi.org/10.1016/j.jpdc.2017.01.017) **[Impact factor: 1.930 (2016)]**
- [PPL] *Li, B., *Chang, H. -C., *Song, S., *Su, C. -Y., *Meyer, T., *Mooring, J., & Cameron, K. (2014). Extending PowerPack for Profiling and Analysis of High-Performance Accelerator-Based Systems. *Parallel Processing Letters*, 24(4), 1442001. doi:[10.1142/S0129626414420018](https://doi.org/10.1142/S0129626414420018)
- [CSRD] *Lively, C., Taylor, V., Wu, X., *Chang, H. -C., *Su, C. -Y., Cameron, K., Moore, S., & Terpstra, D. (2014). E-AMOM: an energy-aware modeling and optimization methodology for scientific applications. *Computer Science - Research and Development*, 29(3-4), 197-210. doi:[10.1007/s00450-013-0239-3](https://doi.org/10.1007/s00450-013-0239-3)
- [TPDS] *Li, D., de Supinski, B. R., Schulz, M., Nikolopoulos, D. S., & Cameron, K. W. (2013). Strategies for Energy-Efficient Resource Management of Hybrid Programming Models. *IEEE Transactions on Parallel and Distributed Systems*, 24(1), 144-157. doi:[10.1109/TPDS.2012.95](https://doi.org/10.1109/TPDS.2012.95) **[ISI Impact factor: 2.173 (2013)]**

- [JSC] Vishnu, A., *Song, S., Marquez, A., Barker, K., Kerbyson, D., Cameron, K., & Balaji, P. (2013). Designing energy efficient communication runtime systems: a view from PGAS models. *The Journal of Supercomputing*, 63(3), 691-709. doi:[10.1007/s11227-011-0699-9](https://doi.org/10.1007/s11227-011-0699-9) [ISI Impact factor: 1.088 (2015)]
- [ITJ] *Chang, H. -C., Kruus, E., Barnes, T. J., Agrawal, A. R., & Cameron, K. W. (2012). Storage Power Optimizations for Client Devices and Data Centers. *Intel Technology Journal*, 16(3), 172-193.
- [ITJ] *Chang, H., T. J., Agrawal, A. R., & Cameron, K. W. (2012). Energy-Aware Computing for Android Platforms. *Intel Technology Journal*, 16(3), 92-113.
- [PER] *Su, C., *Li, D., Nikolopoulos, D. S., *Grove, M., Cameron, K., & de Supinski, B. R. (2012). Critical path-based thread placement for NUMA systems. *ACM SIGMETRICS Performance Evaluation Review*, 40(2), 106-112. doi:[10.1145/2381056.2381079](https://doi.org/10.1145/2381056.2381079)
- [CSR] *Lively, C., Wu, X., Taylor, V., Moore, S., *Chang, H. -C., *Su, C. -Y., & Cameron, K. (2012). Power-aware predictive models of hybrid (MPI/OpenMP) scientific applications on multicore systems. *Computer Science - Research and Development*, 27(4), 245-253. doi:[10.1007/s00450-011-0190-0](https://doi.org/10.1007/s00450-011-0190-0)
- [IJHPCA] *Lively, C., Xingfu Wu., Taylor, V., Moore, S., *Chang, H. -C., & Cameron, K. (2011). Energy and performance characteristics of different parallel implementations of scientific applications on multicore systems. *International Journal of High Performance Computing Applications*, 25(3), 342-350. doi:[10.1177/1094342011414749](https://doi.org/10.1177/1094342011414749) [ISI Impact factor: 1.625 (2013)]
- [IJPED] *Cao, Z., *Easterling, D. R., Watson, L. T., *Li, D., Cameron, K. W., & Feng, W. -C. (2010). Power saving experiments for large-scale global optimisation. *International Journal of Parallel, Emergent and Distributed Systems*, 25(5), 381-400. doi:[10.1080/17445760903492078](https://doi.org/10.1080/17445760903492078)
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- [INFOCOMP] *Li, B., León, E. A., & Cameron, K.W. Understanding Power Measurement Capabilities on Zaius Power9. Proceedings of the 8th International Conference on Advanced Communications and Computation (INFOCOMP 2018). Barcelona, Spain. **Best Paper Award**
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INFLUENTIAL REPORTS AND CONFERENCE PROCEEDINGS

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BOOK FORWARD

Cameron, K.W., Book Forward for B. Steigerwald, C. Lucero, C. Akella, and A. Agrawal, *Energy Aware Computing*, Intel Press, 2012.

BOOK CHAPTERS

- [1] Feng, W.-C., Cameron, K.W., and Scogland, T., The Green500 List: A Look Back to Look Forward, In *Contemporary High Performance Computing: From Petascale toward Exascale*, Jeffrey S. Vetter (Editor), Taylor & Francis, 2013. **(invited)**
- [2] Li, D.*, Nikolopoulos, D. and Cameron, K.W., Modeling and Algorithms for Scalable and Energy Efficient Execution on Multicore Systems. In *Scalable Computing and Communications*, Wiley & Sons, 2012. **(invited)**
- [3] S. Song* and K.W.Cameron, "Green Computing at Scale," *Harnessing Green IT: Principals and Practice*, 2011.

- [4] R. Ge* and K.W. Cameron, “Power-aware, High-Performance Computing,” *Green Computing*, Wiley & Sons, 2011.
- [5] K.W. Cameron, R. Ge, and X. Feng, “Designing Computational Clusters for Performance and Power,” *Advances in Computers*, Elsevier Science BV, Amsterdam, 2007. (*invited*)
- [6] S. Byna, K. W. Cameron, and X.-H. Sun, “Quantification of Memory Communication,” *High Performance Scientific and Engineering Computing: Hardware/Software Support*, Kluwer Academic Publishers, Boston, MA, (2004) pp. 31-44.
- [7] X.-H. Sun, and K. W. Cameron, “A Statistical-Empirical Hybrid Approach to Hierarchical Memory Analysis,” *Lecture Notes in Computer Science 1900*. Springer Verlag Publishers, New York, NY, (2000) pp. 141-148. (from EuroPAR 2000)
- [8] K. W. Cameron, and Y. Luo, “Instruction-level Microprocessor Modeling of Scientific Applications,” *Lecture Notes in Computer Science 1615*, Springer Verlag Publishers, New York, NY, (1999) pp. 29-41. (from ISHPC 99)
- [9] Y. Luo and K. W. Cameron, “Instruction-level Characterization of Scientific Computing Applications Using Hardware Performance Counters,” *Scientific, Engineering and Desktop Workloads of Workload Characterization: Methodology and Case Studies*, IEEE-CS Press, Los Alamitos, CA, (1999) pp. 90-98.

ART AND TECHNOLOGY EXHIBITIONS

- [USHIST] Cameron, K.W. & Blanchard, S. “Lace: Kinetic Computer Sculpture of 30 Microsoft Surface Tablets Demonstrating Distributed Proof of Work Algorithms, Smithsonian National Museum of American History, Washington D.C., April 7-1- , 2022.
- [USASEF] Cameron, K.W. & Blanchard, S. “SeeMore: Kinetic Computer Sculpture”, Highlights from NSF-funded researchers at the biennial USA Science and Engineering Festival, Washington D.C., April 15-17, 2016.
- [SXSW] Cameron, K.W. & Blanchard, S., “SeeMore Exhibit at South by Southwest 2016,” SXSW 2016, New York, NY. March 11—20, 2016.
- [IMF] Cameron, K.W. & Blanchard, S., “SeeMore Exhibit at International Maker’s Faire,” IMF 2015, New York, NY. September 26—27, 2015.
- [MAKERCON] Cameron, K.W. & Blanchard, S., “SeeMore Exhibit at MakerCon,” MakerCon 2015, New York, NY. September 25, 2015.
- [SC14] Cameron, K.W. & Blanchard, S., “’lil SeeMore at SC14 Exhibit,” SC14, New Orleans, LA. Nov 17 – 20, 2014.
- [RHG] Cameron, K.W. & Blanchard, S., “Open at the Source Exhibition,” Ruth C. Horton Gallery, May 3 – 18, Ruth C. Horton Gallery, The Moss Center for the Arts, Blacksburg, Virginia. May 3 – 18, 2014.
- [SIGGRAPH] Cameron, K.W. & Blanchard, S., “Acting in Translation: SeeMore,” SIGGRAPH Art Gallery at the 41st International Conference and Exhibition on Computer Graphics and Interactive Techniques, Vancouver, BC. August 10 – 14, 2014.

SELECT SHORT PAPERS, POSTERS, PANELS, TUTORIALS

- [SIGCSE] Godmar Back, Lance Chao, Pratik Anand, Thomas Lux, Bo Li, Ali Raza Butt, Kirk W. Cameron: Teaching Variability in a Core Systems Course: (Abstract Only). SIGCSE 2018: 1085.
- [SECON] Tyler H. Chang, Layne T. Watson, Thomas C. H. Lux, Bo Li, Li Xu, Ali Raza Butt, Kirk W. Cameron, Yili Hong: A polynomial time algorithm for multivariate interpolation in arbitrary dimension via the Delaunay triangulation. ACM Southeast Regional Conference 2018: 12:1-12:8
- [SECON] Thomas C. H. Lux, Layne T. Watson, Tyler H. Chang, Jon Bernard, Bo Li, Xiaodong Yu, Li Xu, Godmar Back, Ali Raza Butt, Kirk W. Cameron, Danfeng Yao, Yili Hong: Novel meshes for multivariate interpolation and approximation. ACM Southeast Regional Conference 2018: 13:1-13:7
- [SPRSIM] Tyler H. Chang, Layne T. Watson, Thomas C. H. Lux, Jon Bernard, Bo Li, Li Xu, Godmar Back, Ali Raza Butt, Kirk W. Cameron, Yili Hong: Predicting system performance by interpolation using a high-dimensional delaunay triangulation. SpringSim (HPC) 2018: 2:1-2:12
- [SPRSIM] Thomas C. H. Lux, Layne T. Watson, Tyler H. Chang, Jon Bernard, Bo Li, Li Xu, Godmar Back, Ali Raza Butt, Kirk W. Cameron, Yili Hong: Predictive modeling of I/O characteristics in high performance computing systems. SpringSim (HPC) 2018: 8:1-8:12
- [CORR] Kiril Dichev, Kirk W. Cameron, Dimitrios S. Nikolopoulos: Energy-efficient localised rollback after failures via data

flow analysis. CoRR abs/1806.01611 (2018)

- [SC-C] Umar, M., Meredith, J. S., Vetter, J. S., & Cameron, K.W. POSTER: Towards Exascale Computing: An Automatic Hardware-Software Co-design Framework for Aspen, In *2016 SC Companion: IEEE/ACM International Conference on High Performance Computing, Networking, Storage, and Analysis (SC-C)*. **Best poster finalist**.
- [MASCOTS]*Li, B., *Song, S., Bezakova, I., & Cameron, K. W. (2012). SHORT PAPER: Energy-aware replica selection for data-intensive services in cloud. Proceedings of the 2012 *IEEE International Symposium on the Modeling, Analysis, and Simulation of Computer and Telecommunication Systems (MASCOTS)*, (pp. 504-506). IEEE.
- [PACT-SP] *Song, S., & Cameron, K. W. (2012). SHORT PAPER: System-level power-performance efficiency modeling for emergent GPU architectures. Proceedings of the 2012 *ACM/IEEE International Conference on Parallel Architectures and Compilation Techniques (PACT)*, (pp. 473-474).
- [SC-C] *Song, S. L., *Su, C. -Y., Rountree, B., & Cameron, K. W. (2012). POSTER: Three Steps To Model Power-Performance Efficiency for Emergent GPU-Based Parallel Systems. In *2012 SC Companion: IEEE/ACM International Conference on High Performance Computing, Networking, Storage, and Analysis (SC-C)* (pp. 1345-1346). Salt Lake City, UT: IEEE.
- [EUROPAR]Di Martino, B., Petrini, F., Benkner, S., Cameron, K., Kranzlmüller, D., Kurzak, J., Pasetto, D. & Träff, J. L. (2010). SHORT PAPER: Multicore and manycore programming. Proceedings of the 2010 *European Conference on Parallel Processing* (pp. 137-138). Springer Berlin Heidelberg.
- [SC-C] *Li, D., Cameron, K.W., Nikolopoulos, D.S., Schulz, M., & de Supinski (2009). B.R. POSTER: Model-Based Hybrid MPI/OpenMP Power-Aware Computing. In *2009 SC Companion: IEEE/ACM International Conference on High Performance Computing, Networking, Storage, and Analysis (SC-C)* Portland, OR:IEEE.
- [SC-C] *Pyla, H.K., *Li, D., & Cameron, K.W. (2007). POSTER: Thermal-aware High-performance Computing Using TEMPEST, In *2007 SC Companion: IEEE/ACM International Conference on High Performance Computing, Networking, Storage, and Analysis (SC-C)* Reno: NV:IEEE. **[26% accept rate]**
- [SC-C] Cameron, K.W. (2007). PANEL: Is there an HEC energy crisis? In *2007 SC Companion: IEEE/ACM International Conference on High Performance Computing, Networking, Storage, and Analysis (SC-C)* Reno: NV:IEEE.
- [SOSP-WIP] *Tolentino, M. E., & Cameron, K. W. (2005). WIP: Improving the energy efficiency of high-performance server systems. Proceedings of 2005 *ACM Symposium on Operating Systems Principles* (pp. 1). ACM.
- [SC-C] Cameron, K.W., Ge, R., Feng, X., Varner, D., & Jones, C. (2004). POSTER: High-performance, Power-aware Distributed Computing Framework. In *2004 SC Companion: IEEE/ACM International Conference on High Performance Computing, Networking, Storage, and Analysis (SC-C)* Reno: NV:IEEE. **[32% accept rate]**
- [HPCA-T] Luo, Y., Cameron, K.W., Torrellas, J., & Solihin, Y. (2000). TUTORIAL: Performance Modeling using Hardware Performance Counters. *Proceedings of the 2000 IEEE International Symposium on High Performance Computer Architecture (HPCA)* Toulouse FRANCE:IEEE.
- [ISCA-T] Cameron, K.W., & Luo, Y. (1999). TUTORIAL: Performance Evaluation using Hardware Performance Counters. *Proceedings of the 1999 IEEE International Symposium on Computer Architecture (ISCA)* Atlanta, GA:IEEE.

CURRENT SYSTEMS/SOFTWARE DESIGNS AND ARTIFACTS

Lace. First-of-its-kind kinetic sculpture of Microsoft Surface tablets that move to demonstrate proof-of-work in a demonstration of distributed algorithms for use in crypto currency applications. An educational project to impress upon non-technical observers the fundamental computer science technologies that underwrite applications in cryptocurrency.

CSGenome. The CSGenome project (<http://csgenome.org>) evolved from efforts in the NSF sponsored VarSys project and were developed further in the iLORE project. The project involves creating data repositories for computer systems, their performance over time, and their lineage. With the database established, we continue to broaden the coverage while exploring correlation of computer-science advances with advances in hardware and software performance. This project is also a vehicle for broadening participation of students from underrepresented groups in computer systems.

VarViz. Creation of a variability visualization (VarViz) tool. Early on, it was clear that VarSys teams needed a common interface to communicate intentions, needs, findings, and analyses. It was determined that with agreement on a common data interface protocol, the measured data could be automatically visualized for the initial data sets and discussions at weekly meetings. The graphical

interface was so successful at communication and discovery that it was later modified for use by the systems undergraduate course students.

VarSub. Automated job submission system (VarSub) tool. After deployment of our VarViz tool to project participants but prior to release to undergraduate operating system class students, we determined the need for a system to enable non-experts to submit variability jobs to a compute cluster. The result was VarSub, which was subsequently used by the operating system class to submit their variability experiments.

Wendy. New compute cluster (wendy.cs.vt.edu). With funds from the VarSys grant, SCHEV, and the department we were able to purchase, install, and configure a 20-node, 160-core compute cluster with both mechanical HDDs and non-volatile SSDs. With both GigE and a Infiniband interconnect, this cluster provides a much needed local resource for long-duration variability experiments in isolation.

SeeMore. First-of-its-kind kinetic sculpture of Raspberry Pi computers that move in response to computation. An educational project designed to impress upon non-technical observers the beauty, elegance, and importance of parallel computation.

PowerPack 3.0. PowerPack was created initially as a testbed for evaluating power-aware approaches for their energy and performance impact. PowerPack was the first tool of its kind to give detailed system-level power profiles of applications separated by component (CPU, disk, memory, etc). PowerPack can provide power measurement data synchronized at the functional level of an application. This provides a testbed to evaluate both performance and power effects of system and algorithmic efficiency techniques. The software has been used by groups all over the world from Texas A&M and the University of Tennessee to the University of Oxford in the UK and the University of Catalunya in.

PAST SYSTEMS/SOFTWARE DESIGNS AND ARTIFACTS

SystemG. First-of-its-kind \$1.2M Green Supercomputer with over 15,000 temperature and power sensors over 325 nodes. Built with Prof. Varadarajan formerly of Virginia Tech. Sponsored in part by a CRI award from the National Science Foundation. This collection of Mac Pro systems was capable of a sustained 22.8 TFLOPS. The system was designed Cameron and Varadarajan and assembled by dozens of students fueled with pizza and caffeine.

FatBatt. First-of-its-kind commercial software for intelligent battery life management for laptops. Commercially released March 2013. Now retired.

Grano.la. First-of-its-kind commercial software for saving energy without performance loss in laptops, PCs, and servers. Developed by VT spinout company MiserWare. Over 500,000 downloads from 160+ countries during its life. Granola is the culmination and commercialization of 10 years of research in power-aware HPC. Granola uses advanced mathematical, statistical, and machine learning techniques to enable performance SLAs between the user and the power management tool. This ensures users performance and availability expectations are met by the software. Now retired.

Tempest: First-of-its-kind system (*Temperature Estimator*) infrastructure for measuring the temperature of software applications and correlating thermal characteristics to source code. Still available at SourceForge.net.

SystemMISER: System Management Infra-Structure for Energy Reduction includes DVS scheduling techniques (CPU MISER) and power-aware memory techniques (Memory MISER) presently.

Manticore: Sony Playstation 3 cluster running parallel applications on IBM Cell architecture; sponsored in part by Virginia Tech and the National Science Foundation.

PBPI: First large-scale parallel Bayesian-based phylogenetic inference tool; 3 orders of magnitude faster than best available codes at release; sponsored in part by the National Science Foundation and IBM.

DORI: The second-generation, power-aware high-performance cluster built from dual-processor, dual-core AMD systems; sponsored in part by Virginia Tech.

NEMO: The first power-aware, high-performance cluster built from Dell laptop computers; sponsored in part by the National Science Foundation, 2003.

ARGUS: High-density supercomputer built from network load modules; sponsored in part by Ixia Corporation, 2001.

Memory Medic. Global memory checker software for Intel 82450 NX Chipset Validation; sponsored by Intel Corporation, 1996.

INVITED/REFEREED TALKS SINCE 2002 (Excluding conference paper presentations)

- [1] *Invited Talk*, University of Southern California, “Limits of the quantitative approach, or why parallel and distributed system energy management needs to move on,” Los Angeles, CA, February 2020.
- [2] *Invited Talk*, University of Florida, “Rethinking Quantitative Approaches to Computer System Design in the Power Age,” Gainesville, FL, October, 2019.
- [3] *Invited Talk*, George Mason University, “Rethinking Quantitative Approaches to Computer System Design in the Power Age,” Fairfax, VA, January, 2019.
- [4] *Invited Talk*, Microsoft Research, “Revisiting Quantitative Approaches to System Design in the Power Age,” Redmond, WA, October, 2018.
- [5] *Invited Talk*, Clemson University, “Revisiting Quantitative Approaches to System Design in the Power Age,” Clemson, SC, October, 2018.
- [6] *Invited Talk*, University of Edinburgh, “Dance of the Dragons: Winning the war of succession in power management,” Edinburgh, U.K., June 2018.
- [7] *Invited Talk*, University of Central Florida, “Dance of the Dragons: Winning the war of succession in power management,” Orlando, FL, September 2017.
- [8] **Keynote**, Symposium on Sensor Network, Systems and Security, “Green Computing: Or how I learned to stop worrying and embrace HPC energy efficiency,” Orlando, FL, September 2017.
- [9] *Invited Talk*, The Queen’s University – Belfast, “Dance of the Dragons: Winning the war of succession in power management,” Belfast, U.K., July 2017.
- [10] **Plenary Talk**, NSF CSR PI Meeting, Kirk Cameron, “VarSys: Managing Variability in High-Performance Computing Systems,” Orlando, FL, May 2017.
- [11] **Keynote**, High-performance, power-aware computing workshop (HPPAC 2017), “Dance of the Dragons: Winning the war of succession in power management,” Orlando, FL, May 2017.
- [12] *Invited Talk*, BrainPop Educators, “SeeMore: a Kinetic Parallel Computer Sculpture for Educating Broad Audiences on Parallel Computation,” New York, NY, July 2016.
- [13] *Panel*, E2SC Workshop, “The Role of Software in Energy Efficiency,” November 2015.
- [14] **Keynote**, Exa2green Workshop, “Why High-performance Systems Need a Little LUC”, June 2015
- [15] *Panel*, “Architect Cloud and HPC for the Big Data Era,” Big Data Panel, CCGrid 2014, May 2014.
- [16] *Presentation*, “SeeMore: A kinetic sculpture and functional parallel cluster of Raspberry Pi Computers,” ECE/CS Beer Bash, October 2014.
- [17] *Presentation*, “SeeMore: A kinetic sculpture and functional parallel cluster of Raspberry Pi Computers,” Invited Speaker, ICAT Community Playdate, October 2014.
- [18] *Interview*, “On Manfred Mohr,” Invited Speaker, My Take Talk, School of Performing Arts, October 2014.
- [19] *Presentation*, “SeeMore: A kinetic sculpture and functional parallel cluster of Raspberry Pi Computers,” Presentation to NSF Director Cordova, ICAT, November 2014.
- [20] *Presentation*, “Improving LUC in cloud environments,” Invited Speaker, NSF Cloud Workshop, December 2014.
- [21] *Presentation*, “Why high-performance systems need a little LUC,” Invited Speaker, Future Technologies Group Colloquium Series, Oak Ridge National Laboratory, April 2015.
- [22] *Presentation*, “Power and Energy Whack-a-mole in HPC”, University of Tennessee – Knoxville, January 2014. **(invited)**
- [23] *Presentation*, “The Powers That Be in HPC: Energy Oddities”, Presented at the SIAM Conference on Computational Science and Engineering, Boston, MA, February 2013. **(invited)**
- [24] *Masterworks Presentation (Plenary)*, “Pushing Water Up Mountains: Green HPC and other energy oddities”, Presented at the SC 12, Salt Lake City, UT, November 2012. **(invited)**
- [25] *BoF*, Feng, W. and Cameron, K.W., “The Green 500”, Presented at the SC 12, Salt Lake City, UT, November 2012. **(refereed)**
- [26] **Keynote**, “The Powers That Be in HPC”, Energy-Aware High-Performance Computing (ENA-HPC), Hamburg, Germany, September 2012. **(invited)**
- [27] *Presentation*, “The Powers That Be in HPC”, Queens University of Belfast, Belfast, United Kingdom, September 2012. **(invited)**
- [28] *Presentation*, “The Powers That Be in HPC”, Oxford University, Oxford, United Kingdom, September 2012. **(invited)**
- [29] *Presentation*, “The Powers That Be in HPC”, Munich Technical University, Munich, Germany, September 2012. **(invited)**
- [30] *Presentation*, “The Powers That Be in HPC”, University of Innsbruck, Innsbruck, Austria, September 2012. **(invited)**
- [31] *Panel*, Faculty and Student Entrepreneurship, VT Office of Economic Development, August 2012. **(invited)**
- [32] *Presentation*, Being Green in HPC, College of William and Mary Seminar, March 2012. **(invited)**
- [33] *Panel*, Technology Start-ups in Virginia, Governor’s Small Business Summit, Richmond, VA, October, 2012. **(invited)**

- [34] *Presentation, Adventures in Green Computing*, Energy Aware HPC Minisymposium, SIAM Conference on Parallel Processing for Scientific Computing, Feb. 2012. **(invited)**
- [35] *Presentation, Modeling Interactive Effects of Power Performance*, Analysis and Modeling: Techniques and Tools Minisymposium, SIAM Conference on Parallel Processing for Scientific Computing, Feb. 2012. **(invited)**
- [36] *Panel, Energy Efficiency BoF*, SC 2011, Washington DC, Nov. 2011. **(invited)**
- [37] *BoF, Feng, W. and Cameron, K.W.*, The Green 500, Presented at the SC 11, Seattle, WA, November 2011. **(refereed)**
- [38] *Panel, Governor's Small Business Summit, Richmond, VA*, Oct. 2011. **(invited)**
- [39] *Plenary, Adventures in Green Computing: Applications and Algorithms*, Workshop on Green High-Performance Computing, Rutgers University, Oct. 2011 **(invited)**
- [40] *Panel, Workshop on Green High-Performance Computing*, Rutgers University, Oct. 2011. **(invited)**
- [41] *Presentation, "Aim Green: Cyber Energy Research @ VT"*, presented at Air Force Research Laboratory, Syracuse, NY, May, 2011. **(invited)**
- [42] *Plenary, "MiserWare: A University Spinout for Sustainability"*, Sustainable Venture Capital Investment Competition, UNC Kenan-Flagler Business School, Chapel Hill, NC, March, 2011. **(invited)**
- [43] *Presentation, "MiserWare: A University Spinout in the Commonwealth"*, presented to Virginia Commonwealth CIO Sam Nixon, Richmond, VA, December 2010. **(invited)**
- [44] *Poster Presentation, EU-US Frontiers of Engineering Symposium* sponsored by the National Academy of Engineering and the EU Council of Applied Sciences and Engineering, Cambridge, UK, September, 2010. **(invited)**
- [45] *Adventures in Green Computing: HPC and Beyond*, LSU Department of Computer Science, November, 2010. **(invited)**
- [46] *BoF, Feng, W. and Cameron, K.W.*, *The Green 500*, Presented at the SC10, New Orleans, LA, November 2010. **(refereed)**
- [47] *Panel, Software for a Sustainable World*, OOPSLA 2010, October 2010. **(invited)**
- [48] *A Tale of Two Lists: Green500 and SPECPower*, CCGSC Workshop, September 2010. **(invited)**
- [49] *The Past, Present, and Future of Green Computing*, Computer Science Distinguished Lecture Series, Wayne State University, April 2010. **(invited)**
- [50] *Panel, Value Opportunities in Green IT*, The GreenIT Economic Workshop, Washington DC, April 2010. **(invited)**
- [51] *Panel, Present and Future Directions in Sustainable IT*, SustainIT Workshop, San Jose, CA, February 2010. **(invited)**
- [52] *BoF, Feng, W. and Cameron, K.W.*, The Green 500, Presented at the SC 09, Portland, OR, November 2009. **(refereed)**
- [53] *Directions in Energy Efficient Computing*, IBM Federal Strategy and Technology Institute Speaker Series, Washington DC, October 2009. **(invited)**
- [54] *The Past, Present, and Future of High-Performance, Power-Aware Computing*, Portland State University, July 2009. **(invited)**
- [55] *BoF: The Green 500*, (with W. Feng) Presented at the International Supercomputing Conference (ISC), June 2008. **(refereed)**
- [56] *BoF: Improving The Green 500*, (with W. Feng) Presented at the International Conference on High Performance Computing and Communications (SC 2008), November 2008. **(refereed)**
- [57] *The Past, Present, and Future of High-Performance, Power-Aware Computing*, Thai Grid Computing Conference, September 2008. **(invited)**
- [58] *The Past, Present, and Future of High-Performance, Power-Aware Computing*, CCGSC Workshop, September 2008, **(invited)**
- [59] *The Green500 and the HPCChallenge Benchmarks*, HPC Challenge Summit, November 2008, **(invited)**.
- [60] *PBPI: High Performance Implementations of Parallel Bayesian Phylogenetic Inference on IBM Technologies*, IBM Life Sciences Virtual Expo [Apr 2008]
- [61] *Nature, Nurture, and the Green500*, National Science Foundation, Arlington, VA [Jan 2008]
- [62] *The HEC Energy Crisis*, University of Florida, Gainesville, FL [Sep 2007]
- [63] *PowerPack and SysteMISER: The past, present, and future of high-performance, power-aware computing*, Merrill Lynch Power Summit, New York, NY [Mar 2007]
- [64] *The HPC Energy Crisis*, IBM Research, Austin, TX [Feb 2007]
- [65] *Parallel I/O for digital forensics*, Crucial Security. [Dec 2006]
- [66] *The HPC Energy Crisis*, The 7th Annual International Workshop on Performance Analysis and Optimization of High-End Computing Systems (APART) at IEEE/ACM SC06. [Nov 2006]
- [67] *Crucial Technologies for High-end computing*, Crucial Security. [Aug 2006]
- [68] *High-performance, power-aware distributed computing*, Lawrence Livermore National Laboratory. [May 2005]
- [69] *High-performance, power-aware distributed computing*, University of Delaware. [Feb 2005]
- [70] *High-performance, power-aware distributed computing*, Oak Ridge National Laboratory. [Oct 2004]
- [71] *Topics in HPC*, Savannah River National Laboratory. [Aug 2004]

- [72] *High End / Grid Computing*, Software Developers Association. [June 2004]
- [73] *SC Grid Computing*, Columbia Chamber of Commerce. [Nov 2003]
- [74] *Telecommunication workload characterization*, Intel Corporation [Dec 2002].
- [75] *Scalable Performance at USC*, Michelin Corporation visitors. [Nov 2002]
- [76] *Toward a unified, practical model of parallel computation*, Illinois Institute of Technology. [April 2002]
- [77] *Approaches to Telecom Benchmarking*, Intel Corporation. [March 2002]

RECENT MEDIA COVERAGE

- [NPR] “Scientists Studying Why Your Computer Bogs Down,” *WVTF Radio (NPR Affiliate)*, Story on \$3M NSF funded VarSys Project. <http://wvtf.org/post/scientists-studying-why-your-computer-bogs-down-stream/0> (January 19, 2017)
- [HPCWIRE] “VT Researcher Receives NSF Grant to Keep Rogue Forces at Bay in HPC,” *HPCWire.com*, Story on \$3M NSF funded VarSys Project. <https://www.hpcwire.com/off-the-wire/vt-researcher-receives-nsf-grant-keep-rogue-forces-bay-hpc/> (December 9, 2016)
- [MAGPI] “SeeMore: A Raspberry Pi sculpture that’s also secretly a supercomputer,” *MagPi Magazine*, Issue #50, Phillip King. <http://www.raspberrypi.org/magpi/issues/50/> (September, 2016)
- [MAGPI] “SeeMore: Parallel Computing Sculpture,” *MagPi Magazine*, Issue #40, Phillip King. <https://www.raspberrypi.org/magpi/issues/40/> (December 2015)
- [VTUR] “SeeMore: A Living Sculpture of Computational Data Movement,” *VT Presidential Inaugural Highlights Pamphlet*, VA Tech University Relations. <https://www.icat.vt.edu/funding/seemore> (Oct 2014)
- [SIGGRAPH] *Video Production, SeeMore*, ACM SIGGRAPH, Duration: 5:48. <http://www.icat.vt.edu/funding/seemore> (Aug 2014)
- Video Production, The Art and Elegance of Parallel Computing*, J. Scott Parker, VA Tech University Relations, Duration: 3:15. http://www.unirel.vt.edu/audio_video/2014/05/050214-caus-SeeMore.html (May 2014)
- [WIRED] *Interview*, Wired Magazine, Related to November 2011 Green500, November, 2011. **(invited)** <http://www.wired.com/wiredenterprise/2011/11/supercomputers-turn-green/>
- [BLOOM] *Interview*, Bloomberg BusinessWeek, Entrepreneur of the Week, October, 2011. **(invited)** <http://www.businessweek.com/magazine/kirk-cameron-cuts-computers-power-use-10272011.html>
- [ABC] *Interview*, ABC Radio (Nationwide distribution), Related to Granola software, April, 2011. **(invited)**
- [CBS] *Interview*, WDBJ (CBS Affiliate), Related to IBM Watson on Jeopardy, February, 2011. **(invited)**
- [NBC] *Interview*, WSLS (NBC Affiliate), Related to Granola software, February, 2011. **(invited)**

TEACHING – VT/USC RESEARCH SUPERVISION

Ph.D. Advisee Positions Held

Xizhou Feng, 2007, Research Faculty, Clemson University
 Rong Ge, 2008, Professor, Clemson University
 Matthew Tolentino, 2009, Associate Professor, University of Washington (Tacoma)
 Dong Li, 2011, Assistant Professor, University of California – Merced
 Song “Leon” Shuaiwen, 2013, Associate Professor, University of Sydney
 Hung-Ching Chang, 2015, Intel Research
 Chun-Yi Su, 2015, Intel Research
 Mariam Umar, 2018, Intel Research
 Bo Li, 2018, Meta Research

M.S. Advisee Positions Held

Eles Jones, 2022.
 Sam Furman, 2021, PhD Program (4-year GRA), University of Michigan
 Nicolas Hardy, 2021, Amazon
 Chandler Jearls, 2021, Apple

B.S. Advisee Positions Held

Tanvi Haldankar, 2021, Bloomberg
 Sam Furman, 2020, VT BS/MS Program
 Chandler Jearls (ECE), 2020, VT BS/MS Program
 Nicolas Hardy, 2019, VT MS Program

Jiayi “J.W. Wang, 2018, Microsoft
Liz Dao, 2018, Microsoft
Luke McCormick, 2017, Amazon

Advisee Awards

Lalitha Kuppa, Adobe Women in Technology Scholarship [2021]
Greg Bolet, Davenport Leadership Scholar [2020]
Song Shuaiwen, Engineers Australia's Most Innovative Engineers [2020]
Bo Li, Virginia Tech Computer Science Outstanding PhD Thesis [May 2019]
Bo Li, LLNL Deputy Director's Science and Technology Excellence in Publication Award [May 2018]
Song Shuaiwen, IEEE-CS TCHPC Award for Excellence for Early Career Researchers in HPC [Nov 2017]
Dong Li, NSF CAREER Award [Jan 2016]
Rong Ge, NSF CAREER Award [Jan 2015]
Chun-Yi Su, Lawrence Livermore Scholar [May 2013]
Dong Li, Virginia Tech Computer Science Outstanding PhD Thesis [May 2011]
Song Shuaiwen 3rd place Torgersen Graduate Student Research Excellence Award [March 2010]
Matthew Tolentino invited to attend NAE Grand Challenge Summit [March 2009]
Chris Jones, UC System GREAT Award (PhD Fellowship at UCLA) [April 2008]
Rong Ge, VT Computer Science Outstanding Ph.D. Thesis, [June 2007]
Joseph Turner, Virginia Tech Cunningham Graduate Fellowship [May 2007]
Joseph Turner, NSF Fellowship Honorable Mention [May 2007, April 2008]
Chris Jones, NSF Fellowship Honorable Mention [May 2007]
Matt Tolentino, Travel grant to attend HPPAC [April 2007]
Rong Ge, Award to attend Computer Architecture Summer School Workshop, Princeton [July 2006]
Rong Ge, USC CSE Outstanding Graduate Student [April 2005]
Allen Michalski, Grant to attend Landau Meeting of Nobel Laureates [June 2005]
Chris Jones, Joseph Turner, Rong Ge, UPE inductees [March 2005]
Chris Jones, Joseph Turner, Phi Beta Kappa inductees [March 2005]
Joseph Turner, Student Volunteer Grant SC 2005 [November 2005]
Xizhou Feng, IPDPS Student Travel Award [June 2005]
Chris Jones, Student volunteer grant SC 2004 [Nov 2004]
Robert Lewis, Runner-up in Mathematics Division of 2004 SC Region II Science and Engineering Fair.

Supervision of Visiting/Research Faculty

Sand Correa (VT), Power-aware expectations, 1/1/15-1/1/16.
Matthew Grove (VT), Power-aware Software and Architectures, 8/10/10 – 5/1/11.

Supervision of Post-Doctoral Research

Rong Ge (VT), Improving Efficiency in Distributed Systems, 1/1/08 – 8/14/08.
Xizhou Feng (VT), High Performance Computing Algorithms and Systems, 5/16/06 – 5/16/07.
Kiril Dichev (QUB), Resiliency via data flow analysis, 7/15/17 – 5/5/18.
Giorgis Georgakoudis (QUB), Advanced modeling of parallel speedup, 7/15/17 – 5/5/18.

[Chair] Supervision of Doctoral Research (PhD Graduates = 10)

Matthew Tolentino (VT), Managing Memory for Power, Performance, and Thermal Efficiency, 1/1/05 – 5/1/09.
Xizhou Feng (USC, co-chair with D.A. Buell), High Performance Computing Algorithms and Systems, 1/1/03 – 5/15/06.
Rong Ge (VT), Power-performance Efficiency in Distributed Systems, 8/16/02 – 12/31/07.
Dong Li (VT), Scalable and Energy Efficient Execution Methods for Multicore Systems, 8/16/06 – 2/15/11.
Song “Leon” Shuaiwen (VT), Power, Performance and Energy Models and Systems for Emergent Architectures, 8/16/06 – 3/15/13.
Hung-Ching Chang (VT), Power-Performance Efficiency in I/O, 8/16/07 – 5/15/15.
Chun-Yi Su (VT), Power-Performance Analysis of HPC Memory Systems, 8/16/07 – 5/15/15.
Bo Li (VT), Modeling and Runtime Systems for Coordinated Power-Performance Management, 8/16/12 – Present.
Mariam Umar (VT), Extending the Aspen Framework to Support Power and Energy Modeling, 1/15/15 – 5/5/18.
Jon Bernard (VT), TBD, 8/16/17 – Present.
Greg Bolet (VT), TBD, 8/16/20 – Present.

Danny Tsang (VT), TBD, 8/16/22 – Present

[Chair] Supervision of Masters Research (M.S. Graduates = 12)

Eles Jones (VT), “LACE: A Kinetic Decentralized Ledger Sculpture for Educating Broad Audiences on Blockchain Computing, 8/15/21 – 8/1/22.

Sam Furman (VT), CPU Performance and Lineage Repository, 1/15/19 – 8/15/21.

Nicolas Hardy (VT), Computer Systems Performance and Lineage Repository, 1/15/19 – 5/15/21.

Chandler Jearls (VT), Hardware memory compression, 1/15/19 – 5/15/21.

Uday Ananth (VT), Studies of system variability, 1/15/15 – 5/15/17.

Sergio Bernales (VT), Orchestration of a Parallel Kinetic Sculpture of Raspberry Pi’s, 9/1/13 – 12/15/14. M.S. CS.

Song “Leon” Shuaiwen (VT), Thermal-aware High-performance Computing, 8/16/06 – 5/1/09. M.S. CS.

Hari K. Pyla (VT), Thermal Profiling Tools for Emergent Systems, 1/15/06 – 6/1/07. [w/ Varadarajan] M.S. CS.

Rong Ge (USC), Performance Evaluation/Prediction of Communication Overhead, 8/16/02 – 5/1/05. M.S. CE.

Chip Aaron (USC), Thermal Characteristics of Advanced DRAM Architectures, 9/1/04 – 5/1/05. M.S. CE.

Drew Varner (USC), Evaluation of High-performance Power-aware Clusters, 1/1/04 – 5/1/05. M.S. CE.

Vidya Kolipaka (USC), Performance Evaluation of Intel’s Softswitch Architecture, 5/1/02 – 6/1/03. M.S. CE.

Raghuram Renduchintala (USC), Advanced Use of the SimpleScalar Simulator, 7/1/02 – 12/15/02. M.S. CE.

Supervision of Undergraduate Research (Select list, B.S. students mentored = dozens)

* I am executive director of BURGS. As such, I support and mentor 20-25 undergrads per year on research.

* See: <https://cs.vt.edu/research/research-areas/systems/burgs.html> for current students and alumni.

Chandler Jearls, VT. Large-scale, cross-platform, system benchmarking. 9/15/17 – 12/20/18.

Samuel Furman, Research Project: Protocols for cross-system performance comparisons. 9/15/17 – 12/20/18.

Nicolas Hardy, Research Project: Protocols for cross-system performance comparisons. 9/15/17 – 12/20/18.

Jiayi “J.W. Wang, Research Project: Protocols for cross-system performance comparisons. 9/15/17 – 5/15/18.

Liz Dao, Research Project: Protocols for cross-system performance comparisons. 9/15/17 – 5/15/18.

Luke McCormick Research Project: Protocols for cross-system performance comparisons. 9/15/17 – 12/15/17.

Zoe Smith, Research Project: Protocols for cross-system performance comparisons. 9/15/17 – 12/15/18.

Barrett Latimer, VT. Performance and power analysis of the Raspberry Pi Computers. 9/15/17 – 12/15/17.

Kelsey, Farenholtz, VT. Design and implementation of a Raspberry Pi Cluster, 10/15/13 – 5/15/15.

John Mooring, VT: Design and implementation of a Raspberry Pi Cluster, 1/1/13 – 8/15/14.

Timmy Meyer, VT: Power-performance benchmarking on HPC Clusters, 1/1/13 – 5/15/15.

Chris Jones, Honors College Research: Evaluation of Power-aware Clusters, 1/1/04 – 5/15/06.

Joseph Turner, Honors College Research: Hardware counter evaluation of high-end systems, 1/1/04 – 12/15/06. B.S. CE.

Tyler Maxwell, Research Project: Implementation & analysis of Intel Softswitch Architecture, 1/1/02 – 8/30/02. B.S. CE.

Supervision of High School Students

Barrett Lattimer, Blacksburg High School, Summer 2016, Project: Programming SeeMore Kinetic Sculpture

Liam Lawrence, Blacksburg High School, Summer 2016, Project: Programming SeeMore Kinetic Sculpture

Kevin Hencke, Blacksburg High School, Summer 2006 Project: Empirical Study of Memory Hierarchies, B.S. UMD.

Robert Lewis, Dreher High School, Project: Building a Beowulf, entrant in 2004 SC Region II Science and Engineering Fair.

[Member] Advisement Committees

* I am a member of 3-5 CS or ECE PhD committees at any given time. I can provide a full list if needed.

Thomas Lux, Ph.D. [2020]

Tyler Chang, Ph.D. [2020]

Tong Zhang, Ph.D. [2019]

Luna Xu, Ph.D. [2019]

Yue Cheng, Ph.D. [2017]

Guanying Wang, PhD – VT [2014]

Alensandr Khasymyski, PhD – VT [2014]

David Easterling, PhD – VT [2013]

Ruslan Nikolav, PhD – VT [2013]

Mustafa Rafiki, PhD – VT [2013]

Balaji Subramaniam, M.S. – VT [2013]

Filip Balgojevic, PhD – VT [2009]

Amine Chigani, PhD – VT [2009]
 Rajesh Sudarsan, PhD – VT [2010]
 Matthew Curtis-Maury, PhD – VT [2008]
 Mehmet Belgin, PhD – VT [2010]
 Scott Scheider, Ph.D. – VT [2011]
 John Linford – M.S. VT [2009]
 Amine Chigani, M.S. – VT [2007]
 Ankur Shah, M.S. – VT [2008]
 Ashwin Aji, M.S. – VT [2008]
 Veena Basavaraj, M.S. – VT [2006]

TEACHING – VT CS/ECE & USC CSE COURSES AND CLASS SIZE

Course Subject	Course Code	Course Name	Credit Hours	Date	# of students
CS	4284	Systems and Networking Capstone	3.0	Spring 2023	25
CS	6204	Advanced Topics in Systems	3.0	Fall 2021	10
CS	4284	Systems and Networking Capstone	3.0	Spring 2021	40
CS	4284	Systems and Networking Capstone	3.0	Spring 2020	30
CS	4284	Systems and Networking Capstone	3.0	Spring 2019	25
CS	4234	Parallel Computation	3.0	Fall 2018	20
CS	4284	Systems & Networking Capstone	3.0	Fall 2016	16
CS	4234	Parallel Computation	3.0	Fall 2015	24
CS	4284	Systems & Networking Capstone	3.0	Fall 2015	14
CS	4234	Parallel Computation	3.0	Fall 2014	37
CS	6204	Advanced Topics in Systems	3.0	Fall 2014	15
CS	5504	Computer Architecture	3.0	Spring 2014	13
ECE	5504	Computer Architecture	3.0	Spring 2014	25
CS	4284	Systems & Networking Capstone	3.0	Fall 2013	16
CS	5504	Computer Architecture	3.0	Spring 2013	24
ECE	5504	Computer Architecture	3.0	Spring 2013	13
CS	2506	Intro to Computer Organization	3.0	Fall 2012	98
CS	2506	Intro to Computer Organization	3.0	Spring 2012	71
CS	6204	Advanced Topics in Systems	3.0	Spring 2012	15
CS	4234	Parallel Computation	3.0	Fall 2011	25
CS	2506	Intro to Computer Organization	3.0	Spring 2011	72
CS	5504	Computer Architecture	3.0	Spring 2011	7
ECE	5504	Computer Architecture	3.0	Spring 2011	4
CS	4234	Parallel Computation	3.0	Fall 2010	23
CS	2506	Intro to Computer Organization	3.0	Fall 2009	36

CS	4504	Computer Organization	3.0	Spring 2009	3
CS	5504	Computer Architecture	3.0	Spring 2009	15
ECE	4504	Computer Organization	3.0	Spring 2009	3
ECE	5504	Computer Architecture	3.0	Spring 2009	8
CS	6204	Advanced Topics in Systems	3.0	Fall 2008	4
CS	4504	Computer Organization	3.0	Spring 2008	9
CS	5504	Computer Architecture	3.0	Spring 2008	13
ECE	4504	Computer Organization	3.0	Spring 2008	10
ECE	5504	Computer Architecture	3.0	Spring 2008	12
CS	4504	Computer Organization	3.0	Spring 2007	7
CS	5504	Computer Architecture	3.0	Spring 2007	26
ECE	4504	Computer Organization	3.0	Spring 2007	9
ECE	5504	Computer Architecture	3.0	Spring 2007	1
CS	4504	Computer Organization	3.0	Spring 2006	7
CS	6204	Advanced Topics in Systems	3.0	Spring 2006	10
ECE	4504	Computer Organization	3.0	Spring 2006	17
CSE	6xxx	Power Conscious Computing	3.0	Spring 2005	9
CSE	4xxx	Computer Architecture	3.0	Fall 2004	26
CSE	5xxx	Advanced Computer Architecture	3.0	Spring 2004	6
CSE	4xxx	Computer Architecture	3.0	Fall 2003	25
CSE	6xxx	Performance Analysis	3.0	Spring 2003	8
CSE	4xxx	Computer Architecture	3.0	Fall 2002	31
CSE	4xxx	Computer Architecture	3.0	Fall 2001	24

SERVICE –BROADER NATIONAL AND INTERNATIONAL COMMUNITIES

EDITORIAL POSITIONS

Associate Editor in Chief: IEEE Transactions on Parallel and Distributed Systems , (2022– present).

Associate Editor: IEEE Transactions on Parallel and Distributed Systems , (2018 – 2022).

Associate Editor: Journal of Parallel and Distributed Computing , (2015 – 2025).

Associate Editor: IEEE Computer , (2014 – 2017).

Editorial Board: IEEE Computer , (2009 – 2014); editor of Green IT Column (2009 – 2014).

Editorial Board, Sustainable Energy Development Book Series, (2011 – present).

Guest Editor: IEEE Transactions on Parallel and Distributed Systems, Special Issue on Power-Aware Parallel and Distributed Systems (PAPADS), (2007 – 2008).

ELECTED COMMITTEES

Elected Member: NERSC User's Group Executive Committee (2007-2010).

INVITED INTERNATIONAL CONFERENCE ORGANIZATION POSITIONS

Conference General Co-Chair, ACM/IEEE ccGrid 2024 (2023-2024)

Conference General Chair, ACM eEnergy 2023, (2022-2023) "ACM Outstanding Service Award"

Conference General Co-Chair, ACM International Conference on Supercomputing (ICS 2022) (2021-2022) "ACM Outstanding Service Award"

Conference Steering Committee, IEEE ccGrid (2024-)

Conference Steering Committee, ACM eEnergy (2023-)

Conference Steering Committee, ACM International Conference on Supercomputing (ICS 2022) (2022-)

Technical Program Vice-Chair: CCGrid 2016 (Architecture, 2015-2016), CCGrid 2013 (Architecture, 2012-2013)

Technical Program Vice-Chair: SC 2015. (2014-2015)

Technical Program Co-Chair: CCGrid 2014. (2012-2014)

Workshop Co-Chair: Workshop on Energy Efficient Supercomputing (E2SC), 2012-2017.

Workshop Co-Chair: International Parallel and Distributing Processing Symposium (IPDPS), 2015-2016.

Workshop Co-Chair: Workshop on Variability in Systems (VarSys). (2015-2016).

Workshop Co-Chair: Workshop on Science of Power Management, Sponsored by NSF. (2008-2009).

Workshop Co-Chair: High-Performance Power-Aware Computing Workshop (HPPAC), 2007.

Publicity Chair: ACM International Conference on Supercomputing, 2011.

Society Steering Committee, IEEE Technical Committee on Scalable Computing – Technical Area of Green Computing (2011-).

Workshop Steering Committee, The First International Workshop on Energy Consumption and Reliability of Storage Systems (ERSS) 2011.

Conference Steering Committee, IEEE/ACM International Conference on Green Computing and Communications (GreenCom), 2009-present.

Workshop Steering Committee, High-performance, power-aware computing workshop (HPPAC), 2005-present.

Workshop Steering Committee, International workshop on performance analysis and optimization of high-end computing systems Workshop (APART), 2007.

Session Chair, 29th International ACM Symposium on High-Performance Parallel and Distributed Computing (HPDC 2020)

Session Chair: 2018 Extreme Heterogeneity Workshop.

Session Chair: SC 2014, SC 2017, SC 2018, SC 2019.

Session Chair (Breakout Session): NSF CISE PI Workshop, May 2017, Orlando, FL.

Session Chair: MASCOTS 2014.

Session Chair, National Academy of Engineering Frontiers of Engineering Indo-American Symposium, 2014.

Session Chair, International Parallel and Distributing Processing Symposium (IPDPS), 2011.

Session Chair, IEEE/ACM International Conference for High-performance Computing Networking, Storage, and Analysis (SC), 2009.

Session Chair, High-performance, power-aware computing workshop (HPPAC), 2005-2010.

Session Chair, IEEE/ACM International Conference for High-performance Computing Networking, Storage, and Analysis (SC), 2005.

Session Chair, Workshop on Hardware/Software Support for Parallel and Distributed Scientific and Engineering Computing (SPDSEC), 2002.

Session Chair, International Conference on Parallel and Distributed Processing Techniques and Applications (PDPTA), 1999.

INTERNATIONAL CONFERENCE TECHNICAL PROGRAM COMMITTEES (MEMBER)

2024 USENIX Annual Technical Conference (USENIX ATC '24)
33rd International ACM Symposium on High-Performance Parallel and Distributed Computing (HPDC 2024)
2023 International Parallel and Distributed Processing Symposium (IPDPS)
2022 International Parallel and Distributed Processing Symposium (IPDPS)
2022 International Conference on Distributed Computing Systems (ICDCS)
2021 IEEE/ACM International Conference for High-performance Computing Networking, Storage, and Analysis (SC)
2021 International Parallel and Distributed Processing Symposium (IPDPS)
30th International ACM Symposium on High-Performance Parallel and Distributed Computing (HPDC 2021)
2020 International Conference on Parallel Processing (ICPP 2020)
29th International ACM Symposium on High-Performance Parallel and Distributed Computing (HPDC 2020)
2020 IEEE/ACM International Conference for High-performance Computing Networking, Storage, and Analysis (SC)
2020 International Parallel and Distributed Processing Symposium (IPDPS)
28th International ACM Symposium on High-Performance Parallel and Distributed Computing (HPDC 2019)
2019 IEEE/ACM International Conference for High-performance Computing Networking, Storage, and Analysis (SC)
27th International ACM Symposium on High-Performance Parallel and Distributed Computing (HPDC 2018)
2017 IEEE/ACM International Conference for High-performance Computing Networking, Storage, and Analysis (SC)
2016 European Conference on Parallel Computing (EuroPar 2016)
2016 USENIX Workshop on Cool Topics in Sustainable Datacenters (CoolDC)
2015 IEEE/ACM International Conference on Parallel Architecture and Compilation Techniques (PACT 2015)
2014 International Parallel and Distributed Processing Symposium (IPDPS)
2014 IEEE/ACM International Conference for High-performance Computing Networking, Storage, and Analysis (SC)
2013 ACM SIG CHI [ad hoc reviewer]
2013 IEEE HiPC
22nd International ACM Symposium on High-Performance Parallel and Distributed Computing (HPDC 2013)
2012 IEEE HiPC
2012 IEEE CLUSTER
2012 IEEE/ACM International Conference for High-performance Computing Networking, Storage, and Analysis (SC)
21st International ACM Symposium on High-Performance Parallel and Distributed Computing (HPDC 2012)
2011 High Performance Computing Conference (HiPC)
2011 Workshop on Energy Consumption and Reliability of Storage Systems (ERSS)
2011 International Workshop on Power Measurement and Profiling (PMP)
2011 International Conference on Green Information Technology (GREEN IT)
2010 International Green Computing Conference (IGCC)
2010 European Conference on Parallel Computing (EuroPar 2010)
2010 IEEE Cluster
2010 Workshop on Energy Efficient Design (WEED)
2010 USENIX Workshop on Sustainable Information Technology (Sustain IT)
2010 Workshop on high-performance, power-aware computing (HPPAC)
2009 IEEE/ACM International Conference for High-performance Computing Networking, Storage, and Analysis (SC)
20th IEEE/ACM International Conference on Parallel Architecture and Compilation Techniques (PACT)
2009 Workshop on high-performance, power-aware computing (HPPAC)
2009 International Parallel and Distributed Processing Symposium (IPDPS)
2008 International Conference on Parallel Processing (ICPP)
2008 Workshop on high-performance, power-aware computing (HPPAC)
2007 International workshop on performance analysis and optimization of high-end computing systems (APART)
2007 International Conference on Parallel Processing (ICPP)
2007 International Conference on Parallel and Distributed Computing Networks (PDCN)
2007 ACM Southeastern Conference (ACMSE)
2007 Workshop on high-performance, power-aware computing (HPPAC)
2006 ACM Southeastern Conference (ACMSE)
2006 Workshop on high-performance, power-aware computing (HPPAC)
2005 IEEE/ACM International Conference for High-performance Computing Networking, Storage, and Analysis (SC)
2005 Workshop on high-performance, power-aware computing (HPPAC)
2004 International Conference on Parallel Processing (ICPP)

2002 Workshop on Hardware/Software Support for Parallel and Distributed Scientific and Engineering Computing (SPDSEC)

NATIONAL AND INTERNATIONAL OUTREACH ACTIVITIES

Co-founder: CS/root Entrepreneurial Hub, 2022-present.

Co-founder: CSGenome Project, 2018-present.

Co-founder: Green500 list of power efficient supercomputers, 2006-present. (Now merged with Top500.org)

Contributing Member: SPECPower Working Group 2005-present.

Awards Committee: Green Enterprise IT Awards, international competition for achievement in data center energy efficiency held annually at the IT Symposium, 2009-2012.

Session Chair: "Cloud, Serverless Computing, and HPC" session at NSF CISE PI Meeting, November, 2019.

Invited Participant, AFRL Cyber Energy Summit, 2011.

Invited Participant: 2010 US/EU Frontiers of Engr. Symposium, September 2010.

Invited Participant: EPA Stakeholders Workshop 2008.

Invited Participant: 2008 US Frontiers of Engr. Symposium, September 2008.

Invited Participant: EPA Tier II Energy Star Workshop 2007.

Invited Participant: National Security Agency Advanced Computing Systems (ACS) Workshop 2007.

Invited Participant: Interagency High-End Computing Revitalization Task Force, organized by the National Science and Technology Council 2003.

CONSULTING ACTIVITIES

Expert Consult: Goldberg Sagalla, New York, NY, 2023-present.

Expert Consult: Decision Detective, SF Bay Area, California, 2015-2016.

Founder and CEO: MiserWare, Inc. Power management software company, 2007-2014.

Expert Witness: Commonwealth of Virginia, Office of the Attorney General, 2006-2007.

Expert Consult: Oracle via Oblon – Spivak, Alexandria, Virginia, 2014.

Advisory Board Member: READEX Project, Led by Technical University Munich (Germany), Funded by European Union's Horizon 2020 research and innovation programme [No. 671657], 2015-2018.

Advisory Board Member: U.S. General Services Administration (GSA) Technical Operations (GTO) Technical Advisory Board (TAB) – technical advisory board member for GSA GTO \$237M contract awarded to AAC, Inc. 2014-2019.

SERVICE –UNIVERSITY COMMUNITY

VIRGINIA TECH INNOVATION CAMPUS, COLLEGE, AND UNIVERSITY ACTIVITIES

AVP Academic Affairs and Lead Faculty: Innovation Campus (2022-)

AVP Finance and Operations Search Chair (2023-)

Member: LINK Search Committee (2021)

Member: Innovation Campus Faculty Advisory Board (2020-2022)

Member: Innovation Campus Building Planning Committee (2020-2022)

Chair: CS Department Head Review Committee (2020-2021)

Member: COE Diversity Committee (2012-2016)

Director: stack@CS Center for Computing Systems (2013-2022)

Committee member: Associate Dean Search Committee (2010-2011), DH Review Committee Chair (2020-2021)

Faculty Mentor (2011): Jason Holliday (Forestry), Jules White (ECE), and Mantu Hudait (ECE).

VIRGINIA TECH DEPARTMENT OF COMPUTER SCIENCE OUTREACH ACTIVITIES

Associate Department Head, Graduate Studies (2014-2017), Research and Engagement (2018-2022)

HPC Lead, Virginia Tech Computer Science Alliance, coordinate activities with HBCU colleges in region, (2007-2010).

Founder and Chair, NSF CAREER Internal Review Committee, setup mock panels for junior faculty, (2006-2008).

VIRGINIA TECH DEPARTMENT OF COMPUTER SCIENCE ACTIVITIES

Director/Lead, Alumni and Corporate Relations, [2019-2022]
Director/Lead, Marketing and Communications, [2019-2022]
Director/Lead, Blockchain Initiative, [2018-2022]
Chair, Systems Faculty Search Committee [2018-2019]
Chair, CS Personnel (Tenure and Promotion) Committee, [2015-2016]
Member, CS Director of Undergraduate Studies Search [2021]
Member, CS Director of Graduate Studies Search [2021]
Member, CS Personnel (Tenure and Promotion) Committee, [2010-2011, 2013-2015, 2016-2018]
Member, CS Executive Committee, [2014-]
Member, CS Tech Lead Search [2014]
Member, CS External Relations Search [2014]
Member, CS Business Manager Search [2015]
Chair, Graduate Program Committee (2014-2017)
Chair, Systems Faculty Search Committee (2012-2013)
Faculty mentor for: Ali Butt (2010 – 2013), Dongyoon Lee (2014-), Danfeng Yao (2013-), Godmar Back (2013-), Thang Hoang (2020-), Matt Hicks (2019-), Bo Ji (2020-), Xun Jian (2019-), Kurt Luther (2016-)
Committee member, 40th Anniversary Event Committee (2011), 50th Anniversary Committee (2020-2021)
Course coordinator, CS 4504 (2005 – 2015)
Committee member, Marston Entrepreneurial Fund Committee (2007 – 2010)
Chair, Computer Resources Committee (2008 – 2010)
Member, Department Head Search Committee (2007-2008)
Member, Systems Faculty Search (2006, 2010, 2011-2012, 2013-2014)
Chair, Systems Qualifier Committee (2007-2008)
Member, Systems Qualifier Committee (2005-2008, 2016-2017)
Member, Graduate Admissions Committee (2006-2008, 2011-2014)

UNIVERSITY OF SOUTH CAROLINA ACTIVITIES

Faculty mentor for Jijun Tang (2004-2005)
Founder and Chair, NSF CAREER Internal Review Committee, setup mock panels for junior faculty, (2003-2005).
Founder and Chair, USC CSE Distinguished Lecture Series, (2003-2005).
Member, USC CSE Faculty Search Committee (2003-2005)
Member, USC Research and Productive Scholarship Committee (2004)
Member, USC CSE Computing Infrastructure Committee (2003-2005)

SERVICE –NATIONAL AND INTERNATIONAL REVIEWING ACTIVITIES

PROPOSAL REVIEWER

Review Panel, Deutsche Forschungsgemeinschaft (DFG), German Research Foundation
 NSF BLUE RIBBON PANEL (CISE Expeditions, 7 manuscripts, \$15M/proposal)
 NSF CAREER Panel (~10 manuscripts), 2004, 2007, 2009, 2013-2022.
 NSF CCF Panel (~10 manuscripts), 2015-2016, 2020, 2021.
 NSF CNS Panel (~10 manuscripts), 2015-2016, 2020, 2022.
 DOE Office of Science Ad Hoc Reviewer, (1 manuscript), 2014.
 NSF Ad Hoc Reviewer, (2 manuscripts), 2014, 2018.
 Engineering and Physical Sciences Research Council (UK), 2013.
 University of Cyprus, 2012.
 NSF SBIR Panel (8 manuscripts), 2010.
 Department of Energy Early Career Panel (10 manuscripts), 2009.
 NSF Ad Hoc Reviewer (1 manuscript) 2009.
 NSF Expeditions Panel (9 manuscripts), 2008.
 Ontario Research Fund, Canada, (4 manuscripts) 2007.
 NSF CPA Panel (10 manuscripts), 2007.
 Ontario Research Fund, Canada, (4 manuscripts) 2006.

NSF DDDAS Panel (12 manuscripts), 2005.
NSF REU Panel (11 manuscripts), 2005.
NSF ACR Panel (10 manuscripts), 2003.
NSF ITR Panel (12 manuscripts), 2003.

TEXTBOOK REVIEWER

Digital Principals and Design, 1e (702 pgs, McGraw-Hill).

JOURNAL MANUSCRIPT REVIEWER

** I don't really keep this up to date anymore. Too many to count.

IEEE Transactions on Computing
IEEE Transactions on Parallel and Distributed Systems
IEEE Micro
IEEE Computer
ACM Transactions on Computer Systems
ACM Journal of Emerging Technologies
ACM Computing Surveys
IBM Systems Journal
Journal of Future Generation Computing Systems
Journal of Systems Software
Journal of Parallel and Distributed Computing
IEEE Internet Computing
IEEE Transactions on Mobile Computing
Integration: The VLSI Journal
The Computing Journal
Parallel Computing
International Journal of High-Performance Computing
Frontiers of Computer Science China

SERVICE – INTERNATIONAL PROFESSIONAL MEMBERSHIPS

Distinguished Scientist, Association of Computing Machinery (ACM)
Fellow, Institute of Electrical and Electronics Engineers (IEEE)
Upsilon Pi Epsilon (UPE) Honor Society for the Computing Sciences