Patrick G. Bridges

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Professional Preparation

University of Arizona — **Tucson, AZ**
Ph.D. in Computer Science — *December 2002*
Disseratation Title: Composing and Coordinating Adaptations in Cholla

Mississippi State University — **Mississippi State, MS**
B.S. in Computer Science — *May 1994*

Appointments

University of New Mexico — **Department of Computer Science**
Associate Professor, Albuquerque, NM — *July 2009 – present*

Sandia National Laboratories — **Scalable System Software Department**
Faculty Sabbatical Appointment, Albuquerque, NM — *July 2010 – June 2011*

University of New Mexico — **Department of Computer Science**
Assistant Professor, Albuquerque, NM — *January 2003 – June 2009*

Academic Interests

Research: System software for large-scale environments, e.g., high-end systems, grid systems, and sensor networks; reliability and fault tolerance in high-end computing systems; operating system design and implementation;

Teaching: Graduate and undergraduate operating systems; distributed and parallel programming, computer networking; computer architecture and organization

Honors

- UNM School of Engineering Outstanding Junior Faculty Instructor, 2008–2009
- Best Paper/Best Student Paper Nomination, Supercomputing 2008
- UNM Outstanding Teacher of the Year Nomination, 2007–2008
- National Science Foundation Graduate Research Fellow, 1994–1997

Recent Professional Service

Program Committee Member: ACM/IEEE International Conference on Supercomputing (SC), 2010–2014; IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing (CCGrid), 2014–2015; International Conference on Supercomputing (ICS), 2014; International Conference on Parallel Programming (ICPP), 2012, 2006; IEEE International Conference on Computer Communication Networks (ICCCN), 2012, 2014; IEEE International Symposium on Parallel and Distributed Processing with Applications (ISPA), 2012, 2011, 2009, 2006;

Paper Reviewer: IEEE Transactions on Computers, 2010–2012; ACM Transactions on Storage, 2011; IEEE Transactions on Parallel and Distributed Systems, 2011; IEEE Transactions on Software Engineering, 2010–2011

Dissertations Directed

[1] Zheng Cui. *Enhancing HPC on Virtual Systems in Clouds through Optimizing Virtual Overlay Networks*. PhD thesis, University of New Mexico, Albuqueruque, New Mexico, 2013.

[2] Ricardo Villalon. *Fault-Tolerant Wireless Sensor Networks using Evolutionary Games*. PhD thesis, The University of New Mexico, Computer Science Department, Albuquerque, NM 87131, 2012.

[3] Kurt B. Ferreira. *Keeping Checkpointing Viable for Exascale Systems*. PhD thesis, The University of New Mexico, Computer Science Department, Albuquerque, NM, 87131, 2011.

[4] Donour Sizemore. *Parallel Network Protocol Stacks Using Replication*. PhD thesis, The University of New Mexico, Computer Science Department, Albuquerque, NM, 87131, 2011.

[5] Manjunath Gorentla Venkata. *A Protocol Reconfiguration and Optimization System for MPI*. PhD thesis, The University of New Mexico, Computer Science Department, Albuquerque, NM 87131, 2010.

[6] Wenbin Zhu. *Lightweight Online Performance Monitoring and Tuning with Embedded Gossip*. PhD thesis, The University of New Mexico, Computer Science Department, Albuquerque, NM 87131, 2007.

Peer-Reviewed Journal, Conference, and Workshop Publications

[1] Kurt B Ferreira, Rolf Riesen, Patrick Bridges, Dorian Arnold, and Ron Brightwell. Accelerating incremental checkpointing for extreme-scale computing. *Future Generation Computer Systems*, 30:66–77, 2014.

[2] Lei Xia, Zheng Cui, John Lange, Yuan Tang, Peter Dinda, and Patrick G. Bridges. Fast VMM-based overlay networking for bridging the cloud and high performance computing. *Cluster Computing*, 17(1):39–59, 2014.

[3] Scott Levy, Kurt B. Ferreira, and Patrick G. Bridges. Characterizing the impact of rollback avoidance at extreme-scale: A modeling approach. In *Proceedings of the 2014 International Conference on Parallel Processing (ICPP-2014)*, 2014.

[4] Matthew G.F. Dosanjh, Patrick G. Bridges, Suzanne M. Kelly, James H. Laros III, and Courtenay T. Vaughan. An evaluation of bittorrent's performance in hpc environments. In *Proceedings of the 4th International Workshop on Runtime and Operating Systems for Supercomputers*, page 8. ACM, 2014.

[5] Zheng Cui, Patrick G. Bridges, John R. Lange, and Peter A. Dinda. Virtual TCP offload: optimizing Ethernet overlay performance on advanced interconnects. In *Proceedings of the 22nd International Symposium on High-performance Parallel and Distributed Computing (HPDC'13)*, pages 49–60. ACM, 2013.

[6] Kurt B. Ferreira, Patrick G. Bridges, Ron Brightwell, and Kevin Pedretti. Impact of system design parameters on application noise sensitivity. *Journal of Cluster Computing*, 16(1), March 2013.

[7] Patrick Widener, Kurt Brian Ferreira, Scott N. Levy, Ronald B Brightwell, Patrick G. Bridges, and Dorian Arnold. Asking the right questions: benchmarking fault-tolerant extreme-scale systems. In *Proceedings of the 6th Workshop on Resiliency in High Performance Computing in Clusters, Clouds, and Grids (Resilience'13)*, 2013.

[8] Scott Levy, Patrick G. Bridges, Kurt B. Ferreira, Aidan P. Thompson, and Christian Trott. Evaluating the feasibility of using memory content similarity to improve system resilience. In *Proceedings of the 3rd International Workshop on Runtime and Operating Systems for Supercomputers (ROSS'13)*, page 7. ACM, 2013.

[9] Scott Levy, Matthew G.F. Dosanjh, Patrick G. Bridges, and Kurt B. Ferreira. Using unreliable virtual hardware to inject errors in extreme-scale systems. In *Proceedings of the 3rd Workshop on Fault-tolerance for HPC at extreme scale*, pages 21–26. ACM, 2013.

[10] Philip Soltero, Patrick G. Bridges, Dorian Arnold, and Michael Lang. A gossip-based approach to exascale system services. In *Proceedings of the 3rd International Workshop on Runtime and Operating Systems for Supercomputers (ROSS'13)*, page 3. ACM, 2013.

[11] Zheng Cui, Lei Xia, Patrick G. Bridges, Peter A. Dinda, and Jack R. Lange. Optimizing overlay-based virtual networking through optimistic interrupts and cut-through forwarding. In *Proceedings of the 2012 ACM/IEEE Conference on Supercomputing (SC'12)*, Salt Lake City, UT, November 2012.

[12] Rolf Riesen, Kurt B. Ferreira, Dilma Da Silva, Pierre Lemarinie, Dorian Arnold, and Patrick G. Bridges. Alleviating scalability issues of checkpointing protocols. In *Proceedings of the 2012 ACM/IEEE Conference on Supercomputing (SC'12)*, Salt Lake City, UT, November 2012.

[13] Patrick G. Bridges, Dorian Arnold, Kevin T. Pedretti, Madhav Suresh, Feng Lu, Peter Dinda, Russ Joseph, and Jack Lange. Virtual machine-based emulation of future generation high-performance computing systems. *International Journal of High Performance Computing Applications*, 26(2):125–135, May 2012.

[14] Matthew G.F. Dosanjh, Patrick G. Bridges, Sue M. Kelly, and James H. Laros III. A peer-to-peer architecture for supporting dynamic shared libraries in large-scale systems. In *Proceedings of the Fifth International Workshop on Parallel Programming Models and Systems Software for High-End Computing (P2S2)*, pages 55–61. IEEE, 2012.

[15] Lei Xia, Zheng Cui, John Lange, Yuabn Tang, Peter Dinda, and Patrick G. Bridges. VNET/P: Bridging the cloud and high performance computing through fast overlay networking. In *Proceedings of the 21st International ACM Symposium on High-Performance Parallel and Distributed Computing (HPDC'12)*, June 2012.

[16] Jon Stearley, Kurt B. Ferreira, David Robinson, Dorian Arnold, Patrick G. Bridges, James H. Laros III, Kevin Pedretti, and Rolf Riesen. Does partial replication pay off? In *Proceedings of the 2nd Workshop on Fault Tolerance for HPC at Extreme Scale (FTXS'12)*, June 2012.

[17] K.B. Ferreira, K. Pedretti, R. Brightwell, P.G. Bridges, D. Fiala, and F. Mueller. Evaluating operating system vulnerability to memory errors. In *Proceedings of the 2nd International Workshop on Runtime and Operating Systems for Supercomputers (ROSS 2012)*. ACM, 2012.

[18] Kurt B. Ferreira, Rolf Riesen, Patrick G. Bridges, Dorian Arnold, Jon Stearley, James H. Laros, Ron A. Oldfield, Kevin Pedretti, and Ron Brightwell. Evaluating the viability of process replication reliability for exascale systems. In *Proceedings of the 2011 ACM/IEEE Conference on Supercomputing (SC'11)*, Seattle, WA, November 2011.

[19] Kurt B. Ferreira, Rolf Riesen, Ron Brightwell, Patrick G. Bridges, and Dorian Arnold. Libhashckpt: Hash-based incremental checkpointing using GPUs. In *Proceedings of the 18th EuroMPI Conference*, Santorini, Greece, September 2011.

[20] Patrick G. Bridges, Mark Hoemmen, Kurt B. Ferreira, Michael A. Heroux, and Ron Brightwell. Cooperative application/OS DRAM fault recovery. In *Fourth Workshop on Resiliency in High Performance Computing in Clusters, Clouds, and Grids (Resilience'11)*, Bordeaux, France, August 2011.

[21] Dewan Ibtesham, Dorian Arnold, Kurt B. Ferreira, and Patrick G. Bridges. On the viability of checkpoint compression for extreme scale fault tolerance. In *Proceedings of the 4th Workshop on Resiliency in High Performance Computing in Clusters, Clouds, and Grids (Resilience 2011)*, 2011.

[22] Fan Zhang, Wenbo He, Xue Liu, and Patrick G. Bridges. Inferring users' online activities through traffic analysis. In *Proceedings of the Fourth ACM Conference on Wireless Network Security*, Hamburg, Germany, June 2011.

[23] Patrick M. Widener, Matthew Wolf, Hasan Abbasi, Scott McManus, Mary Payne, Patrick G. Bridges, and Karsten Schwan. Exploiting latent I/O asynchrony in petascale science applications. *International Journal of High Performance Computing Applications*, 25(2), May 2011.

[24] Patrick G. Bridges, Donour Sizemore, and Scott Levy. Exploiting MISD performance opportunities in multi-core systems. In *Proceedings of the 13th Workshop on Hot Topics in Operating Systems (HotOS XIII)*, Napa, CA, May 2011.

[25] Patrick G. Bridges, Kevin Pedretti, and Dorian Arnold. VM-based slack emulation of large-scale systems. In *Proceedings of the 2011 International Workshop on Runtime and Operating Systems for Supercomputers (ROSS 2011)*, Tucson, AZ, May 2011.

[26] Jack Lange, Kevin Pedretti, Peter Dinda, Patrick G. Bridges, Chang Bae, Philip Soltero, and Alexander Merritt. Minimal-overhead virtualization of a large scale supercomputer. In *Proceedings of the 2011 ACM SIGPLAN/SIGOPS International Conference on Virtual Execution Environments (VEE 2011)*, Newport Beach, CA, March 2011.

[27] Kevin T. Pedretti and Patrick G. Bridges. Opportunities for leveraging OS virtualization in high-end supercomputing. In *Proceedings of the Workshop on Micro Architectural Support for Virtualization, Data Center Computing, and Clouds (MASVDC'10)*, Atlanta, Georgia, December 2010.

[28] Kurt B. Ferreira, Patrick G. Bridges, Ron Brightwell, and Kevin Pedretti. Impact of system design parameters on application noise sensitivity. In *Proceedings of the 2010 IEEE International Conference on Cluster Computing (Cluster 2010)*, September 2010.

[29] Jack Lange, Kevin Pedretti, Trammell Hudson, Peter Dinda, Zheng Cui, Lei Xia, Patrick Bridges, Andy Gocke, Steven Jaconette, Mike Levenhagen, and Ron Brightwell. Palacios and Kitten: New high performance operating systems for scalable virtualized and native supercomputing. In *Proceedings of the 24th IEEE International Parallel and Distributed Processing Symposium*, April 2010.

[30] Edgar A. León, Rolf Riesen, Arthur B. Maccabe, and Patrick G. Bridges. Instruction-level simulation of a cluster at scale. In *Proceedings of the 2009 ACM/IEEE International Conference on Supercomputing (SC'09)*, November 2009.

[31] Mohammed I. Al-Saleh, Patrick G. Bridges, and Jedidiah R. Crandall. Architectural support for securing sensor networks against remote attacks. In *Proceedings of the First Conference on First International Conference on Sensor Network and Applications*, November 2009.

[32] Patrick G. Bridges, Matti A. Hiltunen, and Richard D. Schlichting. Cholla: A framework for composing and coordinating adaptations in networked systems. *IEEE Transactions on Computers, Special Issue on Autonomic Network Computing*, 58(11):1456–1469, November 2009.

[33] Patrick M. Widener, Matthew Wolf, Hasan Abbasi, Scott McManus, Mary Payne, Patrick G. Bridges, and Karsten Schwan. Exploiting latent I/O asynchrony in petascale science applications. In *Proceedings of the 2009 International Workshop on Parallel Programming Models and Systems Software for High-End Computing (P2S2)*, September 2009.

[34] Wenbin Zhu, Patrick G. Bridges, and Arthur B. Maccabe. Lightweight application monitoring and tuning with embedded gossip. *IEEE Transactions of Parallel and Distributed Systems*, 20(7):1038–1049, July 2009.

[35] Manjunath Gorentla Venkata and Patrick G. Bridges. Using application communication characteristics to drive dynamic MPI reconfiguration. In *Proceedings of the 2009 Workshop on Communication Architectures for Clusters (CAC 2009)*, May 2009.

[36] Rolf Riesen, Ron Brightwell, Patrick G. Bridges, Trammell Hudson, Arthur B. Maccabe, Patrick M. Widener, and Kurt B. Ferreira. Designing and implementing lightweight kernels for capability computing. *Concurrency and Computation: Practice and Experience*, 21(6):791–817, April 2009.

[37] Kurt B. Ferreira, Ron Brightwell, and Patrick G. Bridges. Characterizing application sensitivity to OS interference using kernel-level noise injection. In *Proceedings of the 2008 ACM/IEEE Conference on Supercomputing (SC'08)*, November 2008.

[38] Patrick G. Bridges, Matti A. Hiltunen, Richard D. Schlichting, Gary T. Wong, and Matthew Barrick. A configurable and extensible transport protocol. *ACM/IEEE Transactions on Networking*, 15(6):1254–1265, December 2007.

[39] Wenbin Zhu, Patrick G. Bridges, and Arthur B. Maccabe. Embedded gossiping: Lightweight online measurement for large-scale applications. In *Proceedings of the 2007 IEEE International Conference on Distributed Computing Systems (ICDCS)*, June 2007.

[40] Wenbin Zhu, Patrick G. Bridges, and Arthur B. Maccabe. Light-weight application monitoring and tuning with embedded gossip. In *Proceedings of the 2007 SIGMETRICS Student Workshop*, June 2007.

[41] Galen M. Shipman, Timothy S. Woodall, Richard L. Graham, Arthur B. Maccabe, and Patrick G. Bridges. Infiniband scalability in OpenMPI. In *Proceedings of the 20th IEEE International Parallel and Distributed Processing Symposium (IPDPS)*, 2006.

[42] Arthur B. Maccabe, Patrick G. Bridges, Ron Brightwell, and Rolf Riesen. Recent trends in operating systems and their applicability to HPC. In *Proceedings of the Cray User Group 2006 Technical Meeting*, Lugano, Switzerland, May 2006.

[43] Jean-Charles Tournier, Patrick G. Bridges, Arthur B. Maccabe, Patrick M. Widener, Zaid Abudayyeh, Ron Brightwell, Rolf Riesen, and Trammell Hudson. Towards a framework for dedicated operating systems development in high-end computing. *Operating Systems Review: Special Issue on System Software for High-End Computing Systems*, 40(2):16–21, April 2006.

[44] Manjunath Gorentla Venkata and Patrick G. Bridges. MPI/CTP: A reconfigurable MPI for HPC applications. In Dieter Kranzlmüller, Peter Kacsuk, Jack Dongarra, and Jens Volkert, editors, *Recent Advances in Parallel Virtual Machine and Message Passing Interface: 13th European PVM/MPI Users' Group Meeting*, volume 4192 of *Lecture Notes in Computer Science*. Springer-Verlag, September 2006.

[45] Sushant Sharma, Patrick G. Bridges, and Arthur B. Maccabe. A framework for analyzing Linux system overheads on HPC applications. In *Proceedings of the 2005 Los Alamos Computer Science Institute Symposium (LACSI 2005)*, October 2005.

[46] Wenbin Zhu, Patrick G. Bridges, and Arthur B. Maccabe. Online critical path profiling for parallel applications. In *Proceedings of the 2005 IEEE International Conference on Cluster Computing (Cluster 2005)*, Boston, MA, September 2005.

[47] Patrick G. Bridges and Arthur B. Maccabe. IMPuLSE: Integrated monitoring and profiling for large-scale environments. In *Proceedings of the Seventh Workshop on Languages, Compilers, and Run-time Support for Scalable Systems*, October 2004.

[48] Arthur B. Maccabe, Patrick G. Bridges, Ron Brightwell, Rolf Riesen, and Trammell Hudson. Highly configurable operating systems for ultrascale systems. In *Proceedings of the First International Workshop on Operating Systems, Programming Environments, and Management Tools for High-Performance Computing on Clusters*, June 2004.

[49] Ron Brightwell, Rolf Riesen, Keith Underwood, Patrick G. Bridges, Arthur B. Maccabe, and Trammell Hudson. A performance comparison of Linux and a lightweight kernel. In *Proceedings of the 2003 IEEE International Conference on Cluster Computing (Cluster 2003)*, Hong Kong, China, December 2003.

[50] Patrick G. Bridges, Wen-Ke Chen, Matti A. Hiltunen, and Richard D. Schlichting. Position statement: Supporting coordinated adaptation in networked systems. In *Proceedings of the Eighth Workshop on Hot Topics in Operating Systems (HotOS-VIII)*, 2001.

[51] John H. Hartman, Larry L. Peterson, Andrew C. Bavier, Peter A. Bigot, Patrick G. Bridges, A. Brady Montz, Robert Piltz, Todd A. Proebsting, and Oliver Spatscheck. Experiences building a communication-oriented JavaOS. *Software: Practice and Experience*, 30(10):1107–1126, 2000.

[52] John H. Hartman, Peter A. Bigot, Patrick G. Bridges, A. Brady Montz, Robert Piltz, Oliver Spatscheck, Todd A. Proebsting, Larry L. Peterson, and Andrew C. Bavier. Joust: A platform for liquid software. *Computer*, 32(4):50–56, 1999.

[53] Todd A. Proebsting, Gregg Townsend, Patrick G. Bridges, John H. Hartman, Timothy Newsham, and Scott A. Watterson. Toba: Java for applications–A way ahead of time (WAT) compiler. In *Proceedings of the Third USENIX Conference on Object-Oriented Technologies and Systems (COOTS'97)*, pages 41–53, 1997.

[54] David Mosberger, Larry L. Peterson, Patrick G. Bridges, and Sean O'Malley. Analysis of techniques to improve protocol latency. In *Proceedings of SIGCOMM '96*, 1996.

[55] David Mosberger, Larry L. Peterson, Patrick G. Bridges, and Sean O'Malley. Improving the I-cache effectiveness of network software. In *Proceedings of the Workshop on Compiler Support for System Software*, pages 29–36, 1996.

Other Publications

[1] Patrick M. Widener, Matthew Barrick, Jack Pullikotil, Patrick G. Bridges, and Arthur B. Maccabe. Metabots: A framework for out-of-band processing in large-scale data flows (poster). In *Proc. 2007 International Conference on Grid Computing (Grid 2007)*, Austin, Texas, September 2007.

[2] Donour Sizemore and Patrick G. Bridges. Dominoes: A Scalable Architecture for Parallel Protocol processing (poster). In *Proceedings of 2007 European Conference on System Software (EuroSys 2007)*, 2007.

[3] Patrick G. Bridges, Arthur B. Maccabe, and Orran Krieger. System software for high-end computing. *Operating Systems Review: Special Issue on System Software for High-End Computing Systems*, 40(2), April 2006.

[4] Kurt B. Ferreira, Ron Brightwell, and Patrick G. Bridges. An infrastructure for characterizing the sensitivity of parallel applications to OS noise. In *Proceedings of the 2006 Symposium on Operating System Design and Implementation*, 2006. Work-In-Progress Session.

[5] Patrick G. Bridges. *Composing and Coordinating Adaptation in Cholla*. PhD thesis, University of Arizona, Tucson, Arizona, 2002.

[6] Ewing Lusk, William Gropp, Edward Karrels, Patrick G. Bridges, Nathan Doss, and Anthony Skjellum. Users' guide to mpich, a portable implementation of MPI. Technical report, Mathematics and Computer Science Division, Argonne National Laboratory, Argonne, IL, 1994.

Recent Invited Presentations

Why You Don't Want System Software to Solve Your Problems If You Can Help It **April, 2014**
The Salishan Conference on High-speed Computing, Salishan, OR

HPC in the Cloud: 99 Problems but a VMM Ain't One **November 2012**
SC'12 HPC in the Cloud Birds-of-a-Feather Panel, Salt Lake City, UT

Runtime Support for Integrated Power and Resilience management **October 2012**
Workshop on Exascale Operating Systems and Runtime Software, Washington, DC

Virtualization-based Exascale Runtime System R&D **October 2012**
Department of Energy Exascale Research Conference, Washington, DC

Recent Advances in Computer Go Playing **September 2012**
UNM Department Colloquium, Albuquerque, NM

Chipping Away at the Exascale Resilience Wall **July 2012**
University of Utah Colloqium, Salt Lake City, UT

Cooperative OS/Application DRAM Fault Recovery **April 2012**
Department of Energy Exascale Research Conference, Portland, OR

Virtualization-based Design Space Exploration **April 2012**
Department of Energy Exascale Research Conference, Portland, OR

Virtualization-based Exascale Runtime System R&D **March 2012**
SOS16 Workshop, Santa Barbara, CA

Research Funding

Requested Funding

National Science Foundation **$800,000**
CSR: Integrated Power and Resilience Management for Extreme-Scale Systems *2015-2019*
UNM PI on collaborative proposal with University of Arizona

Current Funding

Department of Energy Office of Science **$450,000**
Hobbes: OS and Runtime Support for Application Composition *2013-2017*
UNM PI of large collaborative proposal lead by Ron Brightwell (Sandia National Laboratories)

RNET Technologies, Inc. **$100,000**
Power Management in MPI Implementations *2014*

Sandia National Laboratories **$20,000**
Modeling MPI Networking Performance *2014*

Previously Funded

Department of Energy Office of Science **$625,000**
Enabling Exascale System Design through Scalable System Virtualization *2010–2013*
Lead PI with co-PIs Peter Dinda (NWU), Kevin Pedretti (SNL), and Stephen Scott (ORNL)

Sandia National Laboratories **$75,000**
A peer-to-peer HPC shared library file system *2012–2013*

Sandia National Laboratories **$55,000**
Resilience in HPC Networking and System Software *2012–2013*

Defense Threat Reduction Agency (DTRA) **$350,000**
Modeling and Mitigating Cascading Failures in Smart Grid Systems *2010–2011*
co-PI with Majeed Hayat(UNM ECE)

National Science Foundation **$300,000**
Community Resource Development: An Open Source Extensible VMM *2007–2011*

Gift from Sun Microsystems **$110,000**
Scalable Multi-core Network Protocol Stacks *2007–2011*

Defense Threat Reduction Agency (DTRA) **$1,080,691**
Collaborative Networks in the Presence of WMD Stressors *2007–2010*
co-PI with Majeed Hayat, UNM ECE

Department of Energy Office of Science **$750,000**
A Framework for Adaptable Operating and Runtime Systems *2005–2009*

Lawrence Berkeley National Laboratory **$225,000**
High End Computing with K42 *2005–2009*

Sandia National Laboratories **$1,500,000**
Scalable Systems Software Research, Co-PI with Barney Maccabe, UNM CS *2003–2007*

Gift from Intel Corporation **$60,000**
Intel Processor Support in the K42 Operating System *2005–2006*

Subcontract from IBM on DARPA Contract **$600,000**
PERCS: Productive, Easy-to-use, Reliable Computing Systems *2003–2006*
co-PI with David Bader, UNM ECE

Los Alamos Computer Science Institute **$600,000**
High Performance Networks and Data Visualization *2003–2006*
Co-PI with Deepak Kapur and Barney Maccabe, UNM CS

Sandia National Labs University Research Program (SURP) **$80,000**
Enabling Custom Protocol Support for Scalable, High Performance Applications *2003–2005*

Collaborators

Advisors: Graduate: Richard D. Schlichting (AT&T Research), Undergraduate: Tony Skjellum (Auburn University)

Advisees: Zheng Cui (VMWare), Ahmad Douglas (Los Alamos National Laboratory), Kurt Ferreira (Sandia National Laboratories), Manjunath Gorentla Venkata (Oak Ridge National Laboratory), Donour Sizemore (Two Sigma, Inc.), Patrick Widener (Sandia National Laboratories), Ricardo Villalon (Universidad de Costa Rica), Wenbin Zhu (Wellkeeper, Inc.)

Other Collaborators: Ron Brightwell (Sandia National Laboratories), Fabian Bustamante (Northwestern University), Dilma DaSilva (IBM Research), Peter Dinda (Northwestern University), Paul Hargrove (Lawrence Berkeley National Laboratory), Mary Hall (University of Utah), Orran Krieger (Northeastern University), Russ Joseph (Northwestern University), Kate Keahey (Argonne National Laboratory), Andrew Lumsdaine (Indiana University), Arthur B. Maccabe (Oak Ridge National Laboratory), Ron Minnich (Google), Bernard Moret (EPFL), Fabrizio Petrini (IBM Research), Karsten Schwan (Georgia Tech), Stephen Scott (Tennessee Tech), Thomas Sterling (Indiana University), Michael Stumm (University of Toronto), Rolf Riesen (Intel Corporation), Keith Underwood (Intel Corporation)