

Richard West

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Research Interests:

- Real-time systems, operating systems, and resource management

Education:

- **Georgia Institute of Technology**, Atlanta, Georgia
 - *Ph.D., Computer Science, August 2000*
 - Thesis: "Adaptive Real-Time Management of Communication and Computation Resources"
 - Thesis committee: Karsten Schwan (advisor), Mustaque Ahamad, Calton Pu, Sudhakar Yalamanchili, and Ellen Zegura
- **Georgia Institute of Technology**, Atlanta, Georgia
 - *M.S., Computer Science, September 1998*
- **University of Newcastle-upon-Tyne**, Newcastle-upon-Tyne, England
 - *M.Eng., Microelectronics and Software Engineering, First-Class Honors, June 1991*
 - Masters project: "Collision Avoidance for a Mobile Robot Using Ultrasound"

Experience:

- **Associate Professor**, Boston University, Boston, MA (September 2006-present). Previously **Assistant Professor** (September 2000-August 2006).
- **Scholar-in-Residence**, VMware, Inc., Cambridge, MA (June 2007-June 2008). Continuing contractor position as an Advanced Research Engineer (August 2008-present).
- **Lab Operations Officer**, Boston University, (September 2005-June 2007). Responsible for departmental annual equipment budget and overseeing of system administration staff.
- **Research Assistant**, College of Computing, Georgia Institute of Technology, Atlanta, GA (September 1994-August 2000). Research on adaptive resource management for real-time, high performance computing and distributed systems. Also worked on scalable, run-time system support for coherent, replicated shared objects.
- **Instructor**, College of Computing, Georgia Institute of Technology, Atlanta, GA (Spring 1999). Taught undergraduate course in operating systems and data management (CS3431).
- **Software Engineer**, Beta Instruments Co. Ltd., England (1992-1993). Developed embedded system software/hardware for laser measurement gauges used in the wire and fiber optic industry. Experience with Intel 80196 microcontrollers, Texas Instruments 9900 assembler, embedded C programming, and firmware.
- **IEE-Approved Engineer** in all divisions of Davis Derby Engineering Ltd, England (1986-1991). Research and development of hardware/software for command, control and communication systems for hazardous atmospheres, especially for mining, oil-rigs and sea vessels. Experience with Intel 8051 microcontrollers, RS232, ROM BIOS programming and interrupt-driven systems.

Professional Services:

- Program Committee member for the 16th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS), Stockholm, Sweden, April 12-15, 2010.
- Program Committee member for the 12th IEEE International Symposium on Object-oriented Real-time Distributed Computing (ISORC), March 17-20, 2008, Tokyo, Japan.
- Program Committee member for the 29th IEEE Real-Time Systems Symposium, November 30-December 3, 2008, Barcelona, Spain.
- Program Committee member for the Workshop on Managed Many-Core Systems (co-located with HPDC 2008), June 2008, Boston, USA.
- Program Committee member for the 20th Euromicro Conference on Real-Time Systems (ECRTS), July 2008, Prague, Czech Republic.
- Program Committee member for the 14th IEEE Real-Time and Embedded Technology and Applications Symposium (Real-Time and Embedded Applications/Benchmarks Area), 2008, St. Louis, MO, USA.
- Program Committee member for the 13th IEEE International Conference on Embedded and Real-Time Computing Systems and Applications (RTCSA), August 2007, Daegu, Korea – Real-Time Track.
- Program Committee member for the 19th IEEE Euromicro Conference on Real-Time Systems (ECRTS), July 2007, Pisa, Italy.
- Program Area Chair for the 13th IEEE Real-Time and Embedded Technology and Applications Symposium (Real-Time and Embedded Applications/Benchmarks Area), 2007, Bellevue, Washington.
- Program Committee member for the 27th IEEE Real-Time Systems Symposium, 2006 (Special Track on Real-Time Middleware and Software Engineering), Rio de Janeiro, Brazil.
- Program Committee Co-Chair for the 12th IEEE Intl. Conference on Embedded and Real-Time Computing and Applications (RTCSA) 2006.
- Program Committee member for IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS), 2006.
- Program Committee member for the 26th IEEE Real-Time Systems Symposium, 2005.
- Publicity Co-Chair for the 11th IEEE International Conference on Embedded and Real-Time Computing Systems and Applications (RTCSA), August, 2005.
- Program Committee member for the 17th Euromicro Conference on Real-Time Systems, July, 2005.
- Reviewer for the Distributed Object and Component-based Software Systems track of the 38th Annual Hawaii International Conference on System Sciences, January, 2005.
- Program Committee member for the 13th International Workshop on Parallel and Distributed Real-Time Systems 2005.
- Program Committee member for the Sixth Real-Time Linux Workshop, Nanyang Executive Centre, Singapore, November, 2004.
- Program Committee member for the Workshop on Quality of Service for Application Servers, October, 2004. In conjunction with the 23rd Symposium on Reliable Distributed Systems, Florianopolis, Brazil, 2004.
- Program Committee member for IEEE Real-Time Systems Symposium, 2004.
- Program Committee member for the 1st International Workshop on Data Distribution in Real-Time Systems (DDRTS), 2003.
- Organizer and Program Committee member for The Fourth Real-Time Linux Workshop, Boston University, December, 2002.
- Program Committee member for IEEE Real-Time and Embedded Technology and Applications Symposium, 2002.
- Program Committee member for IEEE International Conference on Distributed Computing Systems, 2002.

- Publicity Co-Chair for IEEE Real-Time Systems Symposium, 2001.
- Program Committee member for IEEE Real-Time Technology and Applications Symposium, 2001.
- Reviewer for various journals including: IEEE Transactions on Parallel and Distributed Systems, IEEE Transactions on Computers, IEEE Transactions on Software Engineering, the British Computer Society Computer Journal, the Journal of Systems and Software (Elsevier), Computer Networks (Elsevier), Real-Time Systems Journal, and IEEE Multimedia.
- Reviewer for various conferences including IEEE RTSS, RTAS, ICDCS and IPDPS.
- Reviewer and panelist for various NSF proposals including: Cyber-Physical Systems (2009), Embedded and Hybrid Systems (2004), ACR Software Systems (2003), ITR Small Software Systems (2002) and Embedded and Hybrid Systems (2002).

Teaching and Research Group Activities:

- Extensively revised the introductory operating systems and advanced software systems courses at Boston University. See <http://www.cs.bu.edu/fac/richwest/courses.html> for more details.
- Developed a 'sandbox' computing laboratory for undergraduate and graduate systems/networking project work at Boston University. The sandbox allows students to safely develop kernel code and gain practical experience with network routers.
- Developed a thread and packet scheduling algorithm, called DWCS, used in courses at Georgia Tech and Boston University. See <http://www.cs.bu.edu/fac/richwest/dwcs.html> for more details.
- Developed a distributed shared object system, supporting configurable consistency protocols. Wrote a video game application using this system, which was used in several undergraduate courses taught at Georgia Tech. See <http://www.cs.bu.edu/fac/richwest/brobots.html> for more details.
- Created the foundations for a systems research laboratory at Boston University, including a cluster computing environment consisting of Pentium 4 PCs and Xeon machines, connected via switched Gigabit Ethernet.
- Founded the Boston University Operating Systems and Services (BOSS) reading group, for students and faculty to discuss systems research topics.
 - For more details, see <http://www.cs.bu.edu/fac/richwest/groups/boss.html>.

Research Contributions:

- **Composite** – A component-based system that leverages MPDs (see below) to allow the construction of user-configurable systems. Composite adapts the isolation between component services in response to run-time changes in resource usage and execution patterns, attempting to maximize isolation while ensuring end-to-end service/resource constraints.
- **Mutable Protection Domains (MPDs)** – Development of a component-based system that trades fault isolation for inter-component communication costs. The aim is to develop a new system leveraging hardware and software techniques, to addresses service constraints in terms of safety, predictability and efficiency.
- **Window-Constrained Scheduling** - Developed both Dynamic Window-Constrained Scheduling (DWCS) and Virtual Deadline Scheduling (VDS). Designed for weakly-hard real-time and multimedia systems, which can tolerate some missed deadlines, as long as m out of k deadlines are met for a given task or job instance. Both algorithms have been implemented in the Linux kernel as thread and packet schedulers. Software patches for recent Linux kernels are available upon request. This work has been published in IEEE RTSS 2000, IEEE RTSS 2004, and IEEE Transactions on Computers (amongst other places) and has contributed to multiple research efforts at both Georgia Tech and Boston University.
- **User-Level Sandboxing** – Developed an efficient method of application-specific system extensibility for commercial-off-the-shelf (COTS) systems, which enables services and handlers to

execute at user-level without the need for explicit process scheduling and context-switching. As part of this work, my students and I have implemented a number of sandboxed services on a Linux x86 platform, which include ptrace interposition agents, PID-controllers for adaptively managing CPU allocations to threads, and a zero-copy user-level networking stack.

- **Quest** – Developed a new operating system called “Quest” for use in both research and the teaching of systems-oriented concepts. Currently Quest has a shell, basic device support, fork/exec/exit process control semantics, simple preemptive scheduling, co-routine and paging capabilities. The current version of Quest works on the Intel IA32 family of processors and includes a stripped down system library (containing, for the most part, a subset of the libc functionality, including malloc/free routines for dynamic memory allocation). The aim is to use Quest in research on system structure and extensibility, especially for embedded applications with real-time requirements.
 - Further details can be found at: <http://www.cs.bu.edu/fac/richwest/quest.html>.
- **Osmosis: a Scalable System for Stream Processing** – Currently building a scalable and distributed system, that supports the publication, subscription, and on-line processing of real-time data streams. This work is primarily targeted at the delivery and synthesis of real-time data streams generated by one or more publishers and transported to potentially many thousands of subscribers. A logical overlay network connecting various end-systems is used to transport data that may be processed at various intermediate hosts along the path from source to destination. The aim is to manage resources such as CPU and network bandwidth in a distributed manner (without any central control), so as to maximize their usage. Current developments on this project include the implementation of a Java middleware system for dynamically-configuring a collection of end-systems into a (logical) k-ary n-cube overlay topology, which supports QoS-constrained routing of data streams between known publishers and subscribers.
- **SafeX: Safe Kernel Extensions** – With Jason Gloudon (a former BU student), developed a safe extension architecture for general purpose systems, to allow applications to customize the behavior of the system for their individual needs. SafeX provides support for QoS-constrained multimedia and soft real-time applications on COTS systems, by verifying that an extension will provide service guarantees, without affecting the requirements of other applications or the integrity of the system. SafeX has been implemented in the Linux kernel to support a number of configurable service managers (e.g., for adaptive management of CPU cycles to compensate for run-time changes in resource demands).
- **Cuckoo: a thread- and memory-safe language** – Developed a language to support thread and memory safe executable code. The primary use of this language has been to write safe extension code as part of the “user-level sandboxing” and “SafeX” projects.
 - See: <http://www.cs.bu.edu/fac/richwest/cuckoo.html> for further details.
- **Dionisys: End-System QoS Support for Distributed Applications** – Developed a Solaris-based distributed system to support the QoS requirements of applications in the presence of run-time changes to resource demands and availability. This research focuses on different methods of adaptive quality of service management, implemented with the event-based mechanisms offered by the Dionisys quality of service infrastructure.
- **S-DSO: Semantic-Distributed Shared Object Run-time Support** – Developed a distributed shared object system which supports application-configurable consistency protocols, to increase scalability and concurrency. The system leverages application semantics to decide *when* and *who* should be informed of object updates. In particular, this work focuses on the notions of 'temporal' and 'spatial' consistency, which jointly capture a wide range of consistency knowledge and constraints about shared state in complex distributed programs. As part of prior research at Georgia Tech, I designed and built an S-DSO system, along with several consistency protocols tailored to the requirements of a distributed video game, exhibiting dynamically changing requirements regarding shared state information. The actual code and sample video game are available for download. In this research, it was shown that an S-DSO system offers improved programmability for applications using it, without sacrificing performance, compared to equivalent applications programmed with explicit message passing.

Skills:

- **Systems:** Experience with Solaris (since 1994) and Linux (since 1995). Have written software for Linux, Solaris, Irix, SunOS, Ultrix, (Sequent) Dynix, MSDOS, Windows 3.x/95/98/NT. Also designed and co-wrote the Quest operating system, along with fellow research engineer Gary Wong, for the IA-32 architecture.
- **Linux Kernel Programming:** Experience of Linux kernel programming (since 1998), including the development of my CPU schedulers (DWCS and VDS) . Currently involved in the development of service extensions for Linux to adaptively manage resources, to improve QoS for multimedia and real-time applications. This work involves language and runtime support to guarantee system stability and integrity. Further information can be found on my projects webpage: <http://www.cs.bu.edu/fac/richwest/projects.html>. Languages such as Cyclone and our own "in house" thread- and memory-safe language are being used in the development of a "QoS-safe" extensible system.
- **Miscellaneous Software Skills:** C/C++ (since 1989), Pascal, Perl, Tcl/Tk, Xlib, OpenGL, (Bourne,C) Shell Programming, (8051,80x86,68000,9900,80196) assembly, Pthreads, Solaris Threads, TCP/IP, Ethernet, ATM, and BSD Socket Programming. Also have experience in Ada, ML, Lisp, Prolog and Java.
- **X-Windows Programming:** Have used Xlib and Tcl/Tk to develop X-Windows applications including my Battle Robots video game.
- **Hardware:** Analog and digital circuit experience: microcontrollers (8051, 80196), ROM programming, amplifier and filter design. Built an ultrasonic sensor-based system for navigation of a mobile robot as part of my MEng degree. Involved the design of a 40Khz positive feedback bandpass filter, amplification and level-detection circuitry for ultrasonic transducers, H-bridge rectifiers and RS232 communications to an X86-based PC.

Grants and Awards:

- **NSF Award #0720464 (\$65000) -- CSR/EHS: The Design and Self-Organization of Component-based Systems for Dependable and Predictable Embedded Computing Environments**, PI. Effective 09/01/2007.
- **NSF #0615153 (\$150000) – CSR-EHS: Quest: A System for Application-Specific Real-Time Services**, Principal Investigator. Effective 07/01/06.
- **NSF Award #0205294 (\$1665497)-- ITR: Internet Flows as First-Class Values: Support for Dynamic, Flexible Internet Services**, Co-Principal Investigator with Azer Bestavros, Assaf Kfoury, John Byers and Ibrahim Matta. Effective 01/01/03 for 60 months.
- **NSF Research Infrastructure Award #0202067 (\$1247395)-- SENSORIUM: Research Infrastructure for Managing Spatio-Temporal Objects in Video Sensor Networks**, Co-Principal Investigator with Azer Bestavros, Margrit Betke, John Byers, Stan Sclaroff, Mark Crovella, George Kollios, Ibrahim Matta, Gene Itkis, Assaf Kfoury, Leo Reyzin and Hongwei Xi. Effective 08/01/02 for 60 months.
- **IEE-Approved Industry Studentship** (1987-1991). Full academic funding for four years, plus two-year industrial placement in all divisions of an OEM.
- **SERC/EPSRC British Studentship for Overseas Study** (1994-1997). Awarded to prospective PhD students with outstanding academic achievements in engineering and science at the Bachelors and Masters level.

Patents:

- **Thread Compensation for Microarchitectural Contention**, Richard West, Puneet Zaroo, Carl Waldspurger and Xiao Zhang. Filed with the USPTO, August 28, 2009

- **Online Computation of Cache Occupancy and Performance**, Richard West, Puneet Zaroo, Carl Waldspurger, Xiao Zhang and Haoqiang Zheng. Filed with the USPTO, October 14, 2008

Refereed Papers:

1. Scott Brandt, Chris Gill and Richard West, "**Virtual Platform Synthesis for Cyber-Physical Systems**", in CPS Week 2009 Workshop on Mixed Criticality (hosted by the 15th IEEE Real-Time and Embedded Technology and Applications Symposium)
2. Richard West and Gabriel Parmer, "**Software Architecture Challenges and Requirements for Transportation Cyber-Physical Systems**", in the National Workshop for Research on High-Confidence Transportation Cyber-Physical Systems: Automotive, Aviation and Rail, November 18-20, 2008, Washington DC
3. Gabriel Parmer and Richard West, "**Predictable Interrupt Management and Scheduling in the Composite Component-based System**", in Proceedings of the 29th IEEE Real-Time Systems Symposium (RTSS), Barcelona, Spain, 1-3 December 2008
4. Gabriel Parmer and Richard West, "**Mutable Protection Domains: Towards a Component-based System for Dependable and Predictable Computing**", in Proceedings of the 28th IEEE Real-Time Systems Symposium (RTSS), 3-6 December 2007, Tucson Arizona, USA
5. Richard West and Gabriel Parmer, "**Revisiting the Design of Systems for High-Confidence Embedded and Cyber-Physical Computing Environments**", position paper at the NSF Cyber-Physical Systems workshop, Arlington, VA, July 2007
6. Gabriel Parmer, Richard West and Gerald Fry, "**Scalable Overlay Multicast Tree Construction for Media Streaming**", in Proceedings of the International Conference on Parallel and Distributed Processing Techniques and Applications (PDPTA'07), June 2007
7. Gerald Fry and Richard West, "**On the Integration of Real-Time Asynchronous Event Handling Mechanisms with Existing Operating System Services**", in Proceedings of the International Conference on Embedded Systems and Applications (ESA'07), June 2007
8. Richard West and Yuting Zhang, "**Comments on Window-Constrained Scheduling**", in IEEE Transactions on Computers, Vol 56, Number 5, pp. 718-719, May 2007
9. Gabriel Parmer and Richard West, "**Hijack: Taking Control of COTS Systems for Real-Time User-Level Services**", in Proceedings of the 13th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS), Bellevue, WA, April 2007
10. Richard West and Gabriel Parmer, "**A Software Architecture for Next-Generation Cyber-Physical Systems**", position paper at the NSF Cyber-Physical Systems workshop, Austin Texas, October 2006
11. Yuting Zhang and Richard West, "**Process-Aware Interrupt Scheduling and Accounting**", in Proceedings of the 27th IEEE Real-Time Systems Symposium (RTSS), December 2006
12. Richard West and Gabriel Parmer, "**Application-Specific Service Technologies for Commodity Operating Systems in Real-Time Environments**", accepted for publication in an upcoming ACM Transactions on Embedded Computing Systems. This is an extended version of the RTAS 2006 paper below.
13. Richard West and Gabriel Parmer, "**Application-Specific Service Technologies for Commodity Operating Systems in Real-Time Environments**", in Proceedings of the 12th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS 2006), April 2006 (**Best Paper Award**)
14. Richard West and Gary Wong, "**Cuckoo: a Language for Implementing Memory- and Thread-safe System Services**", in Proceedings of the International Conference on Programming Languages and Compilers (PLC'05), June 2005
15. Richard West, Gary Wong and Gerald Fry, "**Comparison of k-ary n-cube and de Bruijn Overlays in QoS-constrained Multicast Applications**", in Proceedings of the International Conference of Parallel and Distributed Computing and Applications (PDPTA'05), June 2005
16. Yuting Zhang, Azer Bestavros, Mina Guirguis, Ibrahim Matta and Richard West, "**Friendly Virtual Machines: Leveraging a Feedback-Control Model for Application Adaptation**", (to appear) in Proceedings of the 1st ACM/USENIX Conference on Virtual Execution Environments (VEE'05), June 2005

17. Yuting Zhang, Richard West and Xin Qi, "**A Virtual Deadline Scheduler for Window-Constrained Service Guarantees**", in Proceedings of the 25th IEEE Real-Time Systems Symposium (RTSS), December 2004
18. Xin Qi, Gabriel Parmer and Richard West, "**An Efficient End-host Architecture for Cluster Communication Services**", in Proceedings of the IEEE International Conference on Cluster Computing (Cluster '04), September 2004
19. Yuting Zhang and Richard West, "**End-to-end Window-Constrained Scheduling for Real-Time Communication**", in Proceedings of the 10th International Conference on Real-Time and Embedded Computing Systems and Applications (RTCSA'04), August 2004
20. Gerald Fry and Richard West, "**Dynamic Characteristics of k-ary n-cube Networks for Real-time Communication**", in Proceedings of the 5th International Conference on Communications in Computing (CIC'04), 2004
21. Gabriel Parmer, Richard West, Xin Qi, Gerald Fry and Yuting Zhang, "**An Internet-wide Distributed System for Data-stream Processing**", in Proceedings of the 5th International Conference on Internet Computing (IC'04), 2004
22. Raj Krishnamurthy, Sudhakar Yalamanchili, Karsten Schwan and Richard West, "**ShareStreams: A Scalable Architecture and Hardware Support for High-Speed QoS Packet Schedulers**", in Proceedings of the 12th IEEE Symposium on Field-Programmable Custom Computing Machines (FCCM), 2004
23. Gerald Fry and Richard West, "**Adaptive Routing of QoS-constrained Media Streams over Scalable Overlay Topologies**", in Proceedings of the 10th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS), 2004
24. Richard West, Yuting Zhang, Karsten Schwan and Christian Poellabauer, "**Dynamic Window-Constrained Scheduling of Real-Time Streams in Media Servers**", IEEE Transactions on Computers, Volume 53, Number 6, pp. 744-759, June 2004
25. Gerald Fry and Richard West, "**Adaptive Routing of QoS-constrained Media Streams over Scalable Overlay Topologies**", IEEE Real-Time Systems Symposium, 2003 (work in progress)
26. Raj Krishnamurthy, Karsten Schwan, Richard West and Marcel Rosu, "**On Network Coprocessors for Scalable, Predictable Media Services**", IEEE Transactions on Parallel and Distributed Systems (TPDS), Volume 14, Number 7, pp. 655-670, July 2003
27. Raj Krishnamurthy, Sudhakar Yalamanchili, Karsten Schwan and Richard West, "**Leveraging Block Decisions and Aggregation in the ShareStreams QoS Architecture**", in Proceedings of the International Conference of Parallel and Distributed Systems (IPDPS), Nice, France, 2003
28. Hasan Abbasi, Christian Poellabauer, Gregory Losik, Karsten Schwan and Richard West, "**A Quality-of-Service Enhanced Socket API in GNU/Linux**", in Proceedings of the 4th Real-Time Linux Workshop, Boston, Massachusetts, December 2002
29. Raj Krishnamurthy, Sudhakar Yalamanchili, Karsten Schwan and Richard West, "**Architecture and Hardware for Scheduling Gigabit Packet Streams**", in Proceedings of the IEEE Symposium on High Performance Interconnects (Hot Interconnects 10), August 2002
30. Richard West and Jason Gloudon, "**'QoS Safe' Kernel Extensions for Real-Time Resource Management**", in the 14th EuroMicro International Conference on Real-Time Systems, June 2002
31. Richard West, Ivan Ganev and Karsten Schwan, "**Window-Constrained Process Scheduling for Linux Systems**", in Proceedings of the 3rd Real-Time Linux Workshop, Milan, Italy, November 2001
32. Christian Poellabauer, Karsten Schwan and Richard West, "**Coordinated CPU and Event Scheduling for Distributed Multimedia Applications**", in Proceedings of the 9th ACM Multimedia Conference (ACM SIGMM), September 2001
33. Richard West and Karsten Schwan, "**Quality Events: A Flexible Mechanism for Quality of Service Management**", in Proceedings of the 7th IEEE Real-Time Technology and Applications Symposium (RTAS), 2001
34. Christian Poellabauer, Karsten Schwan and Richard West, "**Lightweight Kernel/User Communication for Real-Time and Multimedia Applications**", in Proceedings of the 11th International Workshop on Network and Operating Systems Support for Digital Audio and Video (NOSSDAV), 2001

35. Raj Krishnamurthy, Sudhakar Yalamanchili, Richard West and Karsten Schwan, "**Architecture and Hardware Support for Real-Time Scheduling of Packet Streams**", Short paper (work-in-progress) in CD-ROM Proceedings of the IEEE Conference on High Performance Computer Architecture (HPCA-7), January 2001
36. Christian Poellabauer, Karsten Schwan, Richard West, Ivan Ganev, Neil Bright and Gregory Losik, "**Flexible User/Kernel Communication for Real-Time Applications in ELinux**", in Proceedings of the 2nd Real-Time Linux Workshop (RTLWS), 2000
37. Richard West and Christian Poellabauer, "**Analysis of a Window-Constrained Scheduler for Real-Time and Best-Effort Packet Streams**", in Proceedings of the 21st IEEE Real-Time Systems Symposium (RTSS), 2000
38. Raj Krishnamurthy, Karsten Schwan, Richard West and Marcel Rosu , "**A Network Co-processor-Based Approach to Scalable Media Streaming in Servers**", in Proceedings of the 29th Annual International Conference on Parallel Processing (ICPP), 2000
39. Richard West, Karsten Schwan and Christian Poellabauer, "**Scalable Scheduling Support for Loss and Delay Constrained Media Streams**", in Proceedings of the 5th IEEE Real-Time Technology and Applications Symposium (RTAS), 1999
40. Richard West and Karsten Schwan, "**Dynamic Window-Constrained Scheduling for Multimedia Applications**", in Proceedings of the IEEE International Conference on Multimedia Computing and Systems (ICMCS), 1999
41. Richard West, Rajaram Krishnamurthy, William Norton, Karsten Schwan, Sudhakar Yalamanchili, Marcel Rosu and Sarat Chandra Manni, "**QUIC: A Quality of Service Network Interface Layer for Communication in NOWs**", the Heterogeneous Computing Workshop (HCW), in conjunction with IPPS/SPDP, 1999
42. Richard West and Karsten Schwan, "**Interactors: Capturing QoS and Resource Requirements Between Multiple Cooperating Objects**", in the 4th IEEE Real-Time Technology and Applications Symposium (RTAS Work In Progress), 1998
43. Richard West, Karsten Schwan, Ivan Tadic and Mustaque Ahamad, "**Exploiting Temporal and Spatial Constraints on Distributed Shared Objects**", in Proceedings of the 17th IEEE International Conference on Distributed Computing Systems (ICDCS), 1997
44. Charles Allen and Richard West, "**Collision Avoidance Tests Using the Charlie Trike Vehicle**", in Proceedings of the SPIE - The International Society for Optical Engineering, vol.1825, p. 549-60, 1992

Technical Reports and Works In Progress:

45. Gabriel Parmer, Richard West and Gerald Fry, "**Scalable Overlay Multicast Tree Construction for QoS-Constrained Media Streaming**", Technical Report, 2006-020, Boston University, August 2006
46. Richard West and Gary Wong, "**Cuckoo: a Language for Implementing First-class System Services**", Technical Report, 2005-006, Boston University, February 2005
47. Richard West, Jason Gloudon, Xin Qi and Gabriel Parmer, "**An Efficient User-Level Shared Memory Mechanism for Application-Specific Extensions**", Technical Report, 2005-005, Boston University, February 2005 (revised version of Technical Report 2003-014) -- a related paper has been submitted for journal publication
48. Richard West, Gerald Fry and Gary Wong, "**Comparison of k-ary n-cube and de Bruijn Overlays in QoS-constrained Multicast Applications**", Technical Report, 2005-004, Boston University, February 2005
49. Yuting Zhang, Azer Bestavros, Mina Guirguis, Ibrahim Matta and Richard West, "**Friendly Virtual Machines: Leveraging a Feedback-Control Model for Application Adaptation**", Technical Report, 2004-030, Boston University, July 2004
50. Yuting Zhang, Richard West and Xin Qi, "**A Virtual Deadline Scheduler for Window-Constrained Service Guarantees**", Technical Report, 2004-013, Boston University, March 2004
51. Xin Qi, Gabriel Parmer, Richard West, Jason Gloudon and Luis Hernandez, "**Efficient End-Host Architecture for High Performance Communication using User-Level Sandboxing**", Technical Report, 2004-009, Boston University, March 2004

52. Gerald Fry and Richard West, "**Adaptive Routing of QoS-constrained Media Streams over Scalable Overlay Topologies**", Technical Report, 2003-020, Boston University, November 2003
53. Richard West and Jason Gloudon, "**User-Level Sandboxing: a Safe and Efficient Mechanism for Extensibility**", Technical Report, 2003-014, Boston University, June 2003
54. Richard West, Karsten Schwan and Christian Poellabauer, "**Dynamic Window-Constrained Scheduling for Real-Time Media Streaming**", Technical Report, 2003-019, Boston University, August 2003
55. Raj Krishnamurthy, Sudhakar Yalamanchili, Karsten Schwan and Richard West, "**ShareStreams: A Scalable Architecture and Hardware Support for High-Speed QoS Packet Schedulers**", Technical Report, NSF/DOE Active Systems Area Networks, 2002
56. Raj Krishnamurthy, Sudhakar Yalamanchili, Karsten Schwan and Richard West, "**RASA (Reconfigurable Architectures for Scheduling Activities) Architecture and Hardware for Scheduling Gigabit Packet Streams**", Technical Report, GIT-CC-02-39, Georgia Institute of Technology, 2002
57. Christian Poellabauer, Karsten Schwan and Richard West, "**Coordinated CPU and Event Scheduling for Distributed Multimedia Applications**", Technical Report, GIT-CC-01-05, Georgia Institute of Technology, 2001
58. Christian Poellabauer, Karsten Schwan and Richard West, "**Flexible Event Delivery for Kernel Extensions in ELinux**", Technical Report, GIT-CC-00-36, Georgia Institute of Technology, 2000
59. Richard West and Christian Poellabauer, "**Analysis of a Window-Constrained Scheduler for Real-Time and Best-Effort Packet Streams**", Technical Report, GIT-CC-00-20, Georgia Institute of Technology, 2000
60. Richard West, Rajaram Krishnamurthy, William Norton, Karsten Schwan, Sudhakar Yalamanchili, Marcel Rosu and Sarat Chandra Manni, "**QUIC: A Quality of Service Network Interface Layer for Communication in NOWs**", Technical Report, GIT-CC-00-08, Georgia Institute of Technology, 2000
61. Raj Krishnamurthy, Karsten Schwan, Richard West and Marcel Rosu, "**A Network Co-processor-Based Approach to Scalable Media Streaming in Servers**", Technical Report, GIT-CC-00-03, Georgia Institute of Technology, 2000
62. Richard West and Karsten Schwan, "**Experimentation with Event-Based Methods of Adaptive Quality of Service Management**", Technical Report, GIT-CC-99-25, Georgia Institute of Technology, 1999
63. Richard West and Christian Poellabauer, "**An Optimal, On-Line Window-Constrained Scheduler for Real-Time, Heterogeneous Activities**", Technical Report, GIT-CC-99-11, Georgia Institute of Technology, 1999-- NOTE: This paper has been revised and presented in a network-oriented manner (see GIT-CC-00-20)
64. Richard West, Karsten Schwan and Christian Poellabauer, "**Scalable Scheduling Support for Loss and Delay Constrained Media Streams**", Technical Report, GIT-CC-98-29, Georgia Institute of Technology, 1998
65. Richard West and Karsten Schwan, "**Dynamic Window-Constrained Scheduling for Multimedia Applications**", Technical Report, GIT-CC-98-18, Georgia Institute of Technology, 1998
66. Richard West and Karsten Schwan, "**Interactors: Capturing Tradeoffs in Bandwidth versus CPU Usage for Quality of Service Constrained Objects**", Technical Report, GIT-CC-98-03, Georgia Institute of Technology, 1998
67. Richard West, Karsten Schwan, Ivan Tadic and Mustaque Ahamad, "**Exploiting Temporal and Spatial Constraints on Distributed Shared Objects**", Technical Report, GIT-CC-96-36, Georgia Institute of Technology, 1996

Theses:

68. Richard West, "**Adaptive Real-Time Management of Communication and Computation Resources**", PhD Thesis, College of Computing, Georgia Institute of Technology, August 2000
69. Richard West, "**Collision Avoidance for a Mobile Robot Using Ultrasound**", Master's Thesis, Electrical Engineering Department, University of Newcastle-upon-Tyne, England, June 1991

Selected Presentations:

- **Virtual Platform Synthesis for Cyber-Physical Systems**, CPS Week 2009 Workshop on Mixed Criticality, April 13-16, 2009, San Francisco, CA, USA
- **Predictable Interrupt Management and Scheduling in the Composite Component-based System**, 29th IEEE Real-Time Systems Symposium (RTSS), Barcelona, Spain, 1-3 December 2008
- **Towards the Design of Dependable and Predictable Systems**, Washington University in St Louis, November 14, 2008
- **Designing Systems for Dependability and Predictability**, University of Newcastle-upon-Tyne, UK, January 2008
- **Mutable Protection Domains: Towards a Component-based System for Dependable and Predictable Computing**, 28th IEEE Real-Time Systems Symposium (RTSS), 3-6 December 2007, Tucson Arizona, USA
- **Hijack: Taking Control of COTS Systems for Real-Time User-Level Services**, 13th IEEE Real-Time and Embedded Technology and Applications Symposium, April 2007
- **Process-aware Interrupt Scheduling and Accounting**, 27th IEEE Real-Time Systems Symposium (RTSS), December 2006
- **OS / Middleware for Cyber-Physical Systems**, NSF Panel Meeting, Arlington, VA, July 28, 2006
- **Hijack: Taking Control of COTS Systems to Enforce Predictable Service Guarantees**, VMware, Cambridge, MA, June 2006
- **Application-Specific Service Technologies for Commodity Operating Systems in Real-Time Environments**, 12th IEEE Real-Time and Embedded Technology and Applications Symposium, April 2006
- **Cuckoo: a Language for Implementing Memory- and Thread-safe System Services**, International Conference on Programming Languages and Compilers (PLC'05), June 2005
- **Comparison of k-ary n-cube and de Bruijn Overlays in QoS-constrained Multicast Applications**, International Conference of Parallel and Distributed Computing and Applications (PDPTA'05), June 2005
- **A Virtual Deadline Scheduler for Window-Constrained Service Guarantees**, 25th IEEE Real-Time Systems Symposium (RTSS), December 2004
- **An Efficient End-host Architecture for Cluster Communication Services**, IEEE International Conference on Cluster Computing (Cluster '04), September 2004
- **End-to-end Window-Constrained Scheduling for Real-Time Communication**, 10th International Conference on Real-Time and Embedded Computing Systems and Applications (RTCSA'04), August 2004
- **Dynamic Characteristics of k-ary n-cube Networks for Real-time Communication**, 5th International Conference on Communications in Computing (CIC'04), June 2004
- **An Internet-wide Distributed System for Data-stream Processing**, 5th International Conference on Internet Computing (IC'04), June 2004
- **Adaptive Routing of QoS-constrained Media Streams over Scalable Overlay Topologies**, 10th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS), May 2004
- **Towards an Internet-wide Distributed System for Media Stream Processing and Delivery**, University of Newcastle-upon-Tyne, England, February 12, 2004
- **'QoS Safe' Kernel Extensions for Real-Time Resource Management**, 14th EuroMicro International Conference on Real-Time Systems, June 2002
- **Window-Constrained Process Scheduling for Linux Systems**, Third Real-Time Linux Workshop, Milan, Italy, November 2001

- **Quality Events: A Flexible Mechanism for Quality of Service Management**, 7th IEEE Real-Time Technology and Applications Symposium (RTAS), 2001
- **Adaptive Real-Time Management of Communication and Computation Resources**, Compaq Computer Corporation, Nashua, NH, May 22, 2001
- **Analysis of a Window-Constrained Scheduler for Real-Time and Best-Effort Packet Streams**, 21st IEEE Real-Time Systems Symposium, 2000
- **Scalable Scheduling Support for Loss and Delay Constrained Media Streams**, Fifth IEEE Real-Time Technology and Applications Symposium, 1999
- **Dynamic Window-Constrained Scheduling for Multimedia Applications**, IEEE International Conference on Multimedia Computing and Systems, 1999
- **Exploiting Temporal and Spatial Constraints on Distributed Shared Objects**, 17th IEEE International Conference on Distributed Computing Systems, 1997
- Other presentations have been given at various research establishments, including Brown University, University of Pennsylvania, Ohio State University, Johns Hopkins University, and the University of Rochester.

Doctoral Students Advised:

- **Gabriel Parmer**, Ph.D. Thesis defended July 2009.
- **Yuting Zhang**, Ph.D. thesis defended August 2006.
- **Gerald Fry**
- **Ye Li**
- **Mehaben Mehta**
- **Xin Qi**
- **Junfeng Zou**

Doctoral Students, Examining Committee Member:

- **Gabriel Parmer**, Ph.D., Dissertation defense July 2009, “Toward a Dependable and Predictable Component-Based Operating System for Application-Specific Extensibility”, BU Computer Science Department – Advisor/First Reader.
- **Michael Ocean**, Ph.D., Dissertation defense July 2008, “*The Sensor Network Workbench: Towards Functional Specification, Verification and Deployment of Constrained Distributed Systems*”, BU Computer Science Department --Committee Chair.
- **Hany Morcos**, Ph.D., Dissertation defense July 2008 -- Third Reader.
- **Yuting Zhang**, Ph.D., Dissertation defense August 2006, “Window-Constrained Resource Management for Soft Real-Time Applications”, BU Computer Science Department -- Advisor/First Reader.
- **Adam Bradley**, Ph.D., Dissertation defense September 2004, “*A Type-Disciplined Approach to Developing Resources and Applications for the World-Wide Web*”, B.U. Computer Science Department -- Third Reader.
- **Mina Guirguis**, Ph.D., Oral Exam June 2004, “*Dynamics of Network Resource Management*” -- Committee Member.

Masters Students Advised:

- **Luis Hernandez**, M.A. Spring 2004: “*Adding SMP Support to User-Level Sandboxing, and Removing the Requirement for Recompile*”.
- **Daniel Levin**, M.A. Spring 2004: “*Implementation Details of a Scalable, QoS-constrained Overlay Network*”.
- **SuYan Zheng**, M.A. Fall 2003: “*QoS-constrained Media Streams Over k-ary n-cube Networks*”.

- **Jason Gloudon**, postponed degree while working for Revahertz.

Senior Honors Theses Supervised:

- **Raj Ashar**, January-December 2001, "*Applying Classical Control-Theoretic Techniques to Perform On-line Stability Analysis of Adaptive Systems*", B.U. Computer Science Department.

Departmental Services:

- Lab Operations Co-Officer, Fall 2005-Fall 2007.
 - Responsible for budgetary issues relating to departmental computing infrastructure needs and also management of system administration staff.
- Member, Computer Science Faculty Search Committee, 2002, 2005, 2006 and 2007.
- Equipment Chair for Research Laboratory purchases, Fall 2003-present.
- BU Operating Systems and Services Group Organizer, Fall 2000-present.
- Recruiter for Sensorium Research Engineering position, Fall 2003.
- Organizer of the 4th Real-Time Linux Workshop on BU's campus, December 2002.

Further details can be found on my website at:

<http://www.cs.bu.edu/fac/richwest/>
