

# Richard West

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Professor  
Computer Science Department  
111 Cummington Street  
Boston, MA 02215  
+1 617-353-2065  
[richwest@cs.bu.edu](mailto:richwest@cs.bu.edu)  
<http://www.cs.bu.edu/fac/richwest/>  
Senior Member IEEE

## Research Interests:

- Real-time and embedded systems, operating systems, kernels, resource management, hardware-software interaction, distributed computing, machine virtualization
- Side interests include safety-critical systems and robotics

## 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 Honours, June 1991*
  - Masters project: "Collision Avoidance for a Mobile Robot Using Ultrasound"

## Experience:

- **Chief Software Architect**, Drako Motors (August 2017-present).
- **Professor**, Boston University, Boston, MA (February 2017-present).
- **Associate Professor**, Boston University, Boston, MA (September 2006-January 2017).
- **Advanced Research Engineer**, VMware, Inc., Cambridge, MA (August 2008-December 2011).
- **Scholar-in-Residence**, VMware, Inc., Cambridge, MA (June 2007-June 2008).
- **Assistant Professor**, Boston University, Boston, MA (September 2000-August 2006).
- **Lab Operations Officer/Director**, Boston University, (September 2005-June 2007, and again from July 1, 2013-June 30, 2020). 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.

- **Electronics 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:

- IEEE Technical Committee on Real-Time Systems, Industry Outreach Subcommittee member, January 2024-present.
- IEEE Technical Committee on Real-Time Systems, Diversity Subcommittee member, January 2022-December 2023.
- Program Committee member for the 16<sup>th</sup> Annual Workshop on Operating Systems Platforms for Embedded Real-Time Applications (OSPERT), Modena, Italy, July 5, 2022, Co-located with ECRTS 2022 (Resumed after cancellation in 2020 due to Covid).
- Program Committee member for the ACM SIGBED International Conference on Embedded Software (EMSOFT), 2021 (Virtual Conference).
- Associate Editor, Real-Time Systems, The International Journal of Time-Critical Computing Systems, Springer, January 2021-present.
- Program Committee member for the 41st IEEE Real-Time Systems Symposium (RTSS), Houston, Texas, USA, December 1-4, 2020.
- Program Committee member for the 16th Annual Workshop on Operating Systems Platforms for Embedded Real-Time Applications (OSPERT), Modena, Italy, July 7, 2020, Co-located with ECRTS 2020 (Canceled due to Covid).
- Program Committee member for the 40th IEEE Real-Time Systems Symposium (RTSS), Hong Kong, China, December 3-6, 2019.
- Program Committee member for the 15th Annual Workshop on Operating Systems Platforms for Embedded Real-Time Applications (OSPERT), Stuttgart, Germany, July 9, 2019. Co-located with ECRTS 2019.
- Program Committee member for the 25th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS), Montreal, Canada, April 16-18, 2019.
- Program Committee member for the 39th IEEE Real-Time Systems Symposium (RTSS), Nashville, Tennessee, December 11-14, 2018.
- IEEE Technical Committee on Real-Time Systems, Conference Planning Subcommittee member, 2018-2021.
- Program Committee member for the 24th IEEE International Conference on Embedded and Real-Time Computing Systems and Applications (RTCSA), Hakodate, Japan, August 28-31, 2018.
- Program Committee member for the The 14th IEEE International Conference on Embedded Software and Systems (IEEE ICES-17), Sydney, Australia, August 1-4, 2017 (Systems, Models and Algorithms Track).
- Program Committee member for the 13<sup>th</sup> Annual Workshop on Operating Systems Platforms for Embedded Real-Time Applications (OSPERT), Dubrovnik, Croatia, June 27, 2017.
- Program Committee member for the 23rd IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS), Pittsburgh, PA, April 18-21, 2017.
- Program Committee member for the 12<sup>th</sup> Annual Workshop on Operating Systems Platforms for Embedded Real-Time Applications (OSPERT), Toulouse, France, July 5, 2016.
- Program Committee member for the 22nd IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS), Vienna, Austria, April 11-14, 2016.
- Program Committee member for the 11th Annual Workshop on Operating Systems Platforms for Embedded Real-Time Applications (OSPERT), Lund, Sweden, July 7, 2015.
- General Chair for the 21st IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS), Seattle, Washington, April, 2015.
- Program Committee member for the 40th EUROMICRO Conference on Software Engineering and Advanced Applications (SEAA), Verona, Italy, August 27-29, 2014.
- Program Chair for the 20th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS), Berlin, Germany, April 15-17, 2014.

- Program Committee member for the 34th IEEE Real-Time Systems Symposium (RTSS), Vancouver, Canada, December 3-6, 2013.
- Program Committee member for the 9th Annual Workshop on Operating Systems Platforms for Embedded Real-Time Applications (OSPERT), Paris, France, July 9, 2013.
- Program Committee member for the 39th EUROMICRO Conference on Software Engineering and Advanced Applications, Embedded Software Engineering track, Santander, Spain, September 4-6, 2013.
- Guest Editor, ACM Transactions on Embedded Computing Systems, Special Issue on Real-Time and Embedded Technology and Applications, 2012-2013.
- Program Committee member for the 33<sup>rd</sup> IEEE Real-Time Systems Symposium (RTSS), San Juan, Puerto Rico, December 4-7, 2012.
- Program Committee member for the Embedded Software Engineering (ESE) track at the 38th EUROMICRO Conference on Software Engineering and Advanced applications (SEAA), Cesme-Izmir, Turkey, September 5-8, 2012.
- Track Chair, "Applications, Systems, RTOSs and Tools", for the 18th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS), Beijing, China, April 2012.
- Program Committee member for the 15th IEEE International Symposium on Object and Component-oriented Real-time Distributed Computing (ISORC), Shenzhen, China, April 11-13, 2012.
- Program Committee member for the USENIX Annual Technical Conference, Portland, Oregon, USA, June 15-17, 2011.
- Program Committee member for the 17th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS), Chicago, USA, April 11-14, 2011.
- 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 29<sup>th</sup> 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 20<sup>th</sup> 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 13<sup>th</sup> IEEE International Conference on Embedded and Real-Time Computing Systems and Applications (RTCSA), August 2007, Daegu, Korea.
- Program Committee member for the 19<sup>th</sup> IEEE Euromicro Conference on Real-Time Systems (ECRTS), July 2007, Pisa, Italy.
- Program Area Chair for the 13<sup>th</sup> IEEE Real-Time and Embedded Technology and Applications Symposium (Real-Time and Embedded Applications/Benchmarks Area), 2007, Bellevue, Washington.
- Program Committee member for the 27<sup>th</sup> 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 11<sup>th</sup> 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), CAREER (2009), Embedded and Hybrid Systems (2004), ACR Software Systems (2003), ITR Small Software Systems (2002), and Embedded and Hybrid Systems (2002).

### **Departmental and University Services:**

- BU CAS Appointment, Promotion and Tenure (APT) Committee, September 2019-August 2021. Responsible for evaluating tenure and full professor candidates in Boston University College of Arts and Sciences. Worked with 3-member subcommittees to write college reports based on candidate teaching, research and service record, as evidenced by candidate materials, department chair's report, and external evaluation letters.
- BU CS Member, Faculty Annual Review (FAR) Committee, Spring 2020.
- BU CS Chair, Faculty Annual Review (FAR) Committee, Spring 2019.
- Lab Director, BU CS Department, AY 2013-2020. Responsible for overseeing departmental computing needs, and day-to-day management of IT infrastructure, in consultation with the system administration staff.
- BU CS Chair Search Committee member, Fall 2017.
- University Council Committee on Curriculum and Degrees (UCCCD), AY 2013-2014.
- Chair, Natural Sciences Curriculum Committee, College of Arts and Sciences, Boston University, AY 2011-2012 and AY 2012-2013.
- Natural Sciences Curriculum Committee, College of Arts and Sciences, Boston University, AY 2010-2011.
- CS697, Graduate Seminar facilitator, Spring 2009-2015. Designed course to meet the NSF/NIH Responsible Conduct of Research (RCR) requirement for all federally-funded research assistants.
- Academic Conduct Committee, College of Arts and Sciences, Boston University, AY 2006-2007.
- 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, 2005-2007, 2009, 2014 and 2016.
- ECE Faculty Search External Member, 2010-2012.
- Equipment Chair for Research Laboratory purchases, Fall 2003-Fall 2007.
- BU Operating Systems and Services Group Organizer, Fall 2000-present.

- Recruiter for Sensorium Research Engineering position, Fall 2003.
- Organizer of the 4<sup>th</sup> Real-Time Linux Workshop on BU's campus, December 2002.

## Teaching and Research Group Activities:

- Taught 40+ semester-length courses in Boston University's Computer Science Department. A semester is approximately 14 weeks, or 42 hours of lecture time per course. Some courses require additional lab time of 2-3 hours per week, although this time is often managed by teaching assistants rather than the primary instructor.

Courses taught include the following:

- BU CS552 "Operating Systems". This is predominantly an introductory course in OS concepts, including process and thread management, scheduling, synchronization, memory management, filesystems and I/O device management. The course is heavily focused on programming projects. The Linux kernel is used extensively for programming projects, as well as my own operating system called "Quest". Past Linux-based assignments have involved the development of a UNIX-style RAMDISK filesystem, and a streaming video server that requires users to develop their own synchronization primitives within the Linux kernel. Smaller projects have required students to develop new scheduling policies such as earliest deadline first (EDF), fair queueing (FQ), or those based on my own research (e.g., Dynamic Window Constrained Scheduling or Virtual CPU Scheduling). Other systems projects taught in CS552 have required students to use virtualization tools such as BOCHS, QEMU, VMware Workstation, or Oracle VirtualBox to develop standalone operating systems, targeted primarily at the x86 architecture. Here, students are expected to write or use bootloaders such as GRUB to probe for the availability of physical memory and I/O devices, so that these can be managed by their system.
- BU CS410 "Advanced Software Systems". This is a senior undergraduate course that focuses primarily on (UNIX) systems programming. File I/O, libraries, linkers, loaders, system calls, processes, thread management, sockets, IPC, signals, and shell programming are all covered in this class. As with CS552, the course is focused on a "learning by doing" principle. Example assignments include: (1) a recursive filesystem tree walking algorithm to search for regular expression patterns in files, similar to how a recursive grep routine might work, (2) development of shared and static libraries to implement binary utilities for examining various object files (e.g., ELF), (3) an operating system shell environment, (4) the development of a portable thread library, and (5) the implementation of a simple debugger using process tracing techniques.
- BU CS210 "Computer Systems". This second year undergraduate course covers the structure and organization of computer systems, the design and implementation of abstractions that enable humans to use computers efficiently, the basics of assembly programming, how to translate between assembly and machine language, how it is possible to build a machine that executes instructions, and the various interfaces between processors, memory, peripherals, and operating system software. Former projects include the development of an ALU, a simplified MIPS-style processor (using Altera design tools), assembly programming assignments such as the Eight Queens problem, and C-style malloc and free heap memory management routines.
- BU CS350 "Fundamentals of Computing Systems". This course is a required sophomore/junior-level Computer Science course. Topics covered in the course include performance analysis and evaluation, scheduling, resource management, concurrency and synchronization. While this course has several programming assignments, it is more mathematically focused than the above courses,

covering topics in probability and statistics, queueing theory, scheduling algorithms and their analysis.

- BU CS212 "Physical Computing". This was a pilot undergraduate course, to introduce students to programming. The course centers around the use of Arduinos and other types of embedded programming platforms, such as the ARM-based Beagleboard. Using sensors and actuators, students tackle a series of programming assignments that culminated in team projects using small mobile robots to solve problems such as finding paths through mazes.
- BU CS553 "Advanced Operating Systems". This is a graduate-level course, taking the form of a seminar. Students are involved in presenting research papers and developing independent study problems relating to operating systems.

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- Created a new course on physical computing using embedded devices such as Arduinos, along with sensors and actuators. The course was aimed at undergraduates, and emphasized a practical approach to learning to program embedded devices.
- 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://bossbucs.wordpress.com/>.

## Research Contributions:

- **SmartPrint3D** – Currently developing a 3D printer test application for Quest/Qduino. With support from Intel, this project involves the development of a Minnowboard Max and Edison-based 3D printer controller, capable of running a real-time OS such as Quest. Extensions to the Qduino API running on Quest will leverage multicore processing capabilities to support “smart” print processing, including the acceptance and verification of print requests via a webserver while the current job is in progress.
- **Qduino/QduinoMC** – This is an extension of the Arduino API, which is widely used in physical computing domains because of its ease of use and rapid prototyping capabilities. Traditional Arduino devices have been based on MegaAVR microcontrollers from Atmel, which lack memory management (MMU) or protection (MPU) units. More sophisticated devices such as the Intel Galileo, and Raspberry Pi support feature-rich operating systems such as Linux, but most of these are not designed for use in real-time systems. Qduino is built on Quest and provides ease of programming of real-time (multi-threaded) loops. Qduino supports real-time communication between loop threads, as well as predictable I/O processing. QduinoMC adds API calls to support multicore processors.
- **Quest(-V)** – Developed new operating system called “Quest” (and its virtualized counterpart, called “Quest-V”) 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. Quest works on the Intel IA32 family of processors and includes a libc port of newlib. The aim is to use Quest in research on system structure and extensibility, especially for embedded applications with real-time requirements. The system includes a novel virtual CPU (VCPU) scheduling infrastructure, along with support for hardware virtualization to sandbox potentially faulty software components. See [www.questos.org](http://www.questos.org) for more details.

- **RacerX** – Real-time control and autonomous management of high-speed mobile robots. The pilot stages of this project have focused on the use of Arduino-based Atmel ATmega microcontroller boards for analog/digital I/O, Pololu serial servo controllers, and ATOM-based netbook computer control to support real-time record/replay missions of vehicles up to speeds of 30mph. Early investigations include the use of sensors (cameras, GPS, accelerometers, etc) to adapt vehicle trajectory and speed as it interacts with the environment.
- **Composite** – Developed 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)** – Developed 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.
- **Osmosis: a Scalable System for Stream Processing** – Developed 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. Work on this project included the implementation of a 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** – 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.
- **Operating System Design and Implementation:** I designed the Quest operating system for the IA-32 architecture. This has been an ongoing project since 2005, and the code development has now been taken over by my students after I wrote the first version.
- **Linux Kernel Programming:** Experience of Linux kernel programming (since 1998), including the development of my CPU schedulers (DWCS and VDS). Work in this area includes the development of service extensions for Linux to adaptively manage resources, to improve QoS for multimedia and real-time applications. Related work includes the development of language and runtime support to guarantee system stability and integrity. Further information can be found at: <http://www.cs.bu.edu/fac/richwest/projects.html>. Languages such as Cyclone and our own "in house" thread- and memory-safe language have been used in the development of a "QoS-safe" extensible system.
- **Android/Arduino Programming:** I developed an application using an accelerometer and touch screen input, to manage the motor controller and steering servos on a mobile robot. The robot was based on a radio-controlled vehicle, with a laptop mounted on-board. The laptop received wireless signals from an Android device (using TCP sockets), and then translated these commands into serial data for communication to an Arduino device. The Arduino device could then manage the digital outputs for steering and motor speed control. This is part of my **RacerX** project, to develop a real-time, autonomous control system for high-speed vehicles equipped with cameras and other sensors such as laser range finders and GPS devices.
- **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:** I 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 #2151021 (\$150,000) – Collaborative Research: EAGER: Real-time Strategies and Synchronized Time Distribution Mechanisms for Enhanced Exascale Performance-Portability and Predictability**, co-PI with Martin Herbordt (BU Electrical and Computer Engineering). Effective 06/01/2022.
- †**NSF Award #2007707 (\$497,693) – CNS Core: Small: Boomerang: A Symbiotic Software Architecture for Real-Time Distributed Embedded Systems**, PI. Effective 10/01/2020.
- †**Drako Motors Gift (\$160,000)** – PI. Effective June 2019.
- †**Drako Motors Gift (\$118,000)** – PI. Effective August 2017.
- †**Intel Gift (\$225,000) – Quest-V: A Secure and Predictable System for IoT**, PI. Effective Fall 2015 (\$75,000/yr for 3 yrs).
- **Boston University Digital Health Initiative (DHI) Research Award # 2017-02-002 (\$33,450) -- Leveraging Smart Phone Sensing Technology to Identify Social Isolation in Mental Illness**, co-PI with Daniel Fulford (Sargent College of Health and Rehabilitation Sciences) and Yuting Zhang (BU Metropolitan College). Effective June 16, 2017-June 15, 2019.
- **Boston University Hariri Institute Research Award (\$30,000) – Interdisciplinary Development of a Biokinematic Data Acquisition System**, PI with fellow investigators Sheryl Grace (Mechanical Engineering) and Cara Lewis (Health and Rehabilitation Sciences). Effective Spring 2016.
- †**NSF Award #1527050 (\$450,000) – CSR: Small: A Separation Kernel for Mixed Criticality Systems**, PI. Effective 10/01/2015-09/30/2019.
- ‡**AFOSR STTR Subcontract, Charles River Analytics (\$341,656) – SCIF Phase II: Secure Networks Through Isolation of Components Framework**, BU PI. Effective 09/18/12-09/17/14.
- †**NSF Award #1117025 (\$400,000) – CSR: Small: Quest: A Real-Time Operating System for Multicore Processors**, PI. Effective 08/15/11-07/31/2015.
- ‡**ONR STTR Subcontract, Charles River Analytics (\$70,000) – ADOS: Artificially Diverse Operating System**, BU PI. Effective 06/27/2011-04/27/2012.
- ‡**AFOSR/AFRL STTR Subcontract, Charles River Analytics (\$40,000) – SCIF: Secure Networks Through Isolation of Components Framework**, BU PI. Effective 04/21/2011-03/5/2012.
- ‡**AFRL SBIR Subcontract, Charles River Analytics (\$20,000) – ARMAND: Optimized Data Routing and Fusion**, BU PI. Effective 01/5/2011-11/6/2011.
- ‡**DARPA SBIR Phase II Subcontract, Charles River Analytics (\$100,000): Modular Affective Reasoning-based Versatile Introspective Architecture (MARVIN)**, BU PI. Effective 08/01/2009.
- †**NSF Award #0720464 (\$65,000) – CSR/EHS: The Design and Self-Organization of Component-based Systems for Dependable and Predictable Embedded Computing Environments**, PI. Effective 09/01/2007.
- †**NSF Award #0615153 (\$150,000) – CSR-EHS: Quest: A System for Application-Specific Real-Time Services**, Principal Investigator. Effective 07/01/06.
- **NSF Award #0205294 (\$1,665,497) – 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 (\$1,247,395) – 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.

† Indicates awards for which I was/am the sole Principal Investigator.

‡ Indicates awards for which I was/am the sole Boston University Principal Investigator.

I received 100% of the funding amount (in brackets) for all awards on which I was the PI.

## Patents:

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- **Thread Compensation for Microarchitectural Contention**, Richard West, Puneet Zaroo, Carl Waldspurger and Xiao Zhang. Filed with the USPTO, August 28, 2009. United States Patent Number US201100554791A1, March 3, 2011.

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4. Po-Han Chen, Pouta Haghi, Jae Yoon Chung, Tong Geng, Richard West, Anthony Skjellum and Martin Herboldt, **“The Viability of Using Online Prediction to Perform Extra Work while Executing BSP Applications”**, in Proceedings of the 27th IEEE High Performance Extreme Computing Conference, HPEC 2022, Waltham MA, USA, September 19-23, 2022

5. †Ahmad Golchin, and Richard West, “**Jumpstart: Fast Critical Service Resumption for a Partitioning Hypervisor in Embedded Systems**”, in Proceedings of the 28th IEEE Real-Time and Embedded Technology and Applications Symposium, Milano, Italy, May 4-6, 2022
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8. †Anam Farrukh and Richard West, “**smARTflight: An Environmentally-Aware Adaptive Real-Time Flight Management System**”, in Proceedings of the 32nd Euromicro Conference on Real-Time Systems (ECRTS), Modena, Italy, 7-10 July, 2020 ([Outstanding Paper, Best Paper Award](#))
9. †Soham Sinha, Richard West and Ahmad Golchin, “**PAStime: Progress-aware Scheduling for Time-critical Computing**”, in Proceedings of the 32nd Euromicro Conference on Real-Time Systems (ECRTS), Modena, Italy, 7-10 July, 2020
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\* Indicates papers on which I was the primary author.

† Indicates papers on which I was the only non-student/advisor. These papers involve only myself and students I have advised. I contributed significantly to the overall ideas of these papers.

§ Indicates papers on which I was the advisor, along with other non-students. As above, I contributed significantly to the overall ideas of these papers.

‡ Indicates student-led papers on which I was a collaborator. These papers involve people who were students at the time but were not my advisees.

All other papers have been co-authored with people who were neither students at the time of writing nor my advisees. For the most part, my papers tend to be with my own students rather than non-student collaborators. Most papers on which I am a co-author focus on my research ideas/objectives.

## Technical Reports and Works In Progress:

1. Ahmad Golchin, Soham Sinha, Richard West, "**Boomerang: Real-Time I/O Meets Legacy Systems**", Technical Report, arXiv:1908.06807, arXiv.org
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32. 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
33. Richard West and Karsten Schwan, "**Dynamic Window-Constrained Scheduling for Multimedia Applications**", Technical Report, GIT-CC-98-18, Georgia Institute of Technology, 1998
34. 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
35. 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:

1. Richard West, "**Adaptive Real-Time Management of Communication and Computation Resources**", PhD Thesis, College of Computing, Georgia Institute of Technology, August 2000
2. 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:

- **A Software and Hardware Architecture for Next-Generation Automotive Systems**, invited keynote speaker for CPS-IoTWeek, Milan, Italy, May 6, 2022 (Virtual Event). Various related presentations have been given to Polestar, Volvo, Intel, AMD, CARIAD, and Red Hat, 2022 and 2023
- **Architecture & Safety-Critical Software For Next-Generation Vehicles**, invited speaker, Electronics, Software & Hardware Integration for Next Generation Vehicles, virtual meeting, Battery Electric Vehicles Architecture Congress (BEVA), 2-3 February 2022
- **FlyOS: Integrated Modular Avionics for Autonomous Multicopters**, in Proceedings of the 28th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS), Milan, Italy, May 4-6, 2022
- **Jumpstart: Fast Critical Service Resumption for a Partitioning Hypervisor in Embedded Systems**, in Proceedings of the 28th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS), Milan, Italy, May 4-6, 2022
- **Towards an Integrated Vehicle Management System in DriveOS**, in Proceedings of the ACM SIGBED International Conference on Embedded Software (EMSOFT), October 8-15, 2021
- **DriveOS – An Integrated Vehicle Management System for Next-Generation Vehicles**, presentation to industrial partners at Drako Motors, Acronis and SIT Autonomous, September 17, 2021
- **Unique Research Challenges in Real-Time Runtime Software for Autonomous Machines**, invited panelist presentation/discussion at the 27<sup>th</sup> IEEE Real-Time and Embedded Technology and Applications Symposium, May 21, 2021
- **smARTflight: An Environmentally-Aware Adaptive Real-Time Flight Management System**, in Proceedings of the 32nd Euromicro Conference on Real-Time Systems (ECRTS), Modena, Italy, 7-10 July, 2020
- **PAStime: Progress-aware Scheduling for Time-critical Computing**, in Proceedings of the 32nd Euromicro Conference on Real-Time Systems (ECRTS), Modena, Italy, 7-10 July, 2020
- **Boomerang: Real-Time I/O Meets Legacy Systems**, in Proceedings of the 26th IEEE Real-Time and Embedded Technology and Applications Symposium, Sydney, Australia, April 21-24, 2020 (Virtual Conference due to Covid-19)
- **A Paravirtualized Android for Next Generation Interactive Automotive Systems**, in Proceedings of the 21st International Workshop on Mobile Computing Systems and Applications (HotMobile 2020), Austin, Texas, USA, March 3-4, 2020
- **Software and Hardware System Architecture for Next-Generation Vehicles**, invited presentation at the Battery Electric Vehicles Architecture Congress (BEVA), Detroit, Michigan, February 26-27, 2020
- **Partitioned Real-Time NAND Flash Storage**, in Proceedings of the 39th IEEE Real-Time Systems Symposium (RTSS), Nashville, Tennessee, USA, December 11-14, 2018
- **Tuned Pipes: End-to-end Throughput and Delay Guarantees for USB Devices**, in Proceedings of the 39th IEEE Real-Time Systems Symposium (RTSS), Nashville, Tennessee, USA, December 11-14, 2018
- **End-to-end Analysis and Design of a Drone Flight Controller**, in Proceedings of the ACM SIGBED International Conference on Embedded Software (EMSOFT), Torino, Italy, September 30-October 5, 2018
- **Quest-V: A Secure and Predictable System for IoT and Beyond (Part 3: QduinoMC to DroneOS)**, presentation to Intel, July 28, 2017
- **Building Real-Time Embedded Applications on QduinoMC: A Web-connected 3D Printer Case Study**, in Proceedings of the 23rd IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS), Pittsburgh, PA, USA, April 18-21, 2017
- **MARACAS: A Real-Time Multicore VCPU Scheduling Framework**, 37<sup>th</sup> IEEE Real-Time Systems Symposium (RTSS), Porto, Portugal, November 29-December 2, 2016
- **Quest(-V): A Secure and Predictable System for Smart IoT Devices (Part 2)**, presentation to Intel Corporation, August 4, 2016

- **Mixed-Criticality Scheduling with I/O**, 28th Euromicro Conference on Real-Time Systems (ECRTS), Toulouse, France, July 5-8, 2016
- **The Quest Operating System for Real-Time Computing**, invited presentation at the Boston Area IEEE Robotics and Automation Society, February 9, 2016
- **Qduino: A Multithreaded Arduino System for Embedded Computing**, 36<sup>th</sup> IEEE Real-Time Systems Symposium (RTSS), San Antonio, TX, December 4, 2015
- **Quest-V: A Secure and Predictable System for IoT and Beyond (Part 1)**, presentation to Intel, July 22nd, 2015
- **Quest -- A Journey in Space and Time**, invited presentation to NetApp New England, November 20, 2014. Also presented at Intel, Hudson, MA, January 9, 2015, and the University of Pennsylvania, May 13, 2015
- **Predictable Communication and Migration in the Quest-V Separation Kernel**, 35th IEEE Real-Time Systems Symposium (RTSS), Rome, Italy, December 2-5 2014
- **COLORIS: A Dynamic Cache Partitioning System Using Page Coloring**, 23rd International Conference on Parallel Architectures and Compilation Techniques (PACT), Edmonton, Alberta, Canada, August 24-27, 2014
- **Distributed Real-Time Fault Tolerance on a Virtualized Multi-core System**, 10th Annual Workshop on Operating Systems Platforms for Embedded Real-Time applications (OSPERT), in conjunction with ECRTS, Madrid, Spain, July 8, 2014
- **The Quest-V Separation Kernel**, Invited presentation, Advanced Processor Technology Group, University of Manchester, England, March 10, 2014
- **A Virtualized Separation Kernel for Mixed Criticality Systems**, 10th ACM SIGPLAN / SIGOPS International Conference on Virtual Execution Environments (VEE), Salt Lake City, Utah, March 2, 2014
- **The Quest-V Separation Kernel for Mixed Criticality Systems**, in Proceedings of the 1st International Workshop on Mixed Criticality Systems (WMC) at the 34th IEEE Real-Time Systems Symposium (RTSS 2013), Vancouver, Canada, December 2013
- **Distributed Real-Time Fault Tolerance on a Virtualized Multi-Core System**, Demo for RTSS@Work at the 34th IEEE Real-Time Systems Symposium (RTSS 2013), Vancouver, Canada, December 2013
- **Real-Time USB Communication in the Quest Operating System**, 19th IEEE Real-Time and Embedded Technology and Applications Symposium, Philadelphia, USA, April 9-11, 2013
- **Time Management in the Quest-V RTOS**, 8th Workshop on Operating Systems Platforms for Embedded Real-Time Applications (OSPERT), Pisa, Italy, July 10, 2012
- **Quest-V: A Virtualized Multikernel**, Invited presentation, VMware Inc., Cambridge, MA, June 26, 2012. Also invited to presented similar work at Charles River Analytics (CRA), Cambridge, MA, June 8, 2012
- **Quest-V: A Virtualized Multikernel for High-Confidence Systems**, Poster presentation in the High Confidence Software and Systems Conference, Annapolis, MD, May 6-7, 2012
- **Virtual-CPU Scheduling in the Quest Operating System**, 17th IEEE Real-Time and Embedded Technology and Applications Symposium, Chicago, IL, USA, April 11-14, 2011
- **Virtual-CPU Scheduling in the Quest Operating System**, Invited presentation, Charles River Analytics (CRA), Cambridge, MA, October 19, 2010
- **Online Cache Modeling for Commodity Multicore Processors**, 19th International Conference on Parallel Architectures and Compilation Techniques (PACT), regular poster session presentation, Vienna, Austria, September 11-15, 2010
- **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**, Invited presentation, 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**, 27<sup>th</sup> 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**, Invited presentation, VMware, Inc., Cambridge, MA, June 2006
- **Application-Specific Service Technologies for Commodity Operating Systems in Real-Time Environments**, 12<sup>th</sup> 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**, Invited presentation, 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**, Invited presentation, 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.

## Demos:

- **Qduino: A Multithreaded Arduino System for Embedded Computing**, demo'd a working real-time mobile robot running Quest/Qduino at CPSWeek/RTAS 2015, Seattle, WA, USA.

## Student Mentoring:

- I have spent all my career at BU developing a systems culture amongst the students, whereby the students are not afraid to design and develop low-level software and interact with hardware. The nature of my work involves building and experimenting with systems and applications. It requires significant interaction with my students on a daily basis, and an organized engineering methodology to constructing complex software. Most of my research work is conducted with a small team of students.
- I spend at least 20 hours per week working in my lab with my students, when not teaching and handling other service duties. I also hold one-on-one meetings with students on a weekly basis.

## Current Doctoral Advisees:

- **Anam Farrukh** – July 2017-present
- **Anton Njavro** – September 2021-present
- **Zhiyuan (Ryan) Ruan** – September 2020-present
- **Shriram Raja** – September 2023-present

NB: System Ph.D.s typically take 6+ years in the US academic system. Dates shown reflect when the Ph.D. student started working with me.

## Former Doctoral Advisees:

- **Ahmad Golchin**, Ph.D. Thesis defended August 2022, graduated January 2023. Moved to Oracle.
- **Soham Sinha**, Ph.D. Thesis defended June 2022. Moved to Nvidia.
- **Dongxu (Katherine) Missimer**, Ph.D. Thesis defended August 2020.
- **Zhuoqun (Tom) Cheng**, Ph.D. Thesis defended August 2018. Moved to Google.
- **Ying (Chris) Ye**, Ph.D. Thesis defended July 2017. Moved to Qualcomm, later Google and Zoox.
- **Eric Missimer**, Ph.D. Thesis defended July 2017.
- **Ye Li**, Ph.D. Thesis defended June 2015. Went to VMware, Cambridge, MA, USA.
- **Matthew Danish**, Ph.D. Thesis defended March 2015. Became a post-doc at Cambridge University, UK. Co-advised with Professor Hongwei Xi.
- **Gabriel Parmer**, Ph.D. Thesis defended July 2009. Became an Associate Professor (with Tenure) at the George Washington University, Washington DC, USA.
- **Yuting Zhang**, Ph.D. Thesis defended August 2006. Became Assistant Professor at Boston University (Metropolitan College), Massachusetts, USA.
- **Craig Einstein** – Completed Masters Degree, 2020. Moved to ARiA Acoustics.
- **Jingyi Zhang** – Completed Masters Degree, 2016. Moved to VMware, Inc.
- **Gerald Fry** – Completed Masters Degree. Moved to Charles River Analytics, Cambridge, MA.
- **Mehaben Mehta** – Completed Masters Degree. Moved to NetApp, New England.
- **Xin Qi** – Completed Masters Degree. Moved to Qualcomm.
- **Mehrnoosh Sameki** – Changed advisor to Professor Margrit Betke.
- **Junfeng Zou** – Returned to China due to health reasons.

## Doctoral and Masters Students, Examining Committee Member:

- **Sahan Bandara**, Ph.D. Prospectus Defense, June 5, 2023, “*Exploring the Security Primitives Required to Support a Hardware Operating System for FPGAs*” – Committee member.
- **Showan Asyabi**, Ph.D. Dissertation defense, February 24, 2023, “*Resource-efficient Performant In-memory KV Stores for At-scale Data Centers*” – Fourth Reader.
- **Ali Raza**, Ph.D. Dissertation defense, March 2, 2023, “*Specializing a General-Purpose Operating System*” – Fifth Reader.
- **Ahmad (Sasan) Golchin**, Ph.D. Dissertation defense, August 25, 2022, “*Towards a USB Control Area Network*” – Advisor/First Reader.
- **Soham Sinha**, Ph.D. Dissertation defense, June 27, 2022, “*Towards a Centralized Multicore Automotive System*” – Advisor/First Reader.
- **Saranya Natarajan**, Ph.D. Dissertation defense, June 8, 2021, “*Programming Language Primitives and Tools for Integrated Real-Time Systems Development*” – External Grading Committee Member, KTH Roy Institute of Technology, Sweden.
- **Katherine Missimer**, Ph.D., Dissertation defense, August 12, 2020, “*Exploiting Solid State Drive Parallelism for Real-Time Flash Storage*” – Advisor/First Reader.
- **Wil Koch**, Ph.D., Dissertation defense, August 9, 2019, “*Flight Controller Synthesis via Deep Reinforcement Learning*” – Third Reader. Also member of Ph.D. Proposal Committee and Oral Exam.
- **Nabeel Akhtar**, Ph.D., Dissertation defense, August 6, 2019, “*Orchestration and Management of Application Functions over Virtualized Cloud Infrastructures*” – Chair of Examining Committee. Also member of Ph.D. Proposal Committee and Oral Exam.
- **Zhuoqun Cheng**, Ph.D., Dissertation defense, August 9, 2018, “*Qduino: A Cyber-Physical Programming Platform for Multicore Systems-on-Chip*” – Advisor/First Reader.
- **Han Dong**, Ph.D. Oral Exam, December 2017.
- **Emine Ugur Kaynar**, Ph.D. Oral Exam, December 2017.
- **Dan Schatzberg**, Ph.D. Dissertation defense, July 28, 2017, “*Customization and Reuse in Datacenter Operating Systems*” – Second Reader. Also member of Ph.D. Proposal Committee and Oral Exam.
- **Ying Ye**, Ph.D., Dissertation defense, July 24, 2017, “*Real-Time Systems on Multicore Platforms: Managing Hardware Resources for Predictable Execution*” – Advisor/First Reader.
- **Eric Missimer**, Ph.D., Dissertation defense, July 13, 2017, “*Distributed Real-Time Fault Tolerance in a Virtualized Separation Kernel*” – Advisor/First Reader.
- **Yuefeng Wang**, Ph.D., Dissertation defense, November 28, 2016, “*Multi-Layer Virtual Transport Network Design and Management*” – Third Reader. Also member of Ph.D. Proposal Committee and Oral Exam.
- **Ye Li**, Ph.D., Dissertation defense, June 18, 2015, “*Leveraging Virtualization Technologies for Resource Partitioning in Mixed Criticality Systems*” – Advisor/First Reader.
- **Matthew Danish**, Ph.D., Dissertation defense, March 31, 2015, “*Terrier: A Real-Time, Embedded Operating System Using Advanced Types for Safety*” – Co-advisor/Second Reader. Also member of Ph.D. Proposal Committee, and Oral Exam, December 2009.
- **Likai Liu**, Ph.D., Dissertation defense, March 27, 2014, “*Simple, Safe, and Efficient Memory Management Using Linear Pointers*” – Second Reader.
- **Raymond Sweha**, Ph.D., Dissertation defense, November 2012, “*Optimizing On-Demand Resource Deployment for Peer-Assisted Content Delivery*” – Third Reader.
- **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.
- **Natasha Callender**, M.S., Biomedical Engineering, Oral Exam, 2006, Third (External) Reader.

### **Masters Thesis/Project Students Advised:**

- **Weiqian Li, Songlan Wang and Ye Zhou**, Master’s student directed study project, Spring 2024: “*A Digital Twin Testbed for DriveOS*”.
- **Aravind Sridhar**, M.S. Spring 2017: “*A Real-Time System for Autonomous Drone Control*”.
- **Faddy Saad**, M.A. Spring 2014: “*TORCS Vision-Based Autonomous Racers*”.
- **Mehaben Mehta**, M.A. Spring 2010: “*A Real-time Virtual CPU Architecture for Predictable Systems*”.
- **Xin Qi**, M.A. Spring 2005: “*Network Positioning for Online Nearest Neighbors Search*”.
- **Albert Sidelnik**, M.A. Spring 2005: “*Supporting SMP Architectures on User-Level Sandboxing for FAST RPC*”.
- **Luis Hernandez**, M.A. Spring 2004: “*Adding SMP Support to User-Level Sandboxing, and Removing the Requirement for Recompilation*”.
- **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. Went to Revahertz.

### **Senior Honors Thesis Students Advised (CS and ECE):**

- **John Mikulskis**, September 2021-May 2022, “*Automotive Vehicle Twin Hardware-in-the-Loop Simulator*”, B.U. Electrical and Computer Engineering Department.
- **Zhiyuan Ruan**, September 2019-May 2020, “*Real-Time SLAM for the Quest-V System*”, B.U. Electrical and Computer Engineering Department.
- **Vijay Thakkar**, September 2018-May 2019, “*Android OS on x86 Hardware for a Mixed-Criticality Processing Domain*”, B.U. Electrical and Computer Engineering Department.
- **Raj Ashar**, January-December 2001, “*Applying Classical Control-Theoretic Techniques to Perform On-line Stability Analysis of Adaptive Systems*”, B.U. Computer Science Department.

## **UROP (Undergraduate Research Opportunities Program) and Undergraduate Advisees:**

- **Chris Relyea** – Real-time Audio Signal Processing
- **Zhiyuan Ruan** – Real-Time SLAM for the Quest-V System (2 semesters)
- **Sean Smith** – An Intelligent Autonomous Quadcopter
- **Gareth Gray** – A Graphical User-Interface for the Quest Operating System
- **Kyle Brogle** – The RacerX Project: Developing Autonomous Navigation and Decision Making Techniques in Land Vehicles
- **Christopher Gomes, Prakash Lalwani, Joe Zatkovich** – A Computer Systems Perspective on the Design of Large-Scale Coordinated Urban Traffic Networks

**Further details can be found on my website at:**

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

**References: Available upon request**