Bhuvan Urgaonkar

Contact Information

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Education

- Ph.D., Computer Science, University of Massachusetts Amherst, MA, 2005.
    - *Dissertation:* Dynamic Resource Management in Internet Hosting Platforms.
    - *Advisor:* Prof. Prashant Shenoy.
    - *Committee:* Profs. Emergy Berger, Jim Kurose, Don Towsley, Tilman Wolf.
- M.S., Computer Science, University of Massachusetts Amherst, MA, 2002.
- B.Tech. (hons.), Computer Science and Eng., Indian Institute of Tech., Kharagpur, 1999.

Fields of Research Interest

Cloud Computing, Data Centers, Distributed Computing, Fault Tolerance, Modeling & Optimization of Computer Systems, Operating Systems, Power Management, Storage Systems.

Employment

- Professor, Dept. of Comp. Sci. and Eng., The Pennsylvania State Univ., 07/21-onwards.
- Associate Professor, Dept. of Comp. Sci. and Eng., The Pennsylvania State Univ., 07/11-06/21.
- Assistant Professor, Dept. of Comp. Sci. and Eng., The Pennsylvania State Univ., 08/05-07/11.
- Summer Intern, IBM T. J. Watson Research Center, Hawthorne, NY, 05/2004-08/2004.
- Summer Intern, Sprint Advance Technologies Lab., Burlingame, CA, 05/2001-08/2001.
- Research Assistant, Dept. of Comp. Sci., Univ. of Massachusetts Amherst, MA, 08/1999-07/2005.

Visiting Researcher Positions

- Sensing and Energy Research Group, Microsoft Research, Redmond, WA, 07/12-08/12.
- Intel Research, Pittsburgh, PA, 09/12-10/12.
- Alcatel-Lucent Bell Labs, Crawford Hills and Holmdel, NJ, 11/12-12/12.

Awards

1. Google Faculty Research Award, 2020. (Co-recipient with V. Cadambe).

2. Editorial Excellence and Eminence Award, IEEE Transactions on Cloud Computing, 2019.

3. Best Poster Award, ACM Symposium on Cloud Computing (SOCC) 2019.

4. IBM Faculty Collaboration Program, 2018.

5. IBM Faculty Partnership Award, 2017.

6. Best Paper Runner Up, ACM/SPEC Intl. Conference on Performance Engineering (ICPE) 2017.

7. ACM Sigmetrics Test of Time Award, 2016.

8. Best Student Paper Award, IEEE Conference on Cloud Computing (CLOUD) 2016.

9. IBM Faculty Partnership Award, 2015.

10. Best Paper Award - Runner Up, ACM e-Energy 2015.

11. Best Paper Award, IEEE International Symposium on Workload Characterization (IISWC) 2013.

12. Best Paper Award, IEEE MASCOTS 2012.

13. Google Faculty Research Award, 2011. (Co-recipient with A. Sivasubramaniam).

14. HP Labs Innovation Research Program Award Co-Recipient, 2011. (Co-recipient with A. Sivasubramaniam).

15. Faculty Early Career Development (CAREER) Award, National Science Foundation, 2010.

16. Best Student Paper Award, IEEE MASCOTS 2008.

17. Cisco Collaborative Research Initiative, 2007.

18. Best Student Paper Award, IEEE International Conference on Autonomic Computing (ICAC) 2005.

Nominations

1. Best Paper Nomination, IEEE MASCOTS 2017.

2. Best Paper Candidate, IEEE ICAC. (2016)

3. Best Paper Award Nomination (one of 4 nominations), ACM Sigmetrics 2012.

4. Graduate Fellowship Nomination, Univ. of Massachusetts Amherst, MA, 2002.

Other Recognition

1. TOCS'13 paper in Comm. of the ACM (CACM) News, April 2013. `http://cacm.acm.org/news/163668-battery-backups-can-lower-datacenter-energy-costs/fulltext`.

2. ASPLOS'12 paper chosen as IEEE Sustainable Comp. Register's Pick of the Month, Sept. 2012.

3. HotCloud'11 paper in several online news articles (e.g., `http://www.pcworld.com/article/230352/Cloud\_Economics\_Favor\_the\_Small\_Workload.html`).

4. Paper at ICDCN 2010 fast-tracked for publication in Elsevier PMC journal, 2011.

Awards and Honors Received by Advisees

1. Rubaba Hasan, Graduate Fellowship, Penn State, 2018-19.

2. Cheng Wang, Best Graduate Paper and Presentation Award, College of Engg. Research Symposium (CERS 2012), Penn State, 2012.

3. Byung Chul Tak, IBM Ph.D. Fellowship, 2010-11.

4. Byung Chul Tak, Graduate Fellowship, Penn State, 2006-07.

Publications: Refereed Journal/Conference/Workshop Papers

1. **TraceSplitter: A New Paradigm for Downscaling Traces.** Sultan Sajal, Rubaba Hasan, Timothy Zhu, Bhuvan Urgaonkar, Siddhartha Sen. In *Proceedings of the European Conference on Computer Systems* (**EUROSYS 2021**), Edinburgh, April 2021. (40/191 = 21% accepted).

2. **SplitServe: Efficiently Splitting Apache Spark Jobs Across FaaS and IaaS.** Aman Jain, Ataollah Fatahi Baarzi, Nader Alfares, George Kesidis, Bhuvan Urgaonkar, and Mahmut Kandemir. In *Proceedings of the 21st ACM/IFIP International Middleware Conference* (**MIDDLEWARE 2020**), Delft, Netherlands, December 2020. (30/119 = 25% accepted).

3. **Heterogeneous MacroTasking (HeMT) for Parallel Processing in the Cloud.** George Kesidis, Bhuvan Urgaonkar, Yuquan Shan, Aman Jain, Jalal Khamse-Ashari, Ioannis Lambadaris. In *Proceedings of the 6th Workshop on Serverless Computing* (**WoSC 2020**), co-located with MIDDLEWARE 2020, Delft, Netherlands, December 2020.

4. **On a Caching System with Object Sharing.** George Kesidis, Nader Alfares, Xi Li, Bhuvan Urgaonkar, Mahmut Kandemir, Takis Konstanpoulos. In *Proceedings of the 7th International Workshop on Middleware and Applications for the Internet of Things* (**M4IoT 2020**), co-located with MIDDLEWARE 2020, Delft, Netherlands, December 2020.

5. **Fair Write Attribution and Allocation for Consolidated Flash Cache.** Wonil Choi, Bhuvan Urgaonkar, Mahmut Kandemir, Myoungsoo Jung, and David Evans. In *Proceedings of the 25th International Conference on Architectural Support for Programming Languages and Operating Systems* (**ASPLOS 2020**), Lousanne, Switzerland, March 2020. (86/476 = 18% accepted).

6. **BurScale: Using Burstable Instances for Improving the Cost-Efficacy of Autoscaling in the Public Cloud.** Ataollah Fatahi Baarzi, Timothy Zhu, and Bhuvan Urgaonkar. In *Proceedings of ACM Symposium on Cloud Computing* (**SOCC 2019**), November 2019. (39/157=25% accepted).

7. **SplitServe: Efficiently Splitting Complex Workloads Across FaaS and IaaS.** Aman Jain, Ataollah Fatahi Baarzi, Nader Alfares, George Kesidis, Bhuvan Urgaonkar, and Mahmut Kandemir. In *Proceedings of ACM Symposium on Cloud Computing* (**SOCC 2019**), November 2019. (Poster).

8. **Spock: Exploiting Serverless Functions for SLO and Cost aware Resource Procurement in Public Cloud.** Jashwant Raj Gunasekaran, Prashanth Thinakaran, Mahmut Taylan Kandemir, Bhuvan Urgaonkar, George Kesidis, and Chita R. Das. In *Proceedings of IEEE International Conference on Cloud Computing* (**CLOUD 2019**), Milan ITALY, July 2019. (20% accepted).

9. **Fair Resource Allocation in Consolidated Flash Systems.** Wonil Choi, Bhuvan Urgaonkar, Mahmut Kandemir, Myoungsoo Jung. In *Proceedings of the USENIX Workshop on Hot Topics in Storage* (**HOTSTORAGE 2019**), Renton, WA, July 2019. (40% accepted).

10. **Effective Capacity Modulation as an Explicit Control Knob for Public Cloud Profitability.** Cheng Wang, Bhuvan Urgaonkar, George Kesidis, Aayush Gupta, Lydia Y. Chen, Robert Birke. In *Transactions of ACM TAAS*, 13(1): 2:1-2:25, 2018.

11. **A Cost-efficient and Fair Multi-Resource Allocation Mechanism for Self-organizing Servers.** Jalal Khamse-Ashari, Ioannis Lambadaris, George Kesidis, Bhuvan Urgaonkar, and Yiqiang Zhao. In *Proceedings of the IEEE Global Communications Conference* (**GLOBECOM 2018**), Abu Dhabi, UAE, December 2018.

12. **Scheduling Distributed Resources in Heterogeneous Private Clouds.** George Kesidis, Yuquan Shan, Aman Jain, Bhuvan Urgaonkar, Jalal Khamse-Ashari, and Ioannis Lambadaris. In *IEEE International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems* (**MASCOTS 2018**), Milwaukee, WI, September 2018.

13. **An Efficient and Fair Multi-Resource Allocation Mechanism for Heterogeneous Servers.** Jalal Khamse-Ashari, Ioannis Lambadaris, George Kesidis, Bhuvan Urgaonkar, and Yiqiang Zhao. In *IEEE Transactions on Parallel and Distributed Systems* (**TPDS**), 2018.

14. **Constrained Max-Min Fair Scheduling of Variable-Length Packet-Flows to Multiple Servers.** Jalal Khamse-Ashar, George Kesidis, Ioannis Lambadaris, Bhuvan Urgaonkar, and Yiqiang Zhao. In *Annales des Télécommunications* 73(3-4): 219-237, 2018.

15. **An Empirical Analysis of Amazon EC2 Spot Instance Features Affecting Cost-effective Resource Procurement.** Cheng Wang, Qianlin Liang, and Bhuvan Urgaonkar. In *ACM Transactions on Modeling and Performance Evaluation of Computer Systems* (**TOMPECS**) - **Special Issue on ICPE 2017**, Volume 3 Issue 2, Article No. 6, April 2018.

16. **Competition and Peak-Demand Pricing in Clouds Under Tenants' Demand Response** George Kesidis, Uday Shanbhag, Neda Nasiriani, and Bhuvan Urgaonkar. In *Proceedings of the IEEE International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems* (**MASCOTS 2017**), Banff, Canada, September 2017. (26/84 = 31% accepted). Best Paper Nomination.

17. **Using Burstable Instances in the Public Cloud: Why, When, and How?** Cheng Wang, Bhuvan Urgaonkar, Neda Nasiriani, and George Kesidis. In *Proceedings of the ACM Conference on Measurement and Modeling of Computer Systems* (**SIGMETRICS 2017**), Urbana-Champagne, IL, June 2017.

18. **Per-Server Dominant-Share Fairness (PS-DSF): A Multi-Resource Fair Allocation Mechanism for Heterogeneous Servers.** Jalal Khamse-Ashari, Ioannis Lambadaris, George Kesidis, Bhuvan Urgaonkar, and Yiqiang Zhao In *Proceedings of the IEEE International Conference on Communications* (**ICC 2017**), Paris, France, May 2017.

19. **Efficient and Fair Scheduling of Placement Constrained Threads on Heterogeneous Multi-Processors.** Jalal Khamse-Ashari, George Kesidis, Ioannis Lambadaris, Bhuvan Urgaonkar, and Yiqiang Zhao In *Proceedings of the IEEE INFOCOM Workshop on Big Data and Cloud Performance* (**DCPERF 2017**), Atlanta, GA, May 2017.

20. **Multicommodity Games in Public-Cloud Markets Considering Subadditive Resource Demands.** George Kesidis, Neda Nasiriani, Yuquan Shan, Bhuvan Urgaonkar, Ioannis Lambadaris. In *Proceedings of the IEEE INFOCOM Workshop on Smart Data Pricing* (**SDP 2017**), Atlanta GA, May 2017.

21. **Exploiting Spot and Burstable Instances for Improving the Cost-efficacy of In-Memory Caches on the Public Cloud.** Cheng Wang, Bhuvan Urgaonkar, Aayush Gupta, Qianlin Liang, and George Kesidis. In *Proceedings of the European Conference on Computer Systems* (**EUROSYS 2017**), Belgrade, Serbia, April 2017.

22. **An Empirical Analysis of Amazon EC2 Spot Instance Features Affecting Cost-effective Resource Procurement.** Cheng Wang, Qianlin Liang, and Bhuvan Urgaonkar. In *ACM/SPEC International Conference on Performance Engineering* (**ICPE 2017**), L'Aquila, Italy, April 2017. Best Paper Runner Up.

23. **Resource Accounting of Shared IT Resources in Multi-Tenant Clouds.** Byung Chul Tak, Youngjin Kwon, Bhuvan Urgaonkar. *IEEE Trans. Services Computing 10(2): 302-315,* March-April 2017.

24. **Towards Performance Modeling as a Service by Exploiting Resource Diversity in the Public Cloud.** Mark Meredith and Bhuvan Urgaonkar. In *The Eighth IARIA International Conference on Cloud Computing, GRIDs, and Virtualization*, Athens, Greece, February 2017.

25. **On Fair Attribution of Costs Under Peak-based Pricing to Cloud Tenants.** Neda Nasiriani, Cheng Wang, George Kesidis, Bhuvan Urgaonkar, Lydia Chen, and Robert Birke. In *ACM Transactions on Modeling and Performance Evaluation of Computer Systems* (**TOMPECS 2016**), Vol. 2, Issue 1, Article No. 3, October 2016.

26. **Constrained Max-Min Fair Scheduling of Variable-Length Packet-Flows to Multiple Servers.** Jalal Khamse-Ashari, George Kesidis, Ioannis Lambadaris, Bhuvan Urgaonkar, and Yiqiang Zhao. In *Proceedings of the IEEE Global Communications Conference* (**GLOBECOM 2016**), Washington DC, December 2016.

27. **Effective Capacity Modulation as an Explicit Control Knob for Public Cloud Profitability.** Cheng Wang, Bhuvan Urgaonkar, Aayush Gupta, Lydia Chen, Robert Birke, and George Kesidis. In *Proceedings of the Thirteenth IEEE International Conference on Autonomic Computing* (**ICAC 2016**), Wurzberg, Germany, July 2016. Best Paper Candidate (1 out of 3).

28. **Fine-Grained Resource Scaling in a Public Cloud: A Tenant's Perspective.** Cheng Wang, Aayush Gupta, and Bhuvan Urgaonkar. In *Proceedings of the IEEE International Conference on Cloud Computing* (**CLOUD 2016**), San Francisco, CA, July 2016. (15% accepted). Best Student Paper Award.

29. **Profiling Memory Vulnerability of Big-data Applications.** Navneeth Rameshan, Robert Birke, Leandro Navarro, Vladimir Vlassov, Bhuvan Urgaonkar, George Kesidis and Lydia Chen. In *Proceedings of the IEEE/IFIP International Conference on Dependable Systems and Networks industrial track* (**DSN 2016**), Toulouse, France, June-July 2016.

30. **Neutrality in Future Public Clouds: Implications and Challenges.** George Kesidis, Bhuvan Urgaonkar, Neda Nasiriani, and Cheng Wang. In *Proceedings of the USENIX Workshop on Hot Topics in Cloud Computing* (**HOTCLOUD 2016**), Denver, CO, June 2016. (21/68 = 30% accepted).

31. **Navigating the Public Cloud Labyrinth: A Study of Price, Capacity, and Scaling Granularity Trade-offs.** Cheng Wang, Bhuvan Urgaonkar, Aayush Gupta, and Qianlin Liang. In *the USENIX Annual Technical Conference* (**USENIX 2016**). (Poster).

32. **Spot Characterization: What are the Right Features to Model?** Qianlin Liang, Cheng Wang, and Bhuvan Urgaonkar. In *Proceedings of the First International Workshop on System Analytics and Characterization* (**SAC 2016**), co-located with ACM SIGMETRICS 2016, Antibes Juan-les-pines, France, June 2016.

33. **Max-Min Fair Scheduling of Variable-Length Packet-Flows to Multiple Servers by Deficit Round-Robin.** Jalal Khamse-Ashari, George Kesidis, Ioannis Lambadaris, Bhuvan Urgaonkar, and Yiqiang Zhao. In *Proceedings of the Annual Conference on Information Science and Systems* (**CISS 2016**), Princeton, NJ, March 2016.

34. **On Fair Attribution of Costs Under Peak-based Pricing to Cloud Tenants.** Neda Nasiriani, Cheng Wang, George Kesidis, Bhuvan Urgaonkar, Lydia Y. Chen, Robert Birke. In *Proceedings of the IEEE International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems* (**MASCOTS 2015**), Atlanta, GA, September 2015.

35. **Recouping Energy Costs from Cloud Tenants: Tenant Demand Response Aware Pricing Design.** Cheng Wang, Neda Nasiriani, George Kesidis, Bhuvan Urgaonkar, Qian Wang, Lydia Y.

Chen, Aayush Gupta, Robert Birke, In *Proceedings of the Sixth ACM Conference on Future Energy Systems* (**e-Energy 2015**), Bangalore, July 2015. Best Paper Award - Runner Up.

36. **Network Calculus for Parallel Processing.** George Kesidis, Yuquan Shan, Bhuvan Urgaonkar, and Jorg Liebeherr. *Workshop on Mathematical Performance Modeling and Analysis* (**MAMA 2015**), colocated with ACM Sigmetrics, June 2015.

37. **A Hierarchical Demand Response Framework for Data Center Power Cost Optimization Under Real-World Electricity Pricing.** Cheng Wang, Bhuvan Urgaonkar, Qian Wang, and George Kesidis. In *Proceedings of the IEEE International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems* (**MASCOTS 2014**), Paris, September 2014.

38. **A Case for Virtualizing the Electric Utility in Cloud Data Centers.** Cheng Wang, Bhuvan Urgaonkar, George Kesidis, Uday V. Shanbhag, and Qian Wang. In *Proceedings of the Sixth USENIX Workshop on Hot Topics in Cloud Computing* (**HOTCLOUD 2014**), Philadelphia, PA, June 2014.

39. **Towards a Leaner Geo-distributed Cloud Infrastructure.** Iyswarya Narayanan, Aman Kansal, Anand Sivasubramaniam, Bhuvan Urgaonkar, and Sriram Govindan. In *Proceedings of the Sixth USENIX Workshop on Hot Topics in Cloud Computing* (**HOTCLOUD 2014**), Philadelphia, PA, June 2014.

40. **HybridPlan: A Capacity Planning Technique for Projecting Storage Requirements in Hybrid Storage Systems.** Youngjae Kim, Aayush Gupta, Bhuvan Urgaonkar, Piotr Berman, and Anand Sivasubramaniam. *The Journal of Supercomputing*, 67(1):277-303, January 2014.

41. **Data Center Power Cost Optimization Via Workload Modulation.** Cheng Wang, Bhuvan Urgaonkar, Qian Wang, George Kesidis, and Anand Sivasubramaniam. In *Proceedings of the Sixth IEEE/ACM Conference on Utility and Cloud Computing* (**UCC 2013**), Dresden, Germany, December 2013. (Short Paper).

42. **Towards An Effective and General Resource Accounting and Control Framework in Consolidated IT Platforms.** Byung Chul Tak, Youngjin Kwon, and Bhuvan Urgaonkar. *7th Workshop on Large-Scale Distributed Systems and Middleware*, (**LADIS 2013**), colocated with ACM SOSP, November 2013.

43. **Pricing of Service in Clouds: Optimal Response and Strategic Interactions.** Bhuvan Urgaonkar, George Kesidis, Uday V. Shanbhag, and Cheng Wang. *Workshop on Mathematical Performance Modeling and Analysis* (**MAMA 2013**), colocated with ACM Sigmetrics, June 2013.

44. **ACE: Abstracting, Characterizing and Exploiting Datacenter Power Demands.** Di Wang, Chuangang Ren, Sriram Govindan, Anand Sivasubramaniam, Bhuvan Urgaonkar, Aman Kansal, and Kushagra Vaid. In *Proceedings of the IEEE International Symposium on Workload Characterizationi* (**IISWC'13**), Portland, Oregon, USA, September 2013. Best Paper Award. Also, short paper (poster) in *Proceedings of the ACM International Conference on Measurement and Modeling of Computer Systems* (**SIGMETRICS 2013**).

45. **A Temporal Locality-aware Page-Mapped Flash Translation Layer.** Youngjae Kim, Aayush Gupta, and Bhuvan Urgaonkar. *Journal of Computer Science and Technology* (**JCST**), 28(6), pp. 1025-1044, Nov. 2013.

46. **A Case for Heterogeneous Flash.** Di Wang, Anand Sivasubramaniam, and Bhuvan Urgaonkar. In *Proceedings of the Workshop on Data Center Performance* (**DCPerf 2013**), colocated with ICDCS, 2013.

47. **Cloudy with a Chance of Cost Savings**. Byung Chul Tak, Bhuvan Urgaonkar, and Anand Sivasubramaniam. In *IEEE Transactions on Parallel and Distributed Systems* (**TPDS**), 24(6), pp. 1223-1233, June 2013.

48. **Using Dark Fiber to Displace Diesel Generators.** Aman Kansal, Bhuvan Urgaonkar, and Sriram Govindan. In *Proceedings of the XIV USENIX Workshop on Hot Topics in Operating Systems* (**HotOS 2013**), May 2013. (27/90 = 30% accepted).

49. **Aggressive Datacenter Power Provisioning Using Batteries**. Sriram Govindan, Di Wang, Anand Sivasubramaniam, and Bhuvan Urgaonkar. In *ACM Transactions on Computer Systems* (**TOCS**), 31(1), pp. 2:1-2:31, February 2013. Featured in Comm. of the ACM News, April 2013: `http://cacm.acm.org/news/163668-battery-backups-can-lower-datacenter-energy-costs/fulltext`.

50. **Using Batteries to Reduce the Power Costs of Internet-scale Distributed Networks.** Darshan S. Palasamudram, Ramesh K. Sitaraman, Bhuvan Urgaonkar, and Rahul Urgaonkar. In *Proceedings of the Third ACM Symposium on Cloud Computing* (**SOCC 2012**), San Jose, CA, October 2012. (21/163 = 13% accepted).

51. **Carbon-Aware Energy Capacity Planning for Datacenters**. Chuangang Ren, Di Wang, Bhuvan Urgaonkar, and Anand Sivasubramaniam. In *Proceedings of the IEEE International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems* (**MASCOTS 2012**), Washington DC, August 2012. (49/134 = 37% accepted). Best Paper Award.

52. **Energy Storage in Data Centers: What, Where, and How Much?** Di Wang, Chuangang Ren, Anand Sivasubramaniam, Bhuvan Urgaonkar, and Hosam Fathy. In *Proceedings of the ACM International Conference on Measurement and Modeling of Computer Systems* (**Sigmetrics 2012**), pp. 187-198, London, UK, June 2012. (31/203 = 15% accepted). Nominated for Best Paper Award.

53. **Leveraging Stored Energy for Handling Power Emergencies in Aggressively Provisioned Datacenters**. Sriram Govindan, Di Wang, Anand Sivasubramaniam, and Bhuvan Urgaonkar. In *Proceedings of the Seventeenth International Conference on Architectural Support for Programming Languages and Operating Systems* (**ASPLOS 2012**), pp. 75-86, London, UK, March 2012. (37/172 = 21% accepted). Chosen as IEEE Sustainable Computing Register's Pick of the Month, Sept. 2012.

54. **Towards Realizing a Low Cost and Highly Available Datacenter Power Infrastructure**. Sriram Govindan, Di Wang, Lydia Chen, Anand Sivasubramaniam, and Bhuvan Urgaonkar. In *Proceedings of the Fourth Workshop on Power-Aware Computing and Systems* (**HOTPOWER 2011**), co-located with SOSP 2011, Cascais, Portugal, October 2011. (10/38 = 26% accepted).

55. **HybridStore: A Cost-Efficient, High-Performance Storage System Combining SSDs and HDDs**. Youngjae Kim, Aayush Gupta, Bhuvan Urgaonkar, Piotr Berman, and Anand Sivasubramaniam. In *Proceedings of the IEEE International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems* (**MASCOTS 2011**), pp. 227-236, Singapore, July 2011. (41/157 = 26% accepted).

56. **To Move or Not to Move: The Economics of Cloud Computing**. Byung Chul Tak, Bhuvan Urgaonkar, and Anand Sivasubramaniam. Poster at *the Third USENIX Workshop on Hot Topics in Cloud Computing* (**HOTCLOUD 2011**), Portland, OR, June 2011.

57. **Leveraging Value Locality in Optimizing NAND Flash-based SSDs**. Aayush Gupta, Raghav Pisolkar, Bhuvan Urgaonkar, and Anand Sivasubramaniam. Poster at *the USENIX Conference on File and Storage Technologies* (**FAST 2011**), San Jose, CA, February 2011.

58. **To Move or Not to Move: The Economics of Cloud Computing**. Byung Chul Tak, Bhuvan Urgaonkar, and Anand Sivasubramaniam. In *Proceedings of the Third USENIX Workshop on Hot Topics in Cloud Computing* (**HOTCLOUD 2011**), Portland, OR, June 2011. (23/72 = 31% accepted).

59. **Benefits and Limitations of Tapping into Stored Energy for Data Centers**. Sriram Govindan, Anand Sivasubramaniam, and Bhuvan Urgaonkar. In *Proceedings of the Thirty Eighth International Conference on Computer Architecture* (**ISCA 2011**), pp. 341-352, San Jose, CA, June 2011. (40/208 = 19% accepted).

60. **Optimal Power Cost Management Using Stored Energy in Data Centers**. Rahul Urgaonkar, Bhuvan Urgaonkar, Michael Neely, and Anand Sivasubramaniam. In *Proceedings of the ACM International Conference on Measurement and Modeling of Computer Systems* (**Sigmetrics 2011**), pp. 221-232, San Jose, CA, June 2011. (26/177 = 14% accepted).

61. **A Comprehensive Study on Energy Efficiency of Flash Memory Storages**. Seonyeong Park, Youngjae Kim, Bhuvan Urgaonkar, Joonwon Lee, and Euiseong Seo. In *Elsevier Journal of System Architecture* (**JSA**), 57(4), pp. 354-365, April 2011.

62. **Leveraging Value Locality in Optimizing NAND Flash-based SSDs**. Aayush Gupta, Raghav Pisolkar, Bhuvan Urgaonkar, and Anand Sivasubramaniam. In *Proceedings of the USENIX Conference on File and Storage Technologies* (**FAST 2011**), pp. 91-103, San Jose, CA, February 2011. (20/74 = 27% accepted). Also, shorter version in the *Second Annual Non-Volatile Memories Workshop* (**NVMW 2011**), San Diego, CA, March 2011.

63. **Middleware for a Re-configurable Distributed Archival Store Based on Secret Sharing**. Shiva Chaitanya, Dharani S. Vijayakumar, Bhuvan Urgaonkar, and Anand Sivasubramaniam. In *Proceedings of the ACM/IFIP/USENIX Eleventh International Middleware Conference* (**MIDDLE-WARE 2010**), pp. 107-127, Bangalore, India, Nov-Dec 2010. (19/116 = 17% accepted).

64. **Multi-level Crypto Disk: Secondary Storage with Flexible Performance Versus Security Trade-offs.** Shiva Chaitanya, Bhuvan Urgaonkar, and Anand Sivasubramaniam. In *Proceedings of the Eighteenth Annual Meeting of the IEEE International Symposium on Modeling, Analysis, and Simulation of Computer and Telecommunication Systems* (**MASCOTS 2010**), pp. 434-436, Miami Beach, FL, August 2010. (Short paper).

65. **Cloud Computing: A Digital Libraries Perspective**. Pradeep Teregowda, Bhuvan Urgaonkar, and C. Lee Giles. In *Proceedings of the IEEE Third International Conference on Cloud Computing* (**CLOUD 2010**), pp. 115-122, Miami FL, July 2010. (20% accepted).

66. **CiteSeer^x: A Cloud Perspective**. Pradeep Teregowda, Bhuvan Urgaonkar, and C. Lee Giles. In *Proceedings of the Second USENIX Workshop on Hot Topics in Cloud Computing* (**HOTCLOUD 2010**), Boston, MA, June 2010. (24% accepted).

67. **DFTL: A Flash Translation Layer Employing Demand-based Selective Caching of Page-level Address Mappings**. Aayush Gupta, Youngjae Kim, and Bhuvan Urgaonkar. In the *First Annual Non-Volatile Memories Workshop* (**NVMW 2010**), San Diego, CA, April 2010.

68. **Bandwidth Provisioning in Infrastructure-based Wireless Networks Employing Directional Antennas**. Shiva Kasiviswanathan, Bo Zhao, Sudarshan Vasudevan, and Bhuvan Urgaonkar. In *Proceedings of the Eleventh International Conference on Distributed Computing and Networking* (**ICDCN 2010**), pp. 295-306, Kolkata, India, January 2010.

69. **Provisioning Bandwidth in Directional Antenna-based Wireless Networks**. Shiva Kasiviswanathan, Bo Zhao, Sudarshan Vasudevan, and Bhuvan Urgaonkar. In *Elsevier Pervasive and Mobile Computing Journal* (**PMC**), 7(1), pp. 114-127, February 2011 (special section on hot topics in computer networks). (Online version available July 2010). Chosen for fast track publication.

70. **Power Consumption Prediction and Power-Aware Packing in Consolidated Environments**. Jeonghwan Choi, Sriram Govindan, Bhuvan Urgaonkar, and Anand Sivasubramaniam. In *IEEE Transactions on Computers* (**TC**), 59(12), pp. 1640-1654, December 2010.

71. **FlashSim: A Simulator for NAND Flash-based Solid-State Drives**. Youngjae Kim, Brendan Taurus, Aayush Gupta, and Bhuvan Urgaonkar. In *Proceedings of the First International Conference on Advances in System Simulation* (**SIMUL 2009**), Porto, Portugal, September 2009.

72. **vPath: Precise Discovery of Request Processing Paths from Black-Box Observations of Thread and Network Activities**. Byung Chul Tak, Chunqiang Tang, Chun Zhang, Sriram

Govindan, Bhuvan Urgaonkar, and Rong N. Chang. In *Proceedings of the Thirty Fourth USENIX Annual Technical Conference* (**USENIX 2009**), San Diego, CA, June 2009. (32/191 = 17% accepted).

73. **Statistical Profiling-based Techniques for Effective Provisioning of Power Infrastructure in Consolidated Data Centers**. Sriram Govindan, Jeonghwan Choi, Bhuvan Urgaonkar, Anand Sivasubramaniam, and Andrea Baldini. In *Proceeedings of the European Conference on Computer Systems (organised by the European Chapter of SIGOPS, sponsored by ACM SIGOPS)* (**EuroSys 2009**), pp. 317-330, Nuremberg, Germany, April 2009. (25/148 = 17% accepted).

74. **DFTL: A Flash Translation Layer Employing Demand-based Selective Caching of Page-level Address Mappings**. Aayush Gupta, Youngjae Kim, and Bhuvan Urgaonkar. In *Proceedings of the Fourteenth International Conference on Architectural Support for Programming Languages and Operating Systems* (**ASPLOS 2009**), pp. 229-240, Washington DC, March 2009. (29/113 = 25% accepted).

75. **Resource Overbooking and Application Profiling in Shared Internet Hosting Platforms**. Bhuvan Urgaonkar, Prashant Shenoy, and Timothy Roscoe. In *the ACM Transactions on Internet Technologies* (**TOIT**), Volume 9, Number 1, pp. 1-45, 2009.

76. **Xen and Co.: Communication-aware CPU Management in Consolidated Xen-based Hosting Platforms**. Sriram Govindan, Jeonghwan Choi, Arjun R. Nath, Amitayu Das, Bhuvan Urgaonkar, and Anand Sivasubramaniam. In *IEEE Transactions on Computers* (**TC**), 58(8), pp. 1111-1125, 2009.

77. **Cataclysm: Scalable Overload Policing for Internet Applications**. Bhuvan Urgaonkar and Prashant Shenoy. In *the Elsevier Journal of Computer and Networking Applications* (**JCNA**), Volume 31, pp. 891-920, July 2008.

78. **An Empirical Analysis of the Energy Efficiency of Flash-based SSDs**. Euiseong Seo, Seonyeong Park, and Bhuvan Urgaonkar. In *Proceedings of the First Workshop on Power-Aware Computing and Systems* (**HotPower 2008**), *co-located with USENIX OSDI 2008*, San Diego, CA, December 2008.

79. **Profiling, Prediction, and Capping of Power in Consolidated Environments**. Jeonghwan Choi, Sriram Govindan, Bhuvan Urgaonkar, and Anand Sivasubramaniam. In *Proceedings of the Sixteenth Annual Meeting of the IEEE International Symposium on Modeling, Analysis, and Simulation of Computer and Telecommunication Systems* (**MASCOTS 2008**), pp. 3-12, Baltimore, MA, September 2008. (36/94 = 38% accepted). Best Student Paper Award.

80. **Predicting Web Cache Behavior Using Stochastic State-Space Models.** Amitayu Das, Ritendra Datta, Bhuvan Urgaonkar, and Anand Sivasubramaniam. In *Proceedings the Second International Workshop on Scalable Data Management Applications and Systems* (**SDMAS 2008**), pp. 609-616, July 2008, Las Vegas, NV. (29% accepted).

81. **Evaluating the Usefulness of Content-Addressable Storage for High-Performance Data-Intensive Applications.** Partho Nath, Bhuvan Urgaonkar, and Anand Sivasubramaniam. In *Proceedings of the ACM/IEEE International Symposium on High Performance Distributed Computing* (**HPDC 2008**), pp. 35-44, June 2008, Boston, MA. (17% accepted).

82. **QDSL: A Queueing Model for Systems with Differential Service Levels**. Shiva Chaitanya, Bhuvan Urgaonkar, and Anand Sivasubramaniam. In *Proceedings of the ACM International Conference on Measurement and Modeling of Computer Systems* (**Sigmetrics 2008**), pp. 289-300, June 2008, Annapolis, MD. (36/201 = 18% accepted).

83. **Towards Event Source Un-observability with Minimum Network Traffic in Sensor Networks**. Yi Yang, Min Shao, Sencun Zhu, Bhuvan Urgaonkar, and Guohong Cao. In *Proceedings of the First ACM Conference on Wireless Network Security* (**WiSec 2008**), pp. 77-88, March-April 2008, Alexandria, VA. (16/96 = 17% accepted).

84. **Agile Dynamic Provisioning of Multi-tier Internet Applications**. Bhuvan Urgaonkar, Prashant Shenoy, Abhishek Chandra, Pawan Goyal, and Tim Wood. In *the ACM Transactions on Autonomous and Adaptive Systems* (**TAAS**), Volume 3, pp. 1-39, March 2008.

85. **Application Placement on a Cluster of Servers**. Bhuvan Urgaonkar, Arnold Rosenberg, and Prashant Shenoy. In *the International Journal on Foundations of Computer Science* (**IJFCS**), Vol. 18, No. 5, pp. 1023-1041, October 2007.

86. **Analytic Modeling of Multi-tier Internet Applications**. Bhuvan Urgaonkar, Giovanni Pacifici, Prashant Shenoy, Mike Spreitzer, and Asser Tantawi, In *the ACM Transactions on the Web* (**TWEB**), Volume 1, Number 1, pp. 1-35, May 2007.

87. **Xen and Co.: Communication-aware CPU Scheduling for Consolidated Xen-based Hosting Platforms**. Sriram Govindan, Arjun R. Nath, Amitayu Das, Bhuvan Urgaonkar, and Anand Sivasubramaniam. In *Proceedings of the Third International ACM SIGPLAN/SIGOPS Conference on Virtual Execution Environments* (**VEE 2007**), pp. 126-136, June 2007, San Diego, CA. (19/70 = 27% accepted).

88. **Packing to Angles and Sectors**. Piotr Berman, Jieun Jeong, Shiva Kasiviswanathan, and Bhuvan Urgaonkar. In *Proceedings of the Nineteenth ACM Symposium on Parallelism in Algorithms and Architectures* (**SPAA 2007**), pp. 171-180, June 2007, San Diego, CA. (37/130 = 28% accepted).

89. **Optimizing Energy-Efficient Query Processing in Sensor Networks**. Ross Rosemark, Wang-Chien Lee, and Bhuvan Urgaonkar. In *Proceedings of the Eighth International Conference on Mobile Data Management* (**MDM 2007**), pp. 24-29, Mannheim, Germany, May 2007. (Short paper).

90. **Dynamic Cache Reconfiguration Strategies for a Cluster-based Streaming Proxy**. Yang Guo, Zihui Ge, Bhuvan Urgaonkar, Prashant Shenoy, and Don Towsley. In *Elsevier Computer Communications Review* (**CCR**), Volume 29, Issue 10, pp. 1710-1721, June 2006.

91. **Dynamic Provisioning of Multi-tier Internet Applications**. Bhuvan Urgaonkar, Prashant Shenoy, Abhishek Chandra, and Pawan Goyal. In *Proceedings of the Second IEEE International Conference on Autonomic Computing* (**ICAC 2005**), pp. 217-228, Seattle, WA, June 2005. (25/150 = 16% accepted). Best Student Paper Award.

92. **An Analytical Model for Multi-tier Internet Services and its Applications**. Bhuvan Urgaonkar, Giovanni Pacifici, Prashant Shenoy, Mike Spreitzer, and Asser Tantawi. In *Proceedings of the ACM International Conference on Measurement and Modeling of Computer Systems* (**Sigmetrics 2005**), pp. 291-302, Banff, Canada, June 2005. (31/237 = 13% accepted).

93. **Cataclysm: Policing Extreme Overloads in Internet Applications**. Bhuvan Urgaonkar and Prashant Shenoy. In *Proceedings of the Fourteenth International World Wide Web Conference* (**WWW 2005**), pp. 740-749, Chiba, Japan, May 2005. (77/550 = 14% accepted).

94. **Cataclysm: Handling Extreme Overloads in Internet Services**. Bhuvan Urgaonkar and Prashant Shenoy. In *Proceedings of the Twenty-Third Annual ACM SIGACT-SIGOPS Symposium on Principles of Distributed Computing* (**PODC 2004**), p. 390, July 25-28, 2004, St. John's, Newfoundland, Canada. (Brief announcement).

95. **Sharc: Managing CPU and Network Bandwidth in Shared Clusters**. Bhuvan Urgaonkar and Prashant Shenoy. In *IEEE Transactions on Parallel and Distributed Systems* (**TPDS**), Volume 15, Number 1, pp. 2-17, January 2004.

96. **Application Placement on a Cluster of Servers**. Bhuvan Urgaonkar, Arnold Rosenberg, and Prashant Shenoy. In *Proceedings of the Seventeenth International Conference on Parallel and Distributed Computing Systems* (**PDCS 2004**), pp. 85-90, San Fransisco, CA, September 2004. (62/185 = 33% accepted).

97. **Scheduler-aware Virtual Memory Management**. Emery Berger, Scott Kaplan, Bhuvan Urgaonkar, Pritesh Sharma, Abhishek Chandra, and Prashant Shenoy. *Poster at the Nineteenth ACM Symposium on Operating Systems Principles* (**SOSP 2003**), Lake George, NY, October 2003. (Extended Abstract).

98. **On Dynamic Cache Reconfiguration Strategies for a Cluster-based Streaming Proxy**. Yang Guo, Zihui Ge, Bhuvan Urgaonkar, Prashant Shenoy, and Don Towsley. In *Proceedings of the Eighth International Workshop on Web Content Caching and Distribution* (**WCW 2003**), Hawthorne, NY, September 2003.

99. **Resource Overbooking and Application Profiling in Shared Hosting Platforms**. Bhuvan Urgaonkar, Prashant Shenoy, and Timothy Roscoe. In *Proceedings of the Fifth Symposium on Operating Systems Design and Implementation* (**OSDI 2002**), pp. 239-254, Boston, MA, December 2002. (28/150 = 18% accepted).

100. **Maintaining Mutual Consistency for Cached Web Objects**. Bhuvan Urgaonkar, Anoop Ninan, Mohammad Raunak, Prashant Shenoy, and Krithi Ramamritham. In *Proceedings of the Twenty First International Conference on Distributed Computing Systems* (**ICDCS 2001**), pp. 371-380, Phoenix, AZ, April 2001. (69/217 = 31% accepted).

Publications: Non-Refereed Invited Papers/Magazine Articles

1. **Research Challenges at the Intersection of Cloud Computing and Economics.** David Irwin and Bhuvan Urgaonkar. Report based on the NSF Workshop on the Economics of Cloud Computing, Stanford University, May 2018.

2. **Empirical Workload and Energy Management for the Cloud.** Bhuvan Urgaonkar and George Kesidis. NSFCloud Workshop on Experimental Support for Cloud Computing, Arlington, VA, December 2014.

3. **A Case for Virtualizing the Electric Utility in Cloud Data Centers.** Bhuvan Urgaonkar, George Kesidis, Uday V. Shanbhag, and Cheng Wang. *INFORMS Annual Meeting 2014*, session on Optimal Allocation of Scarce Infrastructure Capacity: Lessons from Different Network Industries, San Francisco CA, November 2014.

4. **Pricing of Service in Clouds: Optimal Response and Strategic Interactions.** Uday V. Shanbhag, Cheng Wang, George Kesidis, and Bhuvan Urgaonkar. *INFORMS Annual Meeting 2013*, invited session on Cloud Computing, Minneapolis MN, October 2013.

5. **Understanding the Cost of Cloud: Cost analysis of In-house vs. Cloud-based Hosting Options**. Byung Chul Tak, Bhuvan Urgaonkar and Anand Sivasubramaniam. In *The European Business Review*, pp.76-80 (**EBR 2011**), September-October 2011.

6. **RIVER: Resource Management Infrastructure for Consolidated Hosting in Virtualized Data Centers**. Bhuvan Urgaonkar and Anand Sivasubramaniam. The Next Generation Software Workshop held in conjunction with IPDPS 2008 (**NGS 2008**), April 2008, Miami, FL.

Substantial Software Developed/Supervised

Code available for download at `https://github.com/PSU-Cloud`. Released under the Apache license.

- **LEGOStore**, geo-distributed linearizable key-value store combining replication and erasure coding. Student developers: Hamidreza Zare, Chetan Sharma, Nader Alfares, and Praneet Soni.

- **SplitServe**, Spark enhancements for jointly using AWS instances and Lambdas. Student developer: Aman Jain.

- **MCD-OS**, memcached implementation of a cache with object sharing (across competing users) aware replacement policies.

- **Mesos-PSDSF**, Apache Mesos implementation of PSDSF multi-resource fair scheduler. Student developer: Yuquan Shan.

- **HeMT**, heteogeneous macrotasking based scheduling in Apache Spark. Student developer: Yuquan Shan.

- Enhancements to memcached for cost-effective operation on Amazon EC2 and Google Compute Engine public cloud platforms. Student developer: Cheng Wang.

Funding: Ongoing Projects

1. **NSF Convergence Accelerator - Track C: SQAI: Scalable Quantum Artificial Intelligence for Discovery**. Senior Personnel with S. Ghosh (PI) et al., *National Science Foundation,* September 2020 - August 2021. $960,000.

2. **PPoSS: Planning: Cross-Layer Design for Cost-Effective HPC in the Cloud**, Co-PI (33%) with M. Kandemir (PI) and G. Kesidis, *National Science Foundation*, August 2020 - July 2021, $250,000.

3. **Erasure Coding Based Geo-Distributed Key-Value Stores**, Co-PI with V. Cadambe, *Google Faculty Research Award*, 2020, $55,000 (plus $10,000 in cloud credits).

Funding: Completed Projects

1. **Funding for NSF Workshop on Cloud Economics**, PI (50%) with D. Irwin (UMass-Amherst), *National Science Foundation (CNS)*, 2018, $100,000.

2. **Systematizing Trade-offs Between Recovery Time Objective and Foreground Performance in Modern Databases**, PI (100%), *IBM Faculty Collaboration Program*, 2018, $20,000.

3. **Using Burstable Instances for Cost-Efficacy in the Public Cloud: When and How?**, PI (50%) with G. Kesidis, *National Science Foundation (CNS)*, August 2017 - July 2020, $500,000.

4. **An Exploration of Wimpy Virtual Resource Offerings for Bluemix**, PI (100%), *IBM Faculty Partnership Award*, April 2017 - March 2018, $40,000.

5. **Student Travel Grants for ACM SIGMETRICS 2016**, PI (100%), *National Science Foundation (CNS)*, 2016, $20,000.

6. **Cost-Effective Resource Procurement for Public Cloud Tenants**, PI (100%), *IBM Faculty Partnership Award*, January 2015 - December 2015, $20,000.

7. **Provisioning and Harnessing Energy Storage for Datacenter Demand Response**, Co-PI (33%) with A. Sivasubramaniam and H. K. Fathy, *National Science Foundation (CNS)*, August 2013 - July 2018, $998,477.

8. **II-NEW: INSpiRE: Infrastructure for HeterogeNeous System ResEarch**, Senior Personnel with C. Das et al., *National Science Foundation (CCF)*, August 2012 - July 2015, $550,000.

9. **CAREER: Turning Cloud-Based Hosting into a Utility**, PI (100%), *National Science Foundation (CNS)*, August 2010 - July 2016, $420,000.

10. **Modeling and Feedback Design of Enterprise-scale Virtualized Data Centers**, Co-PI (50%) with Q. Wang, *National Science Foundation (CMMI)*, September 2010 - August 2013, $247,500.

11. **Shaving Peak Power Consumption in Datacenters**, Co-PI (50%) with A. Sivasubramaniam, *Hewlett Packard Labs Innovation Research Program*, September 2010 - August 2011, $75,000.

12. **Using Batteries for Demand Response in Data Centers**, Co-PI (50%) with A. Sivasubramaniam, *Google Faculty Research Award*, September 2010 - August 2011, $150,000.

13. **HybridStore: An Enterprise-scale Storage System Employing Solid-state Memory and Hard Disk Drives**, PI (50%) with A. Sivasubramaniam, *National Science Foundation (CCF)*, August 2008 - July 2013, $450,000.

14. **RIVER: Resource Management Infrastructure for Consolidated Hosting in Virtualized Data Centers**, PI (50%) with A. Sivasubramaniam, *National Science Foundation (CSR)*, August 2007 - July 2012, $463,242.

15. **Resource Management in Virtualized Data Centers**, PI (100%), Cisco Collaborative Research Initiative, August 2007 - July 2009, $100,000.

Professional Teaching Experience

All courses offered in the Dept. of CSE, Penn State. Details at: `http://www.cse.psu.edu/~bhuvan/teaching/`.

- **Operating Systems** (CMPSC 473), core undergraduate course: Summer 2021, Spring 2021, Spring 2019, Fall 2017, Spring 2015, Fall 2013, Spring 2012, Fall 2010, Fall 2009, Fall 2008, Fall 2006.

- **Distributed Systems** (CSE 513), core graduate course: Fall 2020.

- **Operating System Design** (CSE 511), core graduate course: Spring 2020, Fall 2018, Fall 2016, Fall 2014, Fall 2011, Spring 2009, Fall 2007.

- **Distributed Computing** (CSE 597), graduate course: Spring 2018. Co-taught with Prof. Viveck Cadambe (new course).

- **Readings in Deep Learning Systems** (CSE 598), graduate course: Spring 2018. Co-taught with Prof. Mahmut Kandemir (new course).

- **Public Cloud Computing: A Tenant's Perspective** (CSE 597), graduate course: Spring 2017. (new course).

- **Systems Programming** (CMPSC 311), core undergraduate course: Spring 2016.

- **Performance Evaluation for Clouds** (CSE 597B), graduate course: Spring 2014. Co-taught with Prof. George Kesidis (new course).

- **Virtualization: Techniques and Applications** (CSE 598G), graduate course: Spring 2011.

- **Cloud Computing** (CSE 598G), graduate course: Spring 2010.

- **Fundamentals of Distributed Computing** (CSE 598G), graduate course: Fall 2007 (new course).

- **Storage Systems** (CSE 598D), graduate course: Spring 2007. (second offering in the Department).

- **Virtual Machines and their Applications** (CSE 598C), graduate course: Spring 2006 (new course).

- **Self-* Systems** (CSE 598B), graduate course: Fall 2005 (new course).

Advising

Current Ph.D. Students

- Avimita Chatterjee. 2021-.
- Sai Pravallik Gujjula. 2021-.
- Rubaba Hasan, co-advised with Timothy Zhu, heterogeneity-aware cloud resource management. 2018-.
- Raj Kumar Pandey. 2021-.
- Sultan Sajal, co-advised with Timothy Zhu, workload synthesis across diverse platforms. 2018-.
- HamidReza Zare, co-advised with Viveck Cadambe, cost-effective geo-distributed storage on the public cloud. 2019-.

Current M.S. Students

- Chandu Dasari, co-advised with Mahanth Gowda and Mahmut Kandemir, sports analytics.
- Murali Nagaraju, co-advised with Mahanth Gowda and Mahmut Kandemir, health analytics.
- Ranjitha Ramesh, co-advised with Viveck Cadambe, Cassandra distributed storage.

Former Ph.D. Students and Postdocs

- Cheng Wang. 2016. Alibaba.
- Aayush Gupta. 2012. Google.
- Byung Chul Tak. 2012. Assistant Professor, Kyungpook National University, Rep. of Korea.
- Sriram Govindan (co-advised with Anand Sivasubramaniam). 2011. Sr. Software Engineer, Microsoft.
- Euiseong Seo (Ph.D., KAIST, Republic of Korea). 2009. Associate Professor, School of Information and Communication Engineering, Sungkyunkwan University, Rep. of Korea.
- Youngjae Kim (co-advised with Anand Sivasubramaniam). 2009. Assistant Professor, Sogang Univ., Rep. of Korea.
- Shiva Chaitanya (co-advised with Anand Sivasubramaniam). 2009. Sr. Software Engineer, Netflix.

Former M.S. Advisees

- Madhav Deshpande. 2021.
- Michael Wheatman. 2021.
- Nader Alfares. 2020.
- Praneet Soni. 2020. First employer: Apple.
- Aman Jain. 2019. First employer: Microsoft.
- Chetan Sharma. 2018. First employer: Microsoft.
- Sepideh Kamrava. 2016.

- Darshan Palasamudram. 2013.

- Paul Bily. 2013.

- Kanishk Jain. 2008. First employer: Cisco, Inc.

- Arjun R. Nath. 2008. First employer: Intel.

- Dharani S. Vijayakumar. 2008. First employer: VMWare, Inc.

- Mark Johnson. 2007.

Undergraduate Advisees

- James Heinrich. 2019-20.

- Grant Hipkins. 2019.

- Andy Huang. 2019.

- Qianlin Liang. 2016. Honors thesis.

- Ke Wei Chen. 2013. Honors thesis.

- Saul Wecht. 2013. Honors thesis.

Non-advisor Ph.D./M.S. Committee Memberships (graduation year, first employer if known)

- Arun Teja Muluka. M.S. thesis committee member. Ongoing.

- Tianxiang Tan. Ph.D. thesis committee member. Ongoing.

- Adithya Kumar. Ph.D. thesis committee member. Ongoing.

- Jashwant Raj Gunasekaran. Ph.D. thesis committee member. 2021. First employer: Adobe Research.

- Gaurav Kumar Chandel. M.S. thesis committee. 2021. First employer: HP.

- Sai Raghav Keesara. M.S. thesis committee member. 2021.

- Arjun Menon. M.S. thesis committee member. 2021.

- Wonil Choi. Ph.D. thesis committee member. 2021.

- Yunju Lee. M.S. thesis committee member. 2020.

- Ramy H. Ali. Ph.D. thesis committee member. 2020.

- Narges Shahidi. Ph.D. thesis committee member. 2020.

- Iyswarya Narayanan. Ph.D. thesis committee member. 2019.

- Yuquan Shan. Ph.D. thesis committee member. 2018. First employer: Facebook.

- Shihang Lyu. M.S. thesis committee member. 2018.

- Weiling Li. Ph.D. thesis committee member. 2018.

- Neda Nasiriani. Ph.D. thesis committee member. 2018.

- Li Qiu. Ph.D. thesis committee member. 2018.

- Yuqiong Sun. Ph.D. thesis committee member. 2016. First employer: Google.

- Di Wang. Ph.D. thesis committee member. 2014. First employer: Microsoft Research.

- Hayawardh Vijayakumar. Ph.D. thesis committee member. 2014. First employer: Samsung Research.

- Bikash Sharma. Ph.D. thesis committee member. 2013. First employer: Microsoft.

- Shengzhi Zhang. Ph.D. thesis committee member. 2012. First employer: Florida Institute of Technology.

- Seung-Hwan Lim. Ph.D. thesis committee member. 2012. First employer: Oak Ridge Nat. Lab.

- Joshua Schiffman. Ph.D. thesis committee member. 2012.

- Pradeep Teregowda. Ph.D. thesis committee member. 2012.

- Michael Frasca. Ph.D. thesis committee member. 2012.

- Sandra Rueda. Ph.D. thesis committee member. 2011.

- Kevin Butler. Ph.D. thesis committee member. 2010. First employer: University of Oregon.

- Guruprasad Jakka. M.S. thesis committee member. 2010.

- Hungsik Kim. Ph.D. thesis committee member. 2010.

- Ritendra Datta. Ph.D. thesis committee member. 2009. First employer: Google, Pittsburgh.

- Nazneen Irani. M.S. thesis committee member. 2008.

- Min Shao. Ph.D. thesis committee member. 2008.

- Seung Woo Son. Ph.D. thesis committee member. 2008.

- Amitayu Das. M.S. thesis committee member. 2007. First employer: Cisco, Inc.

- Partho Nath. Ph.D. thesis committee member. 2007. First employer: Cisco, Inc.

Selected Professional Activities and Service

- **Program Co-chair (with Lydia Chen, TU-Delft)**: IEEE Intl. Conf. on Autonomic Computing (ICAC) 2019.

- **Co-chair (with David Irwin, UMass-Amherst)**: NSF Workshop on Cloud Economics, Stanford University, May 2018.

- **Associate Editor**: IEEE Transactions on Cloud Computing (TCC), 2018-20.

- **Associate Editor**: IEEE Transactions on Parallel and Distributed Systems (TPDS), 2015-19.

- **Tutorials Co-chair (with Ramya Raghavendra, IBM TJ Watson**: ACM/IFIP/USENIX Middleware 2017.

- **Program Co-chair, Cloud Computing and Big Data track**: IEEE ICCCN 2017.

- **Travel Grants Chair**: ACM Sigmetrics 2016.

- **General Chair**: Workshop on Feedback Computing (Feedback'15).

- **Program Co-Chair**: USENIX Workshop on Feedback Computing (Feedback'14).

- **Communications Vice-Chair**: IEEE Spl. Tech. Community on Sust. Comp., 2012-2014.

- **Deputy Chair for Performance Area**: The World Wide Web Conference (WWW 2012).

- **Co-organizer and Panel Moderator**: First Workshop on Integrating Solid-State Memory into the Storage Hierarchy (WISH 2009), held in conjunction with ASPLOS 2009.

- **Guest Co-editor**: Elsevier Networks Spl. Issue on Virtualized Data Centers, 2009.

- **Web/Publicity Chair**: IEEE Intl. Symp. on Workload Characterization (IISWC 2007).

- **Invited Participant, Panels**:
  - Workshop on Cloud Control, Umea, Sweden, June 2019.
  - National Science Foundation (NSF), Various Panels: 2018, 2015, 2012, 2009.
  - Workshop on Sustainable Data Centers (sponsored by the NSF), Stanford University, June 2015.
  - Microsoft Faculty Research Summit, Redmond WA, July 2014.
  - LCCC Focus Period and Workshop on Cloud Control, Lund, Sweden, May 2014.
  - U.S. Department of Energy (Panel): 2011.
  - Nat. Priorities Research Prog. of the Qatar Nat. Research Fund (QNRF): 2015, 2014, 2013, 2012.
  - Workshop on Green High Performance Computing, Rutgers University, October 2011.
  - Workshop on the Science of Cloud Computing (sponsored by the NSF), March 2011.
  - Workshop on Green Computing (sponsored by the NSF), Rutgers University, May 2009.
  - National Science Foundation Workshop on the Science of Power Management, April 2009.

- **Program Committee Member**:
  - ACM Sigmetrics (2016-2021, 2014, 2013, 2008).
  - ACM Symposium on Cloud Comp. (SOCC 2021, 2020, 2014, 2011).
  - IFIP Performance 2021.
  - IEEE Intl. Symposium on High-Performance Computer Architecture (HPCA) 2021.
  - IEEE Intl. Conf. on Dist. Computing Systems (ICDCS 2020, 2018, 2017, 2015, 2009, 2008).
  - International Conference on Autonomic Computing and Self-Organizing Systems (ACSOS 2020).
  - USENIX Workshop on Hot Topics in Edge Computing (HotEdge 2019).
  - USENIX Annual Technical Conference 2018.
  - IEEE Intl. Conf. on Cloud Engineering (IC2E 2019, 2018).
  - IEEE MASCOTS 2017.
  - USENIX Workshop on Hot Topics in Cloud Computing (HotCloud 2017, 2010, 2009).
  - USENIX Intl. Conf. on Autonomic Computing (ICAC 2017, 2016, 2013).
  - Workshop on Feedback Computing (FC 2017)
  - Workshop on Data Center Performance (DCPerf 2017, 2016, 2012, 2011).
  - IEEE Intl. Conf. on Cloud and Autonomic Comp. (ICCAC 2016, 2015).
  - Intl. Symp. on Comp. Perf., Modeling, Meas. & Eval. (IFIP Performance 2015, 2013, 2007).
  - Workshop on Hot Topics on Power-aware Comp. and Systems (HotPower 2014).
  - Cloud Control Workshop 2014.
  - Workshop on Integration of NVM/Flash with OSs and Workloads (INFLOW 2014).

- IEEE Intl. Green and Sust. Computing Conf. (IGSC 2015, IGCC 2014, 2013, 2012).
- ACM e-Energy 2014.
- ACM MOBIHOC 2014.
- ACM High Perf. Dist. Comp. (HPDC 2014).
- Intl. Conf. on Quant. Eval. of Systems (QEST 2013).
- ACM Intl. Conf. on Arch. Sup. for Prog. Lang. & OS (ASPLOS 2013 external PC, 2009).
- Workshop on Energy-Efficient Design (WEED 2013, 2012, 2009).
- IEEE Intl. Conference on Cloud Computing (CLOUD 2012).
- IEEE Intl. Workshop on Storage Network Architectures and Parallel IOs (SNAPI 2011).
- IEEE Cluster Computing Conference 2010.
- The World Wide Web Conf. (WWW 2010).
- Intl. Workshop on Virt. Perf.: Analysis, Char., and Tools (VPACT 2009, 2008).
- IASTED Intl. Conf. on Par. and Dist. Comp.and Nets. (PDCN 2009, 2008).
- IEEE Intl. Symp. on Workload Characterization (IISWC 2007).
- Intl. Conf. on Parallel and Distributed Systems (ICPADS 2006).

- **External Reviewer for Conferences**: ACM Sigmetrics, ACM SOSP, ACM ASPLOS, USENIX IMC, ACM MULTIMEDIA, IFIP PERFORMANCE, ISCA, WWW, IEEE INFOCOM, IEEE ICDCS, IEEE IISWC.

- **Reviewer for Journals**: ACM Transactions on Computer Systems, ACM Transactions on Storage, ACM Transactions on Internet Technology, ACM Transactions on the Web, ACM Transactions on Autonomous and Adaptive Systems, IEEE Transactions on Cloud Computing, IEEE Transactions on Knowledge and Data Engineering, IEEE Transactions on Parallel and Distributed Systems, IEEE/ACM Transactions on Networking, Multimedia Systems Journal.

Selected Talks

- "Improving the Cost-Efficacy of Autoscaling in the Public Cloud," invited talk, 15th Cloud Control Workshop, Sandhamn, Sweden, June 2019.

- "Improving the Profitability of Public Cloud Computing," invited talk, VMWare Research Group, Palo Alto, CA, June 2017.

- "Using Burstable Instances in the Public Cloud: Why, When, and How?" ACM Sigmetrics, Urbana, IL, June 2017.

- "Innovations for Monetizing Spare Capacity in the Public Cloud: Tenant and Provider Perspectives," invited talk, IBM TJ Watson Research Center, Yorktown Heights NY, June 2017.

- "Exploiting Spot and Burstable Instances for Improving the Cost-efficacy of In-Memory Caches on the Public Cloud," Eurosys 2017, Belgrade, Serbia, April 2017.

- "Reducing Peak Power-related Costs in Colocation Data Centers," keynote talk, Research Workshop on Cloud Computing (RWCC), Jawaharlal Nehru University, New Delhi, India, December 2015.

- "Capacity Provisioning Problems in Geo-distributed Data Centers," Microsoft Faculty Research Summit, July 2014.

- "A Case for Virtualizing the Electric Utility in Cloud Data Centers," USENIX Workshop on Hot Topics in Cloud Computing (HOTCLOUD), June 2014.

- "Reducing Peak Power-related Costs in Cloud Data Centers," LCCC Focus Period and Workshop on Cloud Control, Lund, Sweden, May 2014.

- "Pricing of Service in Clouds: Optimal Response and Strategic Interactions," Workshop on Mathematical performance Modeling and Analysis (MAMA 2013), co-located with ACM SIGMETRICS, Pittsburgh PA, June 2013.

- "Reducing Power Delivery Costs in Data Centers."

    - Cisco Network Architecture Geeks (NAG) Conference, San Jose, CA, October 2013.
    - Bell Labs, Holmdel, NJ, October 2012.
    - Intel Labs, Pittsburgh, PA, September 2012.

- "Statistical Multiplexing and Buffering of Energy for Improving Data Center Utility Costs."

    - NEC Labs, Princeton, NJ, August 2011.
    - Dept. of Computer Science, Princeton University, Princeton, NJ, January 2011.
    - Dept. of Computer Scicene, Duke University, Durham, NC, October 2010.
    - College of Computing, Georgia Tech, Atlanta, September 2010.

- "Exploiting Locality for Scaling Flash-based Drives."

    - Systems Seminar, Dept. of Comp. Sci., University of Wisconsin, Madison, WI, September 2010.
    - Dept. of Comp. Sci., University of Minnesota, Minneapolis, MN, September 2010.

- "Statistical Profiling-based Techniques for Improved Power Provisioning in Data Centers," Workshop on Green Computing, Rutgers University, NJ, May 2009.

- "HybridStore: Enterprise-scale Storage Employing Solid-state Memory with Hard Disk Drives," CSE Colloquium series, December 2008.

- "River: Resource Management Infrastructure for Consolidated Hosting in Virtualized Data Centers," NSFNGS Workshop (part of IPDPS 2008 conference) Miami, FL, April 2008.

- "Profiling, Prediction, and Capping of Power Consumption in Consolidated Environments."

    - Cisco Green Research Symposium, San Jose, CA, March 2008.
    - Raritan, Somerset, NJ, March 2008.

- "Resource and Power Management in Virtualized Hosting Platforms."

    - Hewlett-Packard Labs, Palo Alto, CA, August 2007.
    - IBM TJ Watson Research Center, Hawthorne, NY, July 2007.

- "Bandwidth Provisioning Problems in WiFi Networks Employing Directional Antennas," Communications Seminar, EE Dept., Penn State, Spring 2007.

- "Communication-aware CPU Management for Consolidated Virtualized Hosting Platforms," The Technology Collaborative visit, CSE Dept., Penn State, Fall 2006.

Departmental and University Service

- Graduate Program Professor-in-Charge, CSE: Fall 2017-2021.

- Member, Promotion and Tenure Committee, CSE: Fall 2020-2022.

- CSE representative, Engineering Faculty Council: 2015-2016.

- Member, CSE Undergraduate Curriculum Committee: 2015-2016.

- CyberScience hiring committee (Penn State wide): 2012-2013.

- Colloquium Chair, CSE, Penn State: 2009-2010.

- IEEE Advisor, CSE, Penn State: 2009-2010.

- CSE representative, Engineering Environment Institute at Penn State: 2008-2009.

- Member, CSE Personnel (Hiring) Committee: 2007-2008, 2011-2012, 2012-2013, 2016-2017.

- Advisor (CSE) at the College of Engineering Advising Center: Fall 2007.

- Member, CSE Infrastructure Oversight Group: Spring 2007-onwards.

- Chair, OS Candidacy Exam: Fall'06, Fall'07, Fall'08, Fall'09, Spring'11, Fall'11, Spring'13.

- Member, CSE Graduate Committee: 2005-2008, 2016-2017.

- Member, CSE Software Security Committee: 2005-2010.

Professional Memberships

ACM (senior member), IEEE (senior member), USENIX (member)