Zhenhua Liu

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Research Interests

cloud computing, online convex optimization, energy-efficient computing, machine learning, internet of things, market design, distributed control

Appointments

- 2014.8-pres Assistant Professor (tenure track), Department of Applied Mathematics & Statistics, Department of Computer Science (affiliation), Stony Brook University, Stony Brook, NY (*On leave for 2014.8-2015.8 with active service starting from 2015.8.*)
- 2014.6-2015.8 ITRI-Rosenfeld Fellow, EETD, Lawrence Berkeley National Lab, Berkeley, CA
- 2011.6-2013.9 Research Associate (intern), HP Labs, Palo Alto, CA. Host: Yuan Chen
- 2012.4-2012.7 Software Engineer (intern), Google, Mountain View, CA. Host: Hao Wang
- 2009.9-2014.6 Graduate researcher, California Institute of Technology, Pasadena, CA. Advisors: Adam Wierman, Steven Low

Education

- California Institute of Technology (Caltech), Pasadena, CA
  - Advisors: **Prof. Adam Wierman** and **Prof. Steven Low**
  - Ph.D. in **Computer Science**, June 2014, GPA 4.0/4.0
  - M.S. in Computer Science, June 2011, GPA 4.0/4.0
- Tsinghua University, Beijing, China
  - M.S. Computer Science and Technology, with honor, July 2009
  - B.E. **Measurement, Control Technology and Instruments**, with honor, July 2006
- Peking University, Beijing, China
  - B.S. **Economics**, July 2009

Selected Honors and Awards

- **Outstanding Teacher** award, Stony Brook University, 2017
- **Excellence in Teaching** award, Stony Brook University, 2016
- Nominated for **Best Student Paper Award**, ACM GreenMetrics, 2016
- **Research Initiation Initiative Grant** Award, NSF, 2015
- **SPEC Distinguished Dissertation Award** (honorable mention), 2014
- **ITRI-Rosenfeld Postdoctoral Fellowship**, Lawrence Berkeley National Laboratory, 2014-2016
- **Computerworld Honors Laureate for Net-zero Energy Data Center**, 2013
- **Best Paper Award**, IEEE International Green Computing Conference (IGCC), 2012
- **Best Student Paper Award**, ACM GreenMetrics, 2011
- **IEEE Sustainable Computing Register "Pick of the Month"**, 2013
- Selected to participate 2nd **Heidelberg Laureate Forum**, Heidelberg, Germany, 2014
- Chinese Government Award for Outstanding Students Abroad, 2014

- ACM Sigmetrics Travel Awards, 2012, 2013
- Resnick Fellowship Finalist, 2011
- Caltech Graduate Fellowship, 2009
- **Excellent Master Thesis Award**, Tsinghua University, 2009

Industrial Interactions

- HP Labs, Sustainable Ecosystems Research Group, June 2011–April 2013
  - Project: Sustainable Data Center
  - **Impacts:** I helped HP design and implement the **industry's first Net-Zero Energy Data Center**, and has been widely reported in media and news, e.g. the Wall Street Journal, Computerworld, Wired, ZDNet, The Register, and was named a **2013 Computerworld Honors Laureate**. Additionally, the results of my research provided insight and guidance into the design and management of HP EcoPOD data center, which has been used by many major IT companies, e.g., Facebook, eBay, Apple, and research institute, e.g., National Renewable Energy Laboratory, and won the 2013 InfoWorld Green IT Award.
  - **Three patents filed**.
- HP Labs, Systems Research Lab, May 2013–September 2013
  - Project: Big Data Workloads with Emerging Hardware Systems
  - **One patent filed**.
- Google, Infrastructure–storage, April 2012–June 2012
  - Project: Load Balancing in Next-generation Storage Systems
- Collaboration with HP and Fort Collins Utilities, Colorado on data center demand response
- Collaboration with Cloudera Inc. on big data workload and performance
- Collaboration with Akamai Inc. on geographical load balancing

Proceedings of Refereed Conference

1. Tan N. Le, Jie Liang, **Zhenhua Liu**, Ramesh K. Sitaraman, Jayakrishnan Nair and Bong Jun Choi, "Optimal Energy Procurement for Geo-distributed Data Centers in Multi-timescale Electricity Markets", **IFIP Performance**, 2017. Full paper.
2. Joshua Comden, Tan N. Le, Yue Zhao, Bong Jun Choi and **Zhenhua Liu** , "Geographically Coordinated Frequency Control", **IEEE CDC**, 2017.
3. Joshua Comden, **Zhenhua Liu**, Yue Zhao. "Incentivizing reliable demand response with customers' uncertainties and capacity planning", **ACM Sigmetrics**, 2017. Extended abstract.
4. Joshua Comden, **Zhenhua Liu**, Yue Zhao. "Harnessing Flexible and Reliable Demand Response Under Customer Uncertainties", Proceedings of **ACM E-energy**, 2017.
5. Tan N. Le, Jie Liang, **Zhenhua Liu**, Ramesh K. Sitaraman, Jayakrishnan Nair and Bong Jun Choi, "Optimal Energy Procurement for Geo-distributed Data Centers in Multi-timescale Electricity Markets", Proceedings of **ACM Greenmetrics**, 2017.
6. Joshua Comden, **Zhenhua Liu**, Yue Zhao. "Distributed Algorithm Design for Probabilistic Demand Response", Proceedings of **ACM Greenmetrics**, 2017.
7. Tan Le, **Zhenhua Liu**, Yuan Chen, Cullen Bash. "Joint Capacity Planning and Operational Management for Sustainable Data Centers and Demand Response". Proceedings of **ACM E-energy**, 2016.
8. Joshua Comden, **Zhenhua Liu**, Yue Zhao. "Optimizing the Level of Commitment in Demand Response". Proceedings of **ACM Greenmetrics**, 2016, Nominated for ***Best Student Paper Award***.

9. Niangjun Chen, Joshua Comden, **Zhenhua Liu**, Anshul Gandhi, Adam Wierman. "Using Predictions in Online Optimization: Looking forward with an eye on the past". Proceedings of **ACM Sigmetrics**, 2016.
10. Mosharaf Chowdhury, **Zhenhua Liu**, Ali Ghodsi, Ion Stoica. "Multi-Resource Fairness for Correlated and Elastic Demands". Proceedings of **NSDI**, 2016.
11. Hao Chen, **Zhenhua Liu**, Ayse Coskun and Adam Wierman. "Optimizing Energy Storage Participation in Emerging Power Markets". Proceedings of IEEE IGSC, 2015.
12. **Zhenhua Liu**, Iris Liu, Steven Low and Adam Wierman. "Pricing Data Center Demand Response". Proceedings of **ACM Sigmetrics**, 2014.
13. Adam Wierman, **Zhenhua Liu**, Iris Liu, and Hamed Mohsenian-Rad. "Opportunities and Challenges for Data Center Demand Response". Proceedings of International Green Computing Conference (IGCC), 2014.
14. **Zhenhua Liu**, Adam Wierman, Yuan Chen, Benjamin Razon and Niangjun Chen. "Data Center Demand Response: Avoiding the Coincident Peak via Workload Shifting and Local Generation". Proceedings of IFIP Performance 2013. **67 citations** on Google scholar since September 2013.
15. **Zhenhua Liu**, Adam Wierman, Yuan Chen, Benjamin Razon and Niangjun Chen. "Data Center Demand Response". Proceedings of **ACM Sigmetrics**, 2013. Extended Abstract.
16. **Zhenhua Liu**, Yuan Chen, Cullen Bash, Adam Wierman, Daniel Gmach, Zhikui Wang, Manish Marwah and Chris Hyser. "Renewable and Cooling Aware Workload Management for Sustainable Data Centers". Proceedings of **ACM Sigmetrics**, 2012. An extension of this work is used in the **industry's first Net-zero Energy Data Center** by HP, which was named a ***2013 Computerworld Honors Laureate***. **209 citations** on Google scholar since June 2012. Made the **most downloaded list** of all Sigmetrics papers in ACM Digital Library.
17. Minghong Lin, **Zhenhua Liu**, Adam Wierman and Lachlan L. H. Andrew. "Online Algorithms for Geographical Load Balancing". Proceedings of International Green Computing Conference (IGCC), 2012 **(*Best Paper Award*)**. **114 citations** on Google scholar since June 2012.
18. Lachlan L. H. Andrew, Minghong Lin, **Zhenhua Liu** and Adam Wierman (*alphabetical order*). "Algorithms for Dynamic Capacity Provisioning". Proceedings of Conference on Optical Internet, 2012.
19. Martin Arlitt, Cullen Bash, Sergey Blagodurov, Yuan Chen, Tom Christian, Daniel Gmach, Chris Hyser, Niru Kumari, **Zhenhua Liu**, Manish Marwah, Alan McReynolds, Chandrakant Patel, Amip Shah, Zhikui Wang and Rongliang Zhou (*alphabetical order*). "Towards the Design and Operation of Net-zero Energy Data Centers". Proceeding of 13th IEEE Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems, 2012.
20. **Zhenhua Liu**, Minghong Lin, Adam Wierman, Steven Low and Lachlan L. H. Andrew. "Geographical Load Balancing with Renewables". Proceedings of ACM GreenMetrics, 2011 **(*Best Student Paper Award*)**. **101 citations** on Google scholar since June 2011.
21. **Zhenhua Liu**, Minghong Lin, Adam Wierman, Steven Low and Lachlan L. H. Andrew. "Greening Geographical Load Balancing". Proceedings of **ACM Sigmetrics**, 2011. IEEE Sustainable Computing Register ***"Pick of the Month"***, April 2013. **309 citations** on Google scholar since June 2011.
22. **Zhenhua Liu**, Xiaoping Zhang, Lars Westberg, Youjian Zhao and Ling Chen. "Protective Internet Protocol (PIP)". Proceedings of International Conference on Network Protocols (ICNP), 2008. Extended Abstract.
23. **Zhenhua Liu**, Xiaoping Zhang, Youjian Zhao and Hongtao Guan. "An Asymptotically Minimal Node-degree Topology for Load-Balanced Architectures". Proceedings of IEEE GLOBECOM, 2008.
24. **Zhenhua Liu**, Xiaoping Zhang, Dong Wang, Youjian Zhao, and Hongtao Guan. "A Game-Theoretic Analysis of TCP Vegas and FAST TCP". Proceedings of CIICT, 2008.

25. **Zhenhua Liu**, Xiaoping Zhang, Youjian Zhao, and Hongtao Guan. "Using Direct Interconnection Networks for Load-Balanced Architecture". Proceedings of CIICT, 2008.

Journal Publications

1. Girish Ghatikar, Salman Mashayekh, Michael Stadler, Rongxin Yin and **Zhenhua Liu**. "Distributed Energy Systems Integration and Demand Optimization for Autonomous Operations and Electric Grid Transactions". Applied Energy. Volume 167, April 2016, pp 432-448.
2. **Zhenhua Liu**, Minghong Lin, Adam Wierman, Steven Low and Lachlan L. H. Andrew. "Greening Geographical Load Balancing". **IEEE/ACM Transactions on Networking (ToN)**, Volume 23(2), March 2014, pp 657-671. Extension of a paper that appeared in ACM Sigmetrics, 2011.
3. **Zhenhua Liu**, Adam Wierman, Yuan Chen, Benjamin Razon and Niangjun Chen. "Data Center Demand Response: Avoiding the Coincident Peak via Workload Shifting and Local Generation". Performance Evaluation, vol. 70(10), October 2013. Conference version appeared in the Proceedings of IFIP Performance 2013. Made the **most downloaded list of all Performance Evaluation articles**.
4. **Zhenhua Liu**, Minghong Lin, Adam Wierman, Steven Low and Lachlan L. H. Andrew. "Geographical Load Balancing with Renewables". Performance Evaluation Review, vol. 39(3), December 2011. Conference version appeared in the Proceedings of ACM GreenMetrics 2011.
5. Xiaoping Zhang, **Zhenhua Liu**, Youjian Zhao and Hongtao Guan. "Scalable Router". Journal of Software (China), vol. 19(6), 2008.

Patents and Thesis

- **Four patents** filed during the internship at HP Labs.
- "Scalable Router Based on P2i". China patent CN100440847C.
- "Greening Geographical Load Balancing". Master's Thesis. California Institute of Technology, 2011.
- High Capacity Scalable Switch Fabric based on Load-balanced Architecture". Master's Thesis. Tsinghua University, 2009. **Excellent Master Thesis Award** of Tsinghua University.
- "Migration of Linux on IQ80331 and Code Analysis of REDBOOT". Bachelor's Thesis. Tsinghua University, 2006. Excellent Thesis Award.

Conference and Invited Talks

- Invited talk, INFORMS Annual meeting, Title TBD, 2017.
- Oral presentation, IEEE IGSC. "Optimizing Energy Storage Participation in Emerging Power Markets". December 2015.
- Invited talk, INFORMS Annual meeting, "Towards Multi-resource Fairness in Big Data Systems", Philadelphia, November 1-4, 2015.
- Invited talk, INFORMS Annual meeting, "Optimizing demand response", San Francisco, November 9-12, 2014.
- Invited talk, **Microsoft Research Cambridge, UK**, "Sustainable IT and IT for Sustainability". April 2014.
- Invited talk, **Huawei US**, "Sustainable IT and IT for Sustainability". February 2014.
- Invited talk, **UC Berkeley**, RAD Lab directed by Prof Randy Katz and David Culler, "Sustainable IT and IT for Sustainability". February 2014.
- Invited talk, **UC Berkeley**, NCD Seminar, "Sustainable IT and IT for Sustainability". February 2014.
- Invited talk, **Green Data Storage** workshop at DIMACS, Rutgers University. "Data Center Demand Response: Coordinating IT and the Smart Grid". December 2013.

- Oral presentation, IFIP Performance. "Data Center Demand Response: Avoiding the Coincident Peak via Workload Shifting and Local Generation". September 2013.
- Invited talks, **IBM Research, Bell Labs, Cornell University, Qualcomm Research**. "Sustainable Data Centers and Demand Response". June 2013.
- Invited talk, IIIS directed by **Prof Andrew Yao (Turing Award Laureate)**, Tsinghua University. "Geographical Load Balancing for Renewable Energy Integration". December 2012.
- Oral presentation, ACM Sigmetrics. "Renewable and Cooling Aware Workload Management for Sustainable Data Centers". June 2012.
- Oral presentation, ACM Sigmetrics. "Greening Geographical Load Balancing". June 2011.
- Oral presentation, ACM GreenMetrics. "Geographical Load Balancing with Renewables". June 2011.
- Oral presentation, IEEE GLOBECOM. "An Asymptotically Minimal Node-degree Topology for Load-balanced Architectures". December 2008.

Teaching Experience

- AMS 546: Network flows, Stony Brook University, Spring 2017. **Course evaluation: 4.89/5**.
- AMS 560: Big data, algorithms, and networks, Stony Brook University, Spring 2017. **Course evaluation: 4.82/5**.
- AMS 301-03: Finite Mathematical Structures, Stony Brook University, Fall 2016. **Course evaluation: 4.53/5**.
- AMS/CS 691-01: Algorithms and Big Data Systems, Stony Brook University, Spring 2016. **Course evaluation: 4.83/5**.
- AMS/CS 691-02: Green IT and Smart Grid, Stony Brook University, Spring 2016. **Course evaluation: 4.89/5**.
- Teaching Assistant for "(CS/EE147) Network Performance Analysis", Caltech, Spring, 2013.
- Teaching Assistant for "(CS/EE146) Advanced Networking: Green IT", Caltech, Spring, 2011.
- Teaching Assistant for "(CS/EE145) Projects in Networking", Caltech, Spring, 2011.
- Teaching Assistant for "(CS/EE143) Communication Networks", Caltech, Fall, 2010.

Mentoring Experience

- Xiao Sun, 2017.5-present, PhD student in Operations Research.
- Joshua Comden, 2015.5-present, PhD student in Operations Research.
- Tan Le, 2015.5-present, PhD student in Computer Science.
- Adhita Selvaraj, 2017.5-present, Independent study on cloud resource allocation.
- Aditi Jain, 2017.5-present, Independent study on geo-distributed analytics, e.g., GeoSpark.
- Lei Song,
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- Jie Liang, 2015.8-2016.6, Independent study on data center energy provisioning in multi-timescale electricity markets. (Jie published a full paper in IFIP Performance 2017, one of the best conference in performance evaluation, as the second author. Her work was done as a junior at Stony Brook University.)
- Katie Knister, 2014, Independent study on dynamic pricing for demand response.
- Iris Liu, 2013-2014, Independent study on pricing data center demand response. (Iris published a full paper in ACM Sigmetrics 2014, one of the best conference in performance evaluation, as the second author. Her work was done as a senior at CalTech.)

- Benjamin Razon, 2012-2013, Independent study on data center demand response. (Ben coauthored a full paper in Elsevier Performance Evaluation 2013. His work was done as a senior at CalTech.)
- Yizhen Wang and Michael Hirshleifer, 2012 Summer Undergraduate Research Fellowship (SURF) students on renewable and cooling aware geographical load balancing.

Service

- Thesis committee: Gui Citovsky, PhD in AMS, Stony Brook University
- Preliminary exam committee: Zhi Li, PhD student in AMS, Stony Brook University
- Preliminary exam committee: Sichen Zhong, PhD student in AMS, Stony Brook University
- Preliminary exam committee: Su Jia, PhD student in AMS, Stony Brook University
- Preliminary exam committee: Yan Liang, PhD student in AMS, Stony Brook University
- RPE committee: Muhammad Wajahat, PhD student in CS, Stony Brook University
- RPE committee: Duin Back, PhD student in CS, SUNY Korea

External Funding

- NSF NeTS: Small: Demystifying the role of prediction models: bridging prediction algorithms and resource provisioning, 09/01/2017-08/31/2020, $450,000, co-PI (my portion 50%).
- NSF II-EN: Collaborative Research: Enhancing the Parasol Experimental Testbed for Sustainable Computing, 07/01/2017-06/30/2020, $24,215 (SBU portion), co-PI (my portion 50%).
- NSF NeTS: Small: Collaborative Research: Enabling Application-Level Performance Predictability in Public Clouds, 10/01/2016-09/30/2019, $211,500, **SBU PI**.
- NSF CRII: NeTS: Enabling Demand Response from Cloud Data Centers - from Sustainable IT to IT for Sustainability, 05/01/2015-04/30/2017, $174,957, **sole PI**.

Professional Memberships

- Association for Computing Machinery (ACM)
- Institute of Electrical and Electronics Engineers (IEEE)
- Institute for Operations Research and the Management Sciences (INFORMS)

Invited Referee for Journals and Conferences

- **Organizing Committee**, ACM Greenmetrics 2016, 2017
- **Technical Program Committee**, ACM Sigmetrics 2016, 2018
- Technical Program Committee, IEEE SmartGridComm 2015, 2016
- Technical Program Committee, ACM E-energy 2016, 2017
- Technical Program Committee, IEEE ICDCS 2016, 2017, 2018
- Technical Program Committee, GREEN 2016
- Technical Program Committee, 27th International Teletraffic Congress (ITC), 2015
- IEEE/ACM Transactions on Networking
- IEEE Transactions on Computers
- IEEE Transactions on Communications
- ACM Transactions on Modeling and Performance Evaluation of Computing Systems
- ACM Computer Communication Review
- IEEE Transactions on Parallel and Distributed System
- IEEE Transactions on Services Computing

- IEEE Transactions on Cloud Computing
- IEEE Transactions on Vehicular Technology
- Elsevier Journal of Computer Networks
- Elsevier Journal of Sustainable Computing
- Springer Cluster Computing
- IEEE Green Computing Conference 2014
- ACM Sigmetrics 2014
- ACM MobiHoc 2014
- 10th International Conference on Autonomic Computing (ICAC) 2013
- IEEE 20th International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems (MASCOTS) 2013