

Rich Wolski

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Education

Ph.D.	U.C. Davis/Lawrence Livermore Campus	April, 1994
M.S.	U.C. Davis/Lawrence Livermore Campus	June, 1989
B.S.	California Polytechnic University, San Luis Obispo (Summa Cum Laude)	August, 1986

Professional Experience

July, 2007 - present	Professor	U.C. Santa Barbara
January, 2009 - January, 2013	Chief Technology Officer	Eucalyptus Systems
July, 2002 - 2007	Associate Professor	U.C. Santa Barbara
October, 2004 - 2010	Strategic Advisor	San Diego Supercomputer Center
July, 2001 - October, 2004	Grid Systems Lead	NSF National Partnership for Advanced Computational Infrastructure (initial partner)
July, 2001 - July, 2002	Assistant Professor	U.C. Santa Barbara
October, 2001 - 2010	Faculty Computer Scientist	Lawrence Berkeley Lab
February, 1999 - June, 2001	Assistant Professor	University of Tennessee
June, 1996 - February, 1999	Research Faculty	U.C. San Diego
April, 1994 - June, 1996	Postdoctoral Researcher	U.C. San Diego
April, 1994 - January, 1997	SDSC Junior Fellow	San Diego Supercomputer Center
September, 1986 - June, 1996	Computer Scientist	Lawrence Livermore Laboratory
September, 1993 - December, 1993	Lecturer	Mills College, Oakland CA.

Awards

- Awarded Duval Family Presidential Chair in Energy Efficiency, April 2018.
- UCSB Outstanding Computer Science Faculty member of the Year, June 2016, June 2017, and June 2018.
- Lifetime Achievement Award, ACM/IEEE High-performance Distributed Computing (HPDC), June, 2014.
- Two papers (#1 and #7) selected as the Best Papers of the 20 years of ACM/IEEE High-performance Distributed Computing Conference (HPDC), 2012.

- Test-of-time Best Paper Award, ACM International Conference on Supercomputing, 2012.
- Named to Top-10 Cloud Pioneers List by Information Week, November, 2012.
- Winner of the Cloud Camp Cloud Hero Award, March, 2012.
- Eucalyptus Systems named winner of 2010 California Governor’s Office of Economic Development Game Changer Award.
- Winner of Best Cloud Innovation Award, Cloudies Awards, December 2008
- Outstanding Faculty Member of the Year (co-winner), University of California, Santa Barbara, Computer Science Program, June, 2008.
- Outstanding Faculty Member of the Year, University of California, Santa Barbara, Computer Engineering Program, June, 2006.
- Academic Senate University Distinguished Teaching Award, University of California, Santa Barbara, May 2005.
- Computer Science Teacher of the Year, University of California, Santa Barbara, Computer Science Department, June, 2003.
- ACM Teacher of the Year award, Computer Science Department, University of Tennessee, Knoxville, TN., May 2000.
- Best Acceleration for “Where do you want to Compute Today?” at the High-performance Computing Challenge, SC98, Orlando FL, November 1998.

Patents

Systems and Methods for Predictive Power Management, U.S. Patent No. 9,182,807

Published Work

1. N. Saquib, C. Krintz, and R. Wolski, Ordering Operations for Generic Replicated Data Types using Version Trees, Eurosys Workshop on Principles and Practice of Consistency for Distributed Data, Apr 2022
2. W-T. Lin, C. Krintz, and R. Wolski, A Programmable and Reliable Publish/Subscribe System for Multi-Tier IoT, International Conference on Internet of Things, Systems, Management and Security (IOTSMS) (Best Paper Award)
3. F. Bakir, C. Krintz, and R. Wolski, CAPLets: Resource Aware, Capability-Based Access Control for IoT, ACM/IEEE Symposium on Edge Computing (SEC21), Dec 2021, (Best Paper Honorable Mention)

4. David Bermbach, Abhishek Chandra, Chandra Krintz, Aniruddha Gokhale, Aleksander Slominski, Lauritz Thamsen, Everton Cavalcante, Tian Guo, Ivona Brandic, and Rich Wolski, On the Future of Cloud Engineering, IEEE International Conference on Cloud Engineering (invited), Oct 2021
5. N. Saquib, F. Bakir, C. Krintz, and R. Wolski, A Resource-Efficient Smart Contract for Privacy Preserving Smart Home Systems, IEEE International Conference on Smart City Innovations (SCI), Oct 2021
6. N. Saquib, C. Krintz, and R. Wolski, PEDaLS: Persisting Versioned Data Structures, IEEE Conference on Cloud Engineering (IC2E), Oct 2021
7. M. Zhang, C. Krintz, and R. Wolski, Sparta: A Heat-Budget-based Scheduling Framework on IoT Edge Systems, International Conference on Edge Computing (EDGE), Sep 2021
8. M. Zhang, C. Krintz, and R. Wolski, Edge-Adaptable Serverless Acceleration for Machine Learning IoT Applications, Software: Practice and Experience: Special Issue on Elastic Computing from Edge to the Cloud, 2020, DOI 10.1002/spe.2944
9. G. George, F. Bakir, C. Krintz, and R. Wolski, NanoLambda: Implementing Functions as a Service at All Resource Scales for the Internet of Things, ACM Symposium on Edge Computing (SEC), Nov 2020
10. Malone K, Wolski R. Doing Data Science on the Shoulders of Giants: The Value of Open Source Software for the Data Science Community. Harvard Data Science Review. June, 2020.
11. Vaillancourt, P., Wineholt, B., Barker, B., Deliyannis, P., Zheng, J. Suresh, A., Brazier, A., Knepper, R., Wolski, R. "Reproducible and Portable Workflows for Scientific Computing and HPC in the Cloud.", Experience in Advanced Research Computing (PEARC 20), July 2630, 2020, Portland, OR, USA. ACM, New York, NY, USA, 16 pages.
12. M. Zhang, C. Krintz, and R. Wolski, STOIC: Serverless TeleOperable Hybrid Cloud for Machine Learning Applications on Edge Device, IEEE SmartEdge, Mar 2020.
13. Dimopoulos S, Krintz C, Wolski R. Fair Scheduling for Deadline-Driven, Resource-Constrained, Multi-Analytics Workloads. In 2020 International Conference on Computing, Networking and Communications (ICNC) Feb 2020 (pp. 261-267).
14. S. Dimopoulos, C. Krintz, and R. Wolski, Towards distributed, fair, and deadline-driven resource allocation for Cloudlets, ACM/USENIX Workshop on Middleware for Edge Clouds and Cloudlets (MECC), Dec 2019

15. Golubovic N, Krintz C, Wolski R, Sethuramasamyraja B, Liu B. A scalable system for executing and scoring K-means clustering techniques and its impact on applications in agriculture. *International Journal of Big Data Intelligence*. 2019;6(3-4):163-75.
16. Wolski R, Krintz C, Bakir F, George G, Lin WT. CSPOT: portable, multi-scale functions-as-a-service for IoT. In *Proceedings of the 4th ACM/IEEE Symposium on Edge Computing*, Nov. 2019 (pp. 236-249).
17. Golubovic N, Wolski R, Krintz C, Mock M. Improving the Accuracy of Outdoor Temperature Prediction by IoT Devices. In *2019 IEEE International Congress on Internet of Things (ICIOT)*, Jul. 2019 (pp. 117-124) (Best Paper award).
18. Zhang M, Krintz C, Mock M, Wolski R. Seneca: Fast and Low Cost Hyperparameter Search for Machine Learning Models. In *2019 IEEE 12th International Conference on Cloud Computing (CLOUD)*, Jul. 2019 (pp. 404-408).
19. Carson K, Thomason J, Wolski R, Krintz C, Mock M. Mandrake: Implementing Durability for Edge Clouds. In *2019 IEEE International Conference on Edge Computing (EDGE)* Jul. 2019 (pp. 95-101).
20. George G, Wolski R, Krintz C, Brevik J. Analyzing AWS spot instance pricing. In *2019 IEEE International Conference on Cloud Engineering (IC2E)* Jun. 2019 (pp. 222-228).
21. Baughman M, Caton S, Haas C, Chard R, Wolski R, Foster I, Chard K. Deconstructing the 2017 changes to AWS spot market pricing. In *Proceedings of the 10th Workshop on Scientific Cloud Computing* Jun. 2019 (pp. 19-26).
22. Lin WT, Bakir F, Krintz C, Wolski R, Mock M. Data repair for Distributed, Event-based IoT Applications. In *Proceedings of the 13th ACM International Conference on Distributed and Event-based Systems* Jun. 2019 (pp. 139-150).
23. Nevena Golubovic, Chandra Krintz, Rich Wolski, Balaji Sethuramasamyraja, and Bo Liu, A Scalable System for Executing and Scoring K-Means Clustering Techniques and Its Impact on Applications in Agriculture, *International Journal of Big Data Intelligence*, Oct 2018.
24. C. Krintz, R. Wolski, N. Golubovic, and F. Bakir, Estimating Outdoor Temperature from CPU Temperature for IoT Applications in Agriculture, *International Conference on the Internet of Things (IoT)*, Oct 2018.
25. W-T. Lin, C. Krintz, and R. Wolski, Tracing Function Dependencies Across Clouds, *IEEE Cloud*, July 2018.
26. W-T. Lin, M. Zhang, C. Krintz, and R. Wolski, Tracking Causal Order in AWS Lambda Applications, *IEEE International Conference on Cloud Engineering (IC2E)*, June 2018.

27. Baughman, M., Haas, C., Wolski, R., Foster, I., and Chard, K. Predicting Amazon spot prices with LSTM networks. In Proceedings of the 9th Workshop on Scientific Cloud Computing, June 2018, (pp. 1-7).
28. H. Jayathilaka, C. Krintz, and R. Wolski, Detecting Performance Anomalies in Cloud Platform Applications, IEEE Transactions on Cloud Computing (TCC), Feb 2018.
29. N. Golubovic, A. Gill, C. Krintz and R. Wolski, CENTAURUS: A Cloud Service for K-means Clustering, 3rd IEEE International Conference on Big Data Intelligence and Computing (IEEE DataCom 2017), November, 2017.
30. Wolski, R, Brevik, J., Chard, R., Chard K., Probabalistic Guarantees of Execution Duration for Amazon Spot Instances, Proceedings of SC17, Nov. 2017, (pp. 1-11).
31. S. Dimopoulos, C. Krintz, and R. Wolski, JUSTICE: A Deadline-aware, Fair-share Resource Allocator for Implementing Multi-analytics, IEEE International Conference on Cluster Computing, August, 2017 (Best Paper Award).
32. S. Dimopoulos, C. Krintz, and R. Wolski, PYTHIA: Admission Control For Multi-Framework, Deadline- Driven, Big Data Workloads, IEEE International Conference on Cloud Computing, June, 2017.
33. R. Wolski and J. Brevik, QPRED: Using Quantile Predictions To Improve Power Usage For Private Clouds, IEEE International Conference on Cloud Computing, June, 2017.
34. Jayathilaka, H., Krintz, C., Wolski, R., Performance Monitoring and Root Cause Analysis for Cloud-hosted Web Applications, Proceedings of the 26th ACM International Conference on World Wide Web, April, 2017.
35. Elias, A. R., Golubovic, N., Krintz, C., Wolski, R., Where's the Bear?-Automating Wildlife Image Processing Using IoT and Edge Cloud Systems, IEEE/ACM Second International Conference on Internet-of-Things Design and Implementation (IoTDI), April, 2017 (Best Paper Finalist)
36. Pucher, A., Wolski, R., Krintz, C., EXFed: Efficient Cross-Federation with Availability SLAs on Preemptible IaaS Instance, March, 2017.
37. Jayathilaka, H., Krintz, C., Wolski, R., Service-Driven Computing with APIs: Concepts, Frameworks, and Emerging Trends, Web-Based Services: Concepts, Methodologies, Tools, and Applications, IGI Global, 2016.
38. Dimopoulos, S., Krintz, C., Wolski, R., Big data framework interference in restricted private cloud settings, IEEE International Conference on Big Data, December, 2016.

39. Golubovic, N., Krintz, C., Wolski, R., Lafia, S., Hervey, T., Kuhn, W., Extracting spatial information from social media in support of agricultural management decisions, Proceedings of the ACM 10th Workshop on Geographic Information Retrieval, November, 2016.
40. C. Krintz, R. Wolski, N. Golubovic, B. Lampel, V. Kulkarni, B. Sethuramasamyraja, B. Roberts, and B. Liu, SmartFarm: Improving Agriculture Sustainability Using Modern Information Technology, KDD Workshop on Data Science for Food, Energy, and Water, August, 2016.
41. R. Wolski and J. Brevik, Providing statistical reliability guarantees in the aws spot tier, Proceedings of the 24th High Performance Computing Symposium, Society for Computer Simulation International, April, 2016.
42. H. Jayathilaka, R. Wolski, and C. Krintz, Service-Level Agreement Durability for Web Service Response Time, IEEE International Conference on Cloud Computing Technology and Science (CloudCom) 2015, November, 2015.
43. H. Jayathilaka, R. Wolski, and C. Krintz, Response Time Service Level Agreements for Cloud-hosted Web Applications, ACM Symposium on Cloud Computing (SoCC'15), August, 2015.
44. Chien, A. A., Wolski, R., Yang, F., Zero-Carbon Cloud: A Volatile Resource for High-Performance Computing, IEEE Conference on Autonomic and Secure Computing; Pervasive Intelligence and Computing, August, 2015.
45. C. Krintz, R. Wolski, J. E. Pinsker, S. Dimopoulos, J. Brevik, and E. Dassau, On the Use of Consumer-grade Activity Monitoring Devices to Improve Predictions of Glycemic Variability, International Conference on Smart Wearable Devices and IoT for Health and Wellbeing Applications, July, 2015.
46. A. Pucher, R. Wolski, and C. Krintz, Providing Lifetime Service-Level-Agreements for Cloud Spot Instances, International Conference on Grid and Cloud Computing and Applications (GCA'15) July, 2015.
47. Zhang, W, Agun, D., Yang, T., Wolski, R., and Tang, H., VM-Centric Snapshot Deduplication for Cloud Data Backup, The 31st International Conference on Massive Storage Systems and Technologies, June, 2015.
48. H. Jayathilaka, C. Krintz, and R. Wolski, EAGER: Deployment-time API Governance for Modern PaaS Clouds, IC2E Workshop on the Future of PaaS, March 2015.
49. A. Pucher, C. Krintz, and R. Wolski, Using Trustworthy Simulation to Engineer Cloud Schedulers, IEEE International Conference on Cloud Engineering (IC2E), March, 2015. (Best Paper Award)

50. S. Dimopoulos, C. Krintz, and R. Wolski, SuperContra: Cross-Language, Cross-Runtime Contracts As a Service, IEEE International Conference on Cloud Engineering (IC2E) Future of PaaS Workshop, March, 2015.
51. H. Jayathilaka, A. Pucher, C. Krintz, and R. Wolski, Using Syntactic and Semantic Similarity of Web APIs to Estimate Porting Effort, International Journal of Services Computing, Vol. 2, No.4, October-December 2014.
52. G. Douglas, B. Drawert, C. Krintz, and R. Wolski, CloudTracker: Using Execution Provenance to Optimize the Cost of Cloud Use, International Conference on Economics of Grids, Clouds, Systems, and Services, Sept 2014.
53. C. Horuk, G. Douglas, A. Gupta, C. Krintz, B. Bales, G. Bellesia, B. Drawert, R. Wolski, L. Petzold, and A. Hellander, Automatic and Portable Cloud Deployment for Scientific Simulations, IEEE/ACM International Conference on High Performance Computing and Simulation, July 2014.
54. H. Jayathilaka, C. Krintz, and R. Wolski Towards Automatically Estimating Porting Effort Between Web Service APIs, IEEE International Conference on Services Computing, June 2014.
55. C. Krintz, H. Jayathilaka, S. Dimopoulos, A. Pucher, R. Wolski, and T. Bultan, Cloud Platform Support for API Governance, IC2E Workshop on the Future of PaaS, March 2014.
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59. Krintz, C. and Wolski, R., Unified API Governance in the New API Economy, Cutter IT Journal, Sept, 2013 (published electronically).
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62. Chohan, N., Bunch, C., Pang, S., Krintz, C., Mostafa, N., Soman, S., Wolski, R., AppScale: Scalable and Open AppEngine Application Development and Deployment, Cloud Computing, 2010, pp. 57-70.
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66. Nurmi, D., Wolski, R., Grzegorzczak, C., Obertelli, G., Soman, S., Youseff, L., and Zagorodnov, D., The Eucalyptus Open-Source Cloud-Computing System, Proceedings of 2009 ACM/IEEE International Conference on Grid Computing (CCGrid09), pp. 124-131.
67. Mutz, A., Wolski, R, Efficient Auction-based Grid Reservations Using Dynamic Programming, Proceedings of SC08, November, 2008.
68. Nurmi, D., Brevik, J., Wolski, R., VARQ: Virtual Advance Reservations for Queues, ACM/IEEE International Symposium on High Performance Computing (HPDC), June 2008, Boston, MA
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82. Wolski, R., Nurmi, D., and Brevik, J., An Analysis of Availability Distributions in Condor, Workshop on Next-Generation Software (w/IPDPS), March, 2007.
83. Mousa, H., Krintz, C., Youseff, L., and Wolski, R., VIProf: Vertically Integrated Full-System Performance Profiler Workshop on Next-Generation Software (w/IPDPS), March, 2007

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87. Youseff, L., Wolski, R., Gorda, B., and Krintz, C., Evaluating the Performance Impact of Xen on MPI and Process Execution For HPC Systems, Proceedings of the First International Workshop on Virtualization Technology in Distributed Computing (VTDC), November, 2006, pp. 1–8.
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116. Wolski, R., Brevik, J., Plank, J., and Bryan, T., Grid Resource Allocation and Control Using Computational Economies, In *Grid Computing: Making the Global Infrastructure a Reality*, Berman, F, Fox, G., and Hey, T. editors, Wiley and Sons, pp. 747–772, March 2003.

117. Swamy, M. and Wolski, R., Multivariate Resource Performance Forecasting in the Network Weather Service, Proceedings of SC02, November, 2002.
118. Swamy, M. and Wolski, R., Building Performance Topologies for Computational Grids, Proceedings of the Los Alamos Computer Science Institute Third Annual Symposium, October, 2002.
119. Allen, M., Wolski, R. and Plank, J., Adaptive Timeout Discovery Using the Network Weather Service, Proceedings of the 11th IEEE Symposium on High-Performance Distributed Computing (HPDC-11), August, 2002.
120. Swamy, M., and Wolski, R., Representing Dynamic Performance Information in Grid Environments with the Network Weather Service, in the Proceedings of the Second Conference on Cluster and Grid Computing (CCGrid02), May, 2002.
121. Kennedy, K., Mazina, M., Mellor-Crummy, J., Cooper, K., Torczon, L., Berman, F., Chien, A., Dail, H., Sievert, O., Anguloa, D., Forster, I., Gannon, D., Johnsson, L., Kesselman, C., Ayt, R., Reed, D., Dongarra, J., Vadhiyar, S., Wolski, R., Toward a Framework for Preparing and Executing Adaptive Grid Programs, Proceedings of NSF Next Generation Systems Program Workshop (International Parallel and Distributed Processing Symposium 2002), April, 2002.
122. Wolski, R., Computational Grids: Current Trends in Performance-oriented Distributed Computing, SIAM News, Volume 35, Number 2, page 4, March 2002.
123. Bassi, A., Beck, M., Fagg, G., Moore, T., Plank, J., Swamy, M., and Wolski, R., The Internet Backplane Protocol: A Study in Resource Sharing, in the Proceeding of the Second Conference on Cluster and Grid Computing (CCGrid02), May, 2002.
124. Swamy, D. M., Wolski, R., Data Logistics in Network Computing: The Logistical Session Layer, Proceedings of IEEE International Symposium on Network Computing Applications, February, 2002.
125. Plank, J., Wolski, R. and Allen, M., The Effect of Timeout Prediction and Selection on Wide Area Collective Operations, Proceedings of IEEE International Symposium on Network Computing Applications, February, 2002.
126. Wolski, R., Brevik, J., Obertelli, G., Spring, N., and Su, A., Writing Programs that Run EveryWare on the Computational Grid, IEEE Transactions on Parallel and Distributed Systems, Vol. 12, Number 10, pp. 1066–1080, October, 2001.
127. Berman, F., Chien, A., Cooper, K., Dongarra, J., Foster, I., Gannon, D., Johnsson, L., Kennedy, K., Kesselman, C., Mellor-Crummey, J., Reed, D., Torczon, L., Wolski, R., The GrADS Project: Software Support for High-Level Grid Application Development, International Journal of High Performance Computing Applications, Volume 15, Number 4, pp. 327–344, Winter 2001.

128. Wolski, R., Plank, S., Bryan, T., and Brevik, J, Analyzing Market-based Resource Allocation Strategies for the Computational Grid, *International Journal of High-performance Computing Applications*, Volume 15, Number 3, pp. 258–281, Fall 2001.
129. Plank, J., Bassi, A, Beck, M., Moore, T., Swamy, D. M., R. Wolski, Managing Data Storage in the Network, *IEEE Internet Computing*, Volume 5, Number 5, pp. 50–58, Sept/Oct., 2001.
130. Swamy, D., and Wolski, R., The Logistical Session Layer, *IEEE International Symposium on High Performance Distributed Computing*, August, 2001.
131. Krintz, C., and Wolski, R., NwsAlarm: A Tool for Accurately Detecting Degradation in Expected Performance of Grid Resources, *CCGrid 2001*, May, 2001, pp. 404–413.
132. Elwasif, W., Plank, J., and Wolski, R., Data Staging Effects in Wide Area Task Farming Applications, *CCGrid 2001*, May, 2001.
133. Wolski, R., Plank, J., Brevik, J, and Bryan, T., G-Commerce: Market Formulations Controlling Resource Allocation on the Computational Grid, *IPDPS 01*, March, 2001.
134. Krintz, C., and Wolski, R., Using JavaNws to Compare C and Java TCP-Socket Performance, *The Journal of Concurrency and Computation: Practice and Experience*, Volume 13, Number, 8-9, pp. 815–839, 2001.
135. F. Berman, R. Wolski, The AppLeS Project: Harvesting the Grid, *Newsletter of the IEEE Technical Committee on Distributed Processing*, 2000.
136. Wolski, R., Spring, N. and Hayes, J., Predicting the CPU Availability of Time-shared Unix Systems on the Computational Grid, *The Journal of Cluster Computing*, December, Vol. 3, No. 4 (2000), pp. 293 – 301.
137. Casanova, H., Obertelli, G., Berman, F., and Wolski, R., The AppLeS Parameter Sweep Template: User-Level Middleware, *Proceedings of SC00*, November, 2000, (best paper finalist).
138. Gaidioz, B., Wolski, R., and Tourancheau, B., Synchronizing Network Probes to avoid Measurement Intrusiveness with the Network Weather Service, *The 9th IEEE High-performance Distributed Computing Conference*, August, 2000, pp. 147-154.
139. Krintz, C. and Wolski, R., JavaNws: The Network Weather Service for the Desktop, *Proceedings of ACM JavaGrande*, June, 2000, pp. 116-125.
140. Dail, H., Obertelli, G., Berman, F., and Wolski, R., Application-Aware Scheduling of a Magnetohydrodynamics Application in the Legion Metasystem, *2000 Heterogeneous Computing Workshop at IPDPS*, May, 2000.
141. Shao, G., Berman, F., and Wolski, R., Master/Slave Computing on the Grid, *2000 Heterogeneous Computing Workshop at IPDPS*, May, 2000.

142. Smallen, S., Cirne, W., Frey, J., Berman, F., Wolski, R., Mei-Hui, S., Kesselman, C., Young, S., and Ellisman, M., Combining Workstations and Supercomputers to Support Grid Applications: The Parallel Tomography Experience, 2000 Heterogeneous Computing Workshop at IPDPS, May, 2000.
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144. Faerman, M., Su, A., Wolski, R., and Berman, F., Adaptive Performance Prediction for Distributed Data-Intensive Applications, *Proceedings of SC99*, November, 1999.
145. Lee, C., Stepanek, J., Wolski, R., Kesselman, C., and Foster, I., A Network Performance Tool for Grid Environments, *Proceedings of SC99*, November, 1999.
146. J. Plank, M. Beck, W. Elwasif, T. Moore, M. Swany, and R. Wolski, The Internet Backplane Protocol: Storage in the Network, *Proceedings of NetStore 99: Network Storage Symposium*, October, 1999.
147. W. Elwasif, J. Plank, M. Beck, and R. Wolski, IBP-Mail: Controlled Delivery of Large Mail Files, *Proceedings of NetStore 99: Network Storage Symposium*, October, 1999.
148. M. Beck, H. Casanova, J. Dongarra, T. Moore, J. Plank, F. Berman, and R. Wolski, Logistical Quality of Service in NetSolve, *Computer Communications*, Vol. 22, No. 11, July, 1999, pp. 1034 – 1044.
149. Wolski, R., Spring, N. and Hayes, J., The Network Weather Service: a Distributed resource Performance Forecasting Service for Metacomputing, *Journal of Future Generation Computing Systems*, Volume 15, Numbers 5-6, pp. 757-768, October, 1999.
150. Wolski, R., Predicting CPU Availability on the Computational Grid using the Network Weather Service, *Journal of Parallel Processing Letters*, Volume 9, No. 4, pp. 227-241, 1999.
151. Su, A., Berman, F. Wolski, R., and Mills Strout, M., Using AppLeS to Schedule a Distributed Visualization Tool on the Computational Grid, *International Journal of Supercomputer and High-Performance Applications*, Volume 13, No. 3, pp. 253-262, Fall 1999.
152. Wolski, R., Spring, N. and Hayes, J., Predicting the CPU Availability of Time-shared Unix Systems on the Computational Grid, *Proceedings of 8th High-performance Distributed Computing Systems Conference*, August, 1999.
153. Shao, G., Berman, F., and Wolski, R., Using Effective Network Views to Promote Distributed Application Performance, *Proceedings of the 1999 International Conference on Parallel and Distributed Processing Techniques and Applications*, July, 1999.

154. Spring, N. and Wolski, R., Application Level Scheduling of Gene Sequence Comparison on Metacomputers, *Proceedings of the 12th ACM International Conference on Supercomputing*, Melbourne, Australia, July, 1998.
155. Wolski, R. Dynamically Forecasting Network Performance using the Network Weather Service, in *Journal of Cluster Computing*, Volume 1, pp. 119-132, January, 1998.
156. Wolski, R.M., Spring, N., Peterson, C., Implementing a Performance Forecasting System for Metacomputing: The Network Weather Service, *Proceedings of SC97*, November, 1997.
157. Wolski, R.M., Forecasting Network Performance to Support Dynamic Scheduling Using the Network Weather Service, *Proceedings of the Sixth High-performance Distributed Systems Conference*, August, 1997, pp. 316-325.
158. Berman, F., and Wolski, R., The AppLeS Project: A Status Report, *Proceedings of the 8th NEC Research Symposium*, Berlin, Germany, May 1997.
159. Shao, G., Wolski, R., and Berman, F., Modeling the Cost of Redistribution in Scheduling, in *Proceedings of the SIAM conference on Parallel Processing*, March, 1997.
160. Berman F. Wolski, R.M., Figueira, S., Schopf, J., and Shao, G., Application-Level Scheduling on Distributed Heterogeneous Networks, *Proceedings of Supercomputing 1996*, November, 1996.
161. Berman F. and Wolski, R.M., Scheduling from the Perspective of the Application [invited paper], *Proceedings of the 1996 High-Performance Distributed Computing Conference*, August, 1996.
162. W. G. Griswold, R. Wolski, S. B. Baden, S. J. Fink, S. R. Kohn, Programming Language Requirements for the Next Millennium, *ACM Computing Surveys*, Volume 28, No. 4, pp. 194-196, December, 1996.
163. Wolski, R.M., Cann, D, Compiler Controlled Cache Coherence Using a Functional Language, the *The Journal of Scientific Programming*, Volume 5, 1996.
164. Wolski, R.M., Static Scheduling of Hierarchical Program Graphs, *Journal of Parallel Processing Letters*, Volume 5, Number 4, pp. 611-622, December, 1995.
165. Gorda, B. and Wolski, R.M., Time Sharing Massively Parallel Machines, *Proceedings of the International Conference on Parallel Processing*, August, 1995.
166. Wolski, R.M., Anglano, C, Schopf, J., Berman, F., Developing Heterogeneous Applications Using Zoom and HeNCE, the *Proceedings of the Heterogeneous Processing Workshop, International Parallel Processing Symposium*, Santa Barbara, CA, April, 1995.

167. Wolski, R.M., Cann, D, Compiler Controlled Cache Coherence Using a Functional Language, *Proceedings of the Conference on High-performance Functional Computing*, Denver, CO, April, 1995.
168. Wolski, R.M., Feo, J.T., Program Partitioning for NUMA Multiprocessor Computer Systems, *The Journal of Parallel and Distributed Computing*, Volume 19, No. 3, pp. 203-218, November, 1993.
169. Wolski, R.M., Feo, J.T., Overlapping Computations and Communications on NUMA Architectures, *Proceedings of the Third Annual Sisal Users' Conference*, San Diego, CA, October, 1993.
170. Wolski, R.M., Feo, J.T., Program Partitioning for NUMA Architectures, *Proceedings of the Second Annual Sisal Users' Conference*, San Diego, CA, October, 1992.
171. Wolski, R.M., Feo, J.T., and Cann, D. A Prototype Functional Language Implementation for Hierarchical-Memory Architectures, *Proceedings of the 25th Annual Hawaii International Conference on System Sciences*, Kauai, Hawaii, January, 1992.
172. Cann, D., Wolski, R.M., Feo, J.T., Toward Resolving the Parallel Programming Crisis, *Proceedings of the 1992 International Parallel Processing Symposium Parallel Systems Fair*, Beverly Hills, CA, March, 1992.

Technical Reports

1. Brevik, J., Nurmi, D., and Wolski, R., Predicting Bounds on Queuing Delay in Space-shared Computing Environments, University of California, Santa Barbara Computer Science Technical Report Number 2005-09, April, 2005
2. Nurmi, D., Wolski, R., and Brevik, J., Model-Based Checkpoint Scheduling for Volatile Resource Environments, University of California, Santa Barbara Computer Science Technical Report Number 2004-25, November, 2004
3. Brevik, J., Nurmi, D., and Wolski, R. Quantifying Machine Availability in Networked and Desktop Grid Systems, University of California, Santa Barbara Computer Science Technical Report Number 2003-37, November, 2003
4. Nurmi, D., Brevik, J., and Wolski, R. Modeling Machine Availability in Enterprise and Wide-area Distributed Computing Environments, University of California, Santa Barbara Computer Science Technical Report Number 2003-28, October, 2003
5. Chrabakh, W. and Wolski, R., GrADSAT: A Parallel SAT Solver for the Grid, University of California, Santa Barbara Computer Science Technical Report Number 2003-05, February, 2003.

6. Swamy, M., and Wolski, R., Improving Throughput with Cascaded TCP Connections: the Logistical Session Layer, University of California, Santa Barbara Computer Science Technical Report Number 2002-24, October, 2002.
7. Wen, Y., Krintz, C. and Wolski, R., Predicting Program Power Consumption, University of California, Santa Barbara Computer Science Technical Report Number 2002-20, July, 2002.
8. Wolski, R., Krintz, C., and Wen, Y., Application-level Prediction of Program Power Dissipation, University of California, Santa Barbara Computer Science Technical Report Number 2002-10, February, 2002.
9. Wolski, R., Plank, J., Brevik, J, and Bryan, T., G-Commerce: Analyzing Market-based Resource Allocation Strategies for the Computational Grid, University of Tennessee Technical Report Number CS-00-453, December, 2000.
10. Wolski, R., Plank, J., Brevik, J, and Bryan, T., G-Commerce: Market Formulations Controlling Resource Allocation on the Computational Grid, University of Tennessee Technical Report Number CS-00-450, October, 2000.
11. Wolski, R., Plank, and J., Brevik, G-Commerce – Building Computational Marketplaces for the Computational Grid, University of Tennessee Technical Report Number CS-00-439, October, 2000.
12. Wolski, R., Brevik, J., Krintz, C., Obertelli, G., Spring, N., and Su, A., Writing Programs that Run EveryWare on the Computational Grid, University of Tennessee Technical Report UT-CS-99-420, April, 1999.
13. Wolski, R. Dynamically Forecasting Network Performance using the Network Weather Service, UCSD Technical Report TR-CS96-494, October, 1996.
14. Anglano, C, Schopf, J., Wolski, R., Berman, F., Zoom: A Hierarchical Representation for Heterogeneous Applications, U.C. San Diego Tech. Report No. CS95-451, October, 1995.
15. Wolski, R., Cann, D. Cache-line Based Loop Partitioning to Eliminate False Sharing, U.C. San Diego Tech. Report No. CS95-452, October, 1995.
16. Wolski, R.M., Program Partitioning and Scheduling for NUMA Computer Architectures, Ph.D. Thesis, U.C. Davis, Lawrence Livermore National Laboratory Publication No. UCRL-LR-117760, March, 1994.
17. Wolski, R.M., Feo, J.T., *Implementing Functional Languages to Exploit Locality*, Technical Report UCRL-JC-109744, Lawrence Livermore National Laboratory, Livermore, CA, June, 1991.

18. Cann, D., Wolski, R.M., Feo, J.T., *Parallel Functional Computation: Current Results and Observations*, Technical Report UCRL-JC- 107022, Lawrence Livermore National Laboratory, Livermore, CA, March, 1991.

Invited Professional Talks

Distinguished Lecturer, University of Houston, October, 2012
Invited Keynote, CCGrid, May 2011
Invited Speaker, Cloud Expo NYC, March, 2009
Invited Speaker, SAP research Labs, Fall 2009
Invited Speaker, O' Reily Velocity, June 2008
Invited Speaker, TeraGrid Conference, June 2006
Invited Speaker, Condor Week, April 2006
Invited Speaker, Trends in High Performance Distributed Computing, March 2006
Invited Speaker, Google Research Seminar, Google Inc., June 2006
Invited Speaker, SC05, Rice University Exhibit, November 2005
Session Co-organizer, NSF Workshop on Cyberinfrastructure and Social, Behavior, and Economic Sciences, March, 2005
Invited participant, NSF Workshop on Cyberinfrastructure and Operations Reserach, September, 2004
Invited speaker, SIAM Meeting on Computational Science, December, 2003
Invited panelist, "Open Issues in Grid Computing," GlobusWorld, January, 2003
Keynote speaker at PACT 2002, Charlottesville, VA, October, 2002
APART-01 Workshop on On-line Performance Analysis, SC01, November, 2001
SC00 Tutorial Presentation on the Network Weather Service, November, 2000.
Grid Forum 5 invited presentation, October, 2000.
Keynote speaker at ASCI'00, Lommel, Belgium, June, 2000.
Beta Grids invited speaker, March, 2000.
SIAM mini-symposium and Network-Aware Servers, May, 1999.
Blackberry Farm Conference on Grid Computing, October, 1998.
Invited panelist SC98 Next Generation Computing Systems, November, 1998.
Invited speaker DARPA Performance Engineering Meeting, November, 1997.
Invited panelist at the *ACM International Conference on Supercomputing*, panel on New Directions in Metacomputing, Philadelphia, PA, May, 1996.
Invited participant at the *Second Pasadena Inter-Agency Workshop on System Software and Tools for High-Performance Computing Environments*, Pasadena, CA, January 1995.
Co-organizer of *Mapping Programs to Massively Parallel Computer Systems*, Supercomputing '92, Minneapolis, MN, November 1992.

Invited Seminar Talks

University of Wisconsin Colloquium, January, 2006

Texas Advanced Computing Center, Colloquium, February, 2005
STIET Seminar, University of Michigan, February, 2005
San Diego Supercomputer Center, Colloquium, January, 2005
Colloquium Speaker, ENS I, Lyon, France, December, 2003
Colloquium Speaker, Vrije Universiteit, Amsterdam, NL, September 2003
Colloquium Speaker, University of Texas, Austin, April, 2003
Northridge University Colloquium, April 2003
College of William and Mary Colloquium, December 2002
IBM Hawthorne Research Seminar, December, 1999
Colby College Research Colloquium, September, 1999
Northwestern University Computer Science Research Colloquium, October, 1999
UCSD Computer Science Research Seminar, December, 1999
UCSD Computer Science Research Seminar, February, 1998
Harvey Mudd University Engineering Research Series, May 1997
USC Information Sciences Institute Seminar, March, 1997
Argonne National Laboratory Research Colloquium, May, 1996
Computer Science Research Colloquium, UCSB, March, 1995
Computer Science Research Seminar, Dipartimento di Informatica, Università di Torino, September, 1994
Parallel Computing Seminar, USC, April, 1994
Mills College ICS Colloquium, February and October, 1993
Computer Science Seminar, Harvey Mudd College, April, 1993
Parallel Computing Seminar, USC, April, 1993
Parallel Computing Seminar, UCSD, August, 1992
Apple Computer Research Colloquium, February, 1992

Grants

Next-Generation Cloud Federation via a Geo-Distributed Datastore (NSF-1703560), FY17 - FY21 (\$1,500,000)

CC*DNI DIBBs: Data Analysis and Management Building Blocks for Multi-Campus Cyberinfrastructure through Cloud Federation (NSF-1541215), FY15 - FY20 (\$6,300,000)

Developing MANDRAKE: a Maintenance AND Remediation Anticipatory Knowledge Environment, (DoD/NEEC) FY15 - FY18 (\$560,000)

CyberSEES: Type2: Collaborative Research: SmartFarm - Research and Education for Sustainable Agriculture Practices (NSF-1539586) FY15 - FY18, (\$1,200,000)

Irrigation optimization and well pump monitoring leveraging smart meter data, (California Energy Commission) FY15 - FY17 (\$2,300,000)

Systems and Software Research for Compute-Intensive Cloud Computing, (NSF-0905237) FY10 - FY15 (\$1,000,000).

Towards Scalable Primitives for Graph Operations (NSF-0847925), FY08 - FY11 (\$477,000).

Development of the Allosphere, an Immersive Instrument for Scientific Exploration (NSF-0821858), FY08 - FY11 (\$1,800,000).

Queue Prediction and Virtualized Scheduling Abstractions for NSF Batch-scheduled Cyberinfrastructure (NSF-0751315), FY08-FY11 (\$900,000).

Development of a Research Infrastructure for the Multithreaded Computing Community Using the Cray Eldorado Platform (NSF-0709385), FY07-FY09 (\$85,000).

Improving Low-Density Parity-Check Codes Through Algebraic Analysis of the Sum-Product Algorithm, (NSF-0635391), FY07-FY10 (\$273,000).

SENSIMIDE: Integrated Software Development and Multi-Mode Simulation for Large-Scale Sensor Networks (CNS-0627183), Rich Wolski, PI, FY06 - FY09, (\$500,000).

Predicting Batch Queue Delay on SDSC Datastar (SDSC Strategic Partnership), Rich Wolski, PI, FY-05 - FY07 (\$400,000).

Predicting Batch Queue Waiting Time on ETF Resources, (CCF-0526005), Rich Wolski, PI, FY-05 - FY07 (\$200,000).

Automatic Linux Customization and Optimization for High-performance Scientific Applications, Software Tools for High-end Computing Program, (ST-HEC-0444412), Chandra Krintz, PI, Rich Wolski, Co-PI, FY-04 - FY07 (\$550,000).

VGrADS: Virtual Grid Application Development Software, NSF Information Technology Research (ITR) Program, (CCF-0331645), Ken Kennedy, PI, Rich Wolski (and others), Co-PI, FY04 - FY09, (\$8,000,000)

Models to Support Performance Engineering of Global Computations, NSF Next Generation Software program (NGS-0305390), Rich Wolski, PI, FY04 - FY07. (\$500,000)

Orchestrated Modeling, Analysis, and Composition Strategies for Resource Management in Embedded Systems, Vision of Ubiquitous Computing, NSF Information Technology Research (ITR) Program (EHS-0209195), FY02 - FY05, Michael Franz, PI, Richard Wolski (and others), Co-PI. (\$640,000)

Developing a Resource Aware Adaptive Compilation System for High Performance Distributed Computing Next Generation Software Systems Program, (NGS-0204019), FY02 - FY05, Richard Wolski, PI. (\$30,000)

Developing Performance Monitoring and Analysis Middleware Based on the Network Weather Service, NSF Middleware Infrastructure Research program (ANR 0123911), FY01 – FY04, Richard Wolski, PI. (\$450,000)

Optimizing Performance and Enhancing Functionality of Distributed Applications using Logistical Networking, DOE SciDAC FY01 – FY04, Micah Beck, PI, Richard Wolski (and others) Co-PI. (\$1,600,000)

Effective Grid Programming with EveryWare and G-commerce, NSF CAREER award (0093166), FY01 - FY06, Richard Wolski, PI. (\$500,000)

University of Tennessee Center for Information Technology Research (CITR), Co-founder, FY-01 - FY06. (\$7,000,000)

National Partnership for Advanced Computational Infrastructure, Metasystems Partner, FY-96 - present (renewable \$510,000 current funding level)

NASA Information Power Grid infrastructure partner, FY-98 - FY-02 (renewable \$110,000/year)

A Research Testbed for Services Based on Logistical Networking, NSF Advanced Network Infrastructure program (ANI-9980203), FY00 – FY03, Micah Beck, PI, Richard Wolski (and others) Co-PI. (\$1,000,000)

Virtual Instruments: Scalable Software Instruments for the Grid, NSF Information Technology Research (ITR) Program (ACI-0086092), FY00 - FY02, Francine Berman, PI, Richard Wolski (and others), Co-PI. (\$680,000)

Deploying the NWS on the Information Power Grid, NASA IPG program, FY00 - FY01, Richard Wolski, PI. (\$150,000)

Deploying the NWS on the Information Power Grid, NASA IPG program, FY99 - FY00, Richard Wolski, PI. (\$150,000)

Grid Application Development Software, NSF Next Generation Software program (EIA-9975020), FY99 - FY02, Ken Kennedy, PI, Richard Wolski (and others), Co-PI. (\$7,200,000)

Optimizing distributed Application Performance using Logistical Networking, DOE Next Generation Internet program, FY99 - FY00, Jack Dongarra, PI, Richard Wolski, James Plank, Micah Beck, Co-PIs. (\$890,000)

Logistical QoS through Application-driven Scheduling of Remote Storage, NSF Next Generation Software program (EIA-9975015), FY99 - FY02, J. Plank, PI, Richard Wolski (and others), Co-PI. (\$1,300,000)

Application-Level Scheduling with AppLeS, NSF New Technologies program (ACI-9701333), FY97 - FY00, Francine Berman, PI, Richard Wolski, Co-PI. (\$650,000)

Performance Prediction Engineering for Metacomputing, DARPA ITO BAA 97-12, FY97 - FY00, Francine Berman, PI, Richard Wolski, Co-PI. (\$300,000)

Mapping Parallel Programs to NUMA Architectures Institutional Research and Development Program, Lawrence Livermore National Laboratory, FY91 - FY92, (with J.T. Feo and D.C. Cann). (\$150,000)

Courses Taught

Graduate Operating Systems (UCSB), 2006 – Present

Advanced Topics in Cloud Computing (UCSB), 2014 – Present

Undergraduate Operating Systems (UCSB), 2002 – Present

Computer Engineering Capstone (UCSB), 2002 – 2006

Advanced Topics in Data Analysis (UCSB), 2006

Advanced Topics in Operating Systems (UCSB), 2002 – 2005

Computational Grid Computing (UCSB), 2002 – 2004

Unix Internals (University of Tennessee), Fall 2000

Systems Programming (University of Tennessee), Spring 2000

Distributed Operating Systems (University of Tennessee), Summer 1999

Grid Computing (University of Tennessee), Fall 1999

High-performance Computer Architectures (Mills College), Fall 1993

C and Unix Programming (Mills College), Fall 1993

High-performance Distributed Computing (with C. Krintz at U.C Santa Barbara), Fall 2001.

Professional Activities

Associate Editor, Communications of the ACM, 2020 to present.

Associate Editor, IEEE Transactions on Cloud Computing, 2016 to 2019.

Co-organizer First International Workshop on Cloud Analytics (IWCA 2014), Boston, MA, 2014 (with Shu Tao, IBM Watson)

Program Review Panelist, DOE ASC Alliance Center, University of Utah, 2004 and 2005.

Steering Committee member, IEEE Symposium on High-performance Distributed Computing (HPDC), 2004 – present.

Technical Program co-Chair, IEEE Symposium on High-performance Distributed Computing (HPDC15), 2006.

General Chair, IEEE Symposium on High-performance Distributed Computing (HPDC13), 2004.

Partner in the *National Partnership for Advanced Computational Infrastructure (NPACI)*, 1997 - 2004. Principle architect of the Network Weather Service (<http://nws.npaci.edu>) which is being used to monitor and forecast network conditions across the NSF vBNS sites and the general Internet.

Program Committee Member, SC06, November 2005.

Program Committee Member, SC05, November 2005.

Program Committee Member, HPDC 14, June 2005.

Program Committee Member, Conference on Mobile Systems, Applications, and Services (Mobisys), June, 2005.

Program committee member for Cluster Computing and Grid Computing *CCGrid04*, April 2004.

Program committee member for *SC03*, November 2003.

Program Committee member for ACM Symposium on Principles and Practice of Parallel Programming (PPoPP), June, 2003.

Program committee member for Cluster Computing and Grid Computing *CCGrid03*, April 2003.

Program committee member for *SC02*, November 2002.

Co-editor Special Issue of the Journal of Parallel and Distributed Computing on Grid Computing, September, 2002.

Program committee member for *10th IEEE High-performance and Distributed Computing (HPDC11)*, August 2002.

Program committee member for *SC01*, November 2001.

Program committee member for *10th IEEE High-performance and Distributed Computing (HPDC10)*, August 2001.

Program committee member for *SC00*, November 2000.

Program committee member for *9th IEEE High-performance and Distributed Computing (HPDC9)*, August 2000.

Program committee member for *SC99*, November 1999.

Program committee member for *IEEE International Parallel Processing Symposium*, November 1999.

Program committee member for *8th IEEE High-performance and Distributed Computing (HPDC8)*, August 1999.

Program committee member for *1999 IEEE Workshop on Internet Applications*, March 1999.

Program committee member for *ACM International Conference on Supercomputing*, July 1998.

Program committee member for the *1996 Heterogeneous Computing Workshop*, April 1996.

Advising and Mentoring

- Stratos Dimopoulos, granted 2017, Thesis entitled “Resource allocation in Multi-analytics, Resource-Constrained Environments” (now at Apple)
- Hiranya Jayathilaka, granted 2016, Thesis entitled “Governance of Cloud Hosted Web Applications” (now at Google)
- Alex Pucher, granted 2016, Thesis entitled “Workload Federation across IaaS Clouds using Preemptible Resources with Availability Guarantees” (now at LinkedIn)
- Lamia Youseff, granted 2009, Thesis entitled “Shared Memory Programming Support for Next Generation Virtualized High Performance Computing Systems,” (now at Google)
- Matthew Allen, granted 2009, Thesis entitled “Peer-to-Peer Proxy Caching for Video-on-Demand on Hybrid Fiber-Coax Networks,” (now at Barclays)
- Daniel Nurmi, granted 2009, Thesis entitled “Statistical Methods for Mitigating Resource Provisioning Dynamism in Large-Scale Batch-Scheduled Systems,” (co-founder Anchore Inc.)
- Andrew Mutz, granted 2008, Thesis entitled “Eliciting Honest Behavior on Computational Grids,” (now at AppFolio)
- Ye Wen, P.D. granted 2007, Thesis entitled “Toward a debugging and development system for sensor networks based on scalable high fidelity simulation,” (now at Google)
- Wahid Chrabakh, Ph.D. granted 2006, Thesis entitled “GridSAT: A Distributed Large Scale Satisfiability Solver for the Computational Grid”

- Josep Blanquer, Ph.D. granted 2005, Thesis entitled “Flexible and Non-Invasive QoS for Scalable Internet Services,” (co-advised with Klaus Schauer, now at RichScale Inc.)
- Todd Bryan, M.S. granted 2001, Thesis entitled “Market-based Resource Allocation on the Computational Grid,” (now Software Engineer UCSB Environmental Sciences)
- Saranyan Rajagopalan, M.S. granted 2004, Thesis entitled “Using Box-Jenkins Forecasting Method to predict GRID Resource Performance, Online,” (now Senior Software Engineer with Alfred Mann Foundation)
- William Strathearn, M.S. granted 2004 (co-advised with Tao Yang), Thesis entitled “On-Demand Server Allocation for Network Services,” (now a Software Engineer with LogMeIn)
- D. Martin Swamy, Ph.D. granted 2003, Thesis entitled “Logistical Scheduling for Data Movement for Computational Grids,” (now Professor, Indiana University)
- Rajiv, Thonadoor, M.S. granted 2004, non-thesis option, (now Software Engineer with Ask Jeeves/Teoma)
- Vladimir Veytser, M.S. granted 2003, Thesis entitled “The Network Weather Service for .NET,” (now Staff Scientist with the San Diego Supercomputer Center)

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Technical Referee:

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 IEEE Transactions on Parallel and Distributed Systems
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 Supercomputing (SC)
 International Conference High-performance Distributed Computing
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 International Conference on Supercomputing
 International Conference on Parallel Processing
 International Conference on Computer Architecture
 International Parallel Processing Symposium
 Frontiers of Massively Parallel Computing
 International Conference on Distributed Computing