

Bhuvan Urgaonkar

Assistant Professor

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Education

- Ph.D., Computer Science, University of Massachusetts Amherst, MA, 2005.
Dynamic Resource Management in Internet Hosting Platforms, Advisor: Prof. P. Shenoy.
- M.S., Computer Science, University of Massachusetts Amherst, MA, 2002.
- B.Tech. (hons.), Computer Science and Eng., Indian Institute of Technology, Kharagpur, 1999.

Research Interests

Design and evaluation of distributed/operating/storage systems, virtual machines, data centers, power management.

Academic Positions and Professional Experience

- Assistant Professor, Dept. of Computer Science and Eng., The Pennsylvania State University, 08/05-onwards. *Co-director of the Computer Systems Lab* (<http://cs1.cse.psu.edu>.)
- Summer Intern, Services Middleware Management Dept., IBM T. J. Watson Research Center, Hawthorne, NY, 05/2004-08/2004.
- Summer Intern, System Group, Sprint Advance Technologies Lab., Burlingame, CA, 05/2001-08/2001.
- Research Assistant, Dept. of Computer Science, University of Massachusetts Amherst, MA, 08/1999-07/2005.

Selected Awards and Nominations

- Best student paper award, IEEE MASCOTS 2008.
- Best student paper award, IEEE Intl. Conf. on Autonomic Computing (ICAC), 2005.
- Graduate Fellowship nomination, Univ. of Massachusetts Amherst, MA, 2002.

Publications: Journal Articles

- **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. To appear in the *IEEE Transactions on Computers (TC)*, 2009.
- **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.
- **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.

- **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.
- **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.
- **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.
- **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.
- **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.

Publications: Conference and Workshop Papers

- **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. To appear in *Proceedings of the Thirty Fourth USENIX Annual Technical Conference (USENIX 2009)*, San Diego, CA, June 2009. (32 accepted out of 191 submissions = 17%.)
- **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 *Proceedings of the European Conference on Computer Systems (organised by the European Chapter of SIGOPS, sponsored by ACM SIGOPS) (EuroSys 2009)*, Nuremberg, Germany, April 2009. Also, *Technical Report CSE-08-006, Department of Computer Science and Engineering, The Pennsylvania State University, February 2008.* (25 accepted out of 148 submissions = 17%.)
- **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. Also, *Technical Report CSE-08-012, Department of Computer Science and Engineering, The Pennsylvania State University, July 2008.* (29 accepted out of 113 submissions = 25%.)
- **An Empirical Analysis of the Energy Efficiency of Flash-based SSDs.** Euseong Seo, Seonyeong Park, and Bhuvan Urgaonkar. To appear 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.
- **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)*, Baltimore, MA, September 2008. Also, *Technical Report CSE-08-006, Department of Computer Science and Engineering, The Pennsylvania State University, April 2008.* (36 accepted out of 94 submissions = 38%.) **Awarded best student paper.**

- **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)*, July 2008, Las Vegas, NV. Also, *Technical Report CSE-06-018, Department of Computer Science and Engineering, The Pennsylvania State University*, October 2006. (29% acceptance ratio.)
- **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% acceptance ratio.)
- **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 accepted out of 201 submissions = 18%.)
- **RIVER: Resource Management Infrastructure for Consolidated Hosting in Virtualized Data Centers.** Bhuvan Urgaonkar and Anand Sivasubramaniam. In *Proceedings of the The Next Generation Software Workshop held in conjunction with IPDPS 2008 (NGS 2008)*, April 2008, Miami, FL.
- **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 accepted out of 96 submissions = 17%.)
- **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 accepted out of 70 submissions = 27%.)
- **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 accepted out of 130 submissions = 28%.)
- **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)*, Seattle, WA, June 2005. (25 accepted out of 150 submissions = 16%.) **Awarded best student paper.**
- **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 accepted out of 237 submissions = 13%.)
- **Cataclysm: Policing Extreme Overloads in Internet Applications.** Bhuvan Urgaonkar and Prashant Shenoy. In *Proceedings of the Fourteenth International World Wide Web Conference (WWW 2005)*, Chiba, Japan, May 2005. (77 accepted out of 550 submissions = 14%.)
- **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 accepted out of 185 submissions = 33%.)
- **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.

- **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 accepted out of 150 submissions = 18%.)
- **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 accepted out of 217 submissions = 31%.)

Publications: Short Papers

- **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.)
- **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)*, July 25-28, 2004, St. John's, Newfoundland, Canada. (Brief announcement.)

Publications: Posters

- **Scheduler-aware Virtual Memory Management (Extended Abstract).** 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.

Publications: Technical Reports and Other Manuscripts

- **FlashSim: A Simulator for NAND Flash-based Solid-State Drives.** Youngjae Kim, Brendan Taurus, Aayush Gupta, Dragos Mihai Nistor, and Bhuvan Urgaonkar. *Technical Report CSE-09-008, Department of Computer Science and Engineering, The Pennsylvania State University*, May 2009.
- **Multi-level Crypto Disk: Secondary Storage with Improved Performance vs Security Trade-offs.** Shiva Chaitanya, Bhuvan Urgaonkar, and Anand Sivasubramaniam. *Technical Report CSE-09-006, Department of Computer Science and Engineering, The Pennsylvania State University*, April 2009.
- **Bandwidth Provisioning in Infrastructure-based Wireless Networks Employing Directional Antennas.** Shiva Kasiviswanathan, Bo Zhao, Sudarshan Vasudevan, and Bhuvan Urgaonkar. *Technical Report CSE-07-008, Department of Computer Science and Engineering, The Pennsylvania State University*, July 2007.

Substantial Software Developed

(Code available for download at the URLs indicated below.)

- **FlashSim**, simulator for NAND Flash-based Solid-state drives (<http://csl.cse.psu.edu/hybridstore>.)
- Enhancements to OPNET to enable the simulation of WiFi networks employing directional antennas (<http://csl.cse.psu.edu/dawn>.)

- **Xen and Co.**, Communication-aware CPU scheduling and accounting in the Xen Virtual Machine Monitor (<http://cs1.cse.psu.edu/river/>.)
- **QLinux**, A QoS-aware Linux Kernel (<http://lass.cs.umass.edu/software/qlinux/>.)

Professional Teaching Experience

(Details at: <http://www.cse.psu.edu/~bhuvan/teaching/>.)

- Instructor, **Operating System Design** (CSE 511), Dept. of Computer Science and Engineering, Spring 2009.
- Instructor, **Operating Systems** (CMPSC 473), Dept. of Computer Science and Engineering, Fall 2008.
- Instructor, **Fundamentals of Distributed Computing** (CSE 598G), Dept. of Computer Science and Engineering, Fall 2007 (new course.)
- Instructor, **Operating System Design** (CSE 511), Dept. of Computer Science and Engineering, Fall 2007 (fully revised.)
- Instructor, **Storage Systems** (CSE 598D), Dept. of Computer Science and Engineering, Spring 2007. (second offering in the Department.)
- Instructor, **Operating Systems** (CSE 411), Dept. of Computer Science and Engineering, Fall 2006.
- Co-Instructor, **Self-* Networks of Unmanned Vehicles** (CSE 598A), Dept. of Computer Science and Engineering, Fall 2006 (new course.)
- Instructor, **Virtual Machines and their Applications** (CSE 598C), Dept. of Computer Science and Engineering, Spring 2006 (new course.)
- Instructor, **Self-* Systems** (CSE 598B), Dept. of Computer Science and Engineering, Fall 2005 (new course.)

Ph.D. Advisees

- Shiva Chaitanya (Co-Chair, expected graduation Summer 2009.)
- Sriram Govindan (Co-Chair, expected graduation Spring 2010.)
- Aayush Gupta (Chair, expected graduation Spring 2012.)
- Youngjae Kim (Co-Chair, expected graduation Fall 2009.)
- Byung Chul Tak (Chair, expected graduation Spring 2011.)

Post-doctoral Scholars

- Jeong Hwan Choi (Post-doc from KAIST, Republic of Korea.)
- Euseong Seo (Post-doc from KAIST, Republic of Korea.) First employer: Assistant Professor at the Ulsan National Institute of Science and Technology (UNIST), Spring 2009.

M.S. Advisees

- Kanishk Jain, graduated Fall 2008. First employer: Cisco, Inc.
- Arjun R. Nath, graduated Fall 2008. First employer: Intel.

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

Other Student Supervision

- Kevin Butler, member Ph.D. thesis committee.
- Amitayu Das, member M.S. thesis committee, graduated 2007. First employer: Cisco, Inc.
- Ritendra Datta, member Ph.D. thesis committee.
- Hungsik Kim, member Ph.D. thesis committee.
- Partho Nath, member Ph.D. thesis committee, graduated 2007. First employer: Cisco, Inc.
- Min Shao, member Ph.D. thesis committee, graduated Fall 2008.
- Seung Woo Son, member Ph.D. thesis committee, graduated Fall 2008.

Selected Professional Activities and Service

- **Program Committee Member:** The World Wide Web Conference (WWW 2010.)
- **Program Committee Member:** Workshop on Energy-Efficient Design (WEED 2009), held in conjunction with ISCA 2009.
- **Program Committee Member:** Workshop on Hot Topics in Cloud Computing (HotCloud 2009), held in conjunction with USENIX 2009.
- **Program Committee Member:** Second Intl. Workshop on Virtualization Performance: Analysis, Characterization, and Tools (VPACT 2009.)
- **Co-organizer and Panel Moderator:** First Workshop on Integrating Solid-State Memory into the Storage Hierarchy (WISH 2009), held in conjunction with ASPLOS 2009.
- **Program Committee Member:** The Twenty Ninth International Conference on Distributed Computing Systems (ICDCS 2009.)
- **Program Committee Member:** The IASTED International Conference on Parallel and Distributed Computing and Networks (PDCN 2009.)
- **Guest Co-editor:** Elsevier Networks Spl. Issue on Virtualized Data Centers, 2009.
- **Program Committee Member:** Fourteenth International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS 2009.)
- **Program Committee Member:** First Intl. Workshop on Virtualization Performance: Analysis, Characterization, and Tools (VPACT 2008.)
- **Program Committee Member:** ACM SIGMETRICS Intl. Conf. on Measurement and Modeling of Computer Systems (SIGMETRICS 2008.)
- **Program Committee Member and Session Chair:** IEEE Intl. Conf. on Distributed Computing Systems (ICDCS 2008.)
- **Program Committee Member:** The IASTED Intl. Conf. on Parallel and Distributed Computing and Networks (PDCN 2008.)
- **Program Committee Member and Web/Publicity Chair:** IEEE Intl. Symp. on Workload Characterization (IISWC 2007.)

- **Program Committee Member:** Intl. Symp. on Computer Performance, Modeling, Measurements, and Evaluation (Performance 2007.)
- **Program Committee Member and Session Chair:** Intl. Conf. on Parallel and Distributed Systems (ICPADS 2006.)
- **Reviewer:** SIGMETRICS, SOSP, ASPLOS, IMC, MULTIMEDIA, ACM TSE, ACM TOIT, ACM TWEB, PERFORMANCE, WWW, INFOCOM, ICDCS, IEEE IISWC, IEEE TPDS, MMSJ, ICPADS.

Selected Invited Talks

- “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

- CSE representative in the steering committee of the Engineering Environment Institute at Penn State: Fall 2008 onwards.
- Member, CSE Personnel Committee: 2007-2008.
- Advisor (CSE) at the College of Engineering Advising Center: Fall 2007.
- Member, CSE Infrastructure Oversight Group: Spring 2007 onwards.
- Chair, OS Candidacy Exam: Fall 2006, Fall 2007, Fall 2008.
- Member, CSE Graduate Committee: Fall 2005 onwards.
- Member, CSE Software Security Committee: Fall 2005 onwards.

Professional Memberships

ACM, IEEE, USENIX.