Stacy J. Prowell

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Vehicle Security Center
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Program Manager
Cybersecurity for Energy Delivery Systems (CEDS)
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Chief Cyber Security Research Scientist
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Cyber Warfare Research Team Leader
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Current Research

- Computationally-intensive methods in cyber security and software engineering
- Deep inspection of compiled software for vulnerability detection and software assurance
- Microelectronics assurance using advanced imaging techniques

Experience

November 2015 – Present: *Director*, Vehicle Security Center, Oak Ridge National Laboratory

> *Director*: Responsible for strategic direction of center.
> Accomplishments: Created the Vehicle Security Center by combining expertise in vehicle systems, embedded systems, and cyber security, with specialized facilities at the National Transportation Research Center in Knoxville, TN.

August 2013 – Present: *Program Manager*, Cybersecurity for Energy Delivery Systems (CEDS), Sustainable Electricity Program, Oak Ridge National Laboratory. http://web.ornl.gov/sci/eere/sustainable_electricity.shtml

> *Program Manager*: Manage ORNL's portfolio of research efforts for security the nation's energy distribution systems. This program currently consists of a per year basic research investment from the Department of Energy's CEDS program, along with competitively-funded efforts and the lab's own internal investments.

December 2009 – Present: *Chief Cyber Security Research Scientist*, Computational Sciences and Engineering Division, Oak Ridge National Laboratory. http://computing.ornl.gov/cse/index.shtml

> *Chief Cyber Security Research Scientist*: Responsible for development and execution of laboratory strategy and priorities on cyber security. Focus on entrepreneurial development of new programs and growth of existing programs.
>
> *Cyber Warfare Research Team Lead*: Assembled and presently manage a team of 18 researchers in cyber security, focusing on four strategic thrusts: Automated Behavior Computation, Embedded System Security, Developing a National Malware Repository, and Ultra-Secure Communications and Authentication.
>
> - **ORNL Significant Event Award**: Three technologies (Hyperion, Choreographer, and USB-ARM) selected for DHS Transition to Practice (TTP) program. DHS selected eight technologies nationwide for TTP; three came from the Cyber Warfare Research Team.
>
> *Support Efforts:* In order to support the CWR team and CSIIR group research efforts, created specialized facilities within the team.
>
> - **Center for Trustworthy Embedded Systems (CTES)**, Dr. Jason Carter (Director). This is a dedicated laboratory facility with a large Faraday cage, offices, and laboratory space that supports the team's efforts in embedded software for multiple sponsors, including the transportation, military, and medical device communities.

- **Blackbox**, Dr. Stacy Prowell (Director) and Dr. Jeff Nichols (Facility Manager). This is a computing facility that provides multiple cluster computer architectures, elastic cloud computing, network storage, and research networks for use by multiple projects using a simple subscription model.

Principal Investigator:

- **1SR** (2016-Present) – Multiple sponsors. Comprehensive solution for performing network operations training, evaluating alternative network configurations, and deploying untrusted and early-stage cyber security solutions on a network to improve security in a manner that *can not* disrupt the operational network.
- **Cyber Science Laboratory** (anticipated 2017 start) – US Department of Energy. This is a large-scale effort combining eight national laboratories and one test site for ongoing, sustained efforts in cyber security.
- **Transition to Practice – Hyperion** (2012-2014) – US Department of Homeland Security, $300k over two years. Hyperion is commercially licensed and is an R&D 100 Award Winner (November 2015).
- **Legacy** (2012-2014) – Applied Communication Sciences (ACS), $3.2M over two years. Automated computation of legacy software component behavior.
- **Automated Vulnerability Detection (AVUD) Demonstration** (2013-2014) – US Department of Energy, $300k over one year. Demonstrate automated vulnerability detection in a smart meter. Partnership with Sensus USA, Inc.
- **Decision Support Systems Component for DDDAS** (2013-2015) – University of Arizona (for Air Force Office of Scientific Research), $200k.
- **Function Extraction and Executable Decomposition (FEED)** (2012-2013) – Lockheed Martin Federal Systems, $500k over 1 year. Automatically assess the impact of software patches.
- **Beholder: Robust Cyber Event Detection** (2011-2013) – US Department of Energy, $240k over 2 years. Exploit the physics of computation to remotely detect intrusion events in deployed systems. Partnership with General Electric Research.
- **Automated Vulnerability Detection (AVUD) for Compiled Smart Grid Software** (2010-2012) – US Department of Energy, $3M over 2 years.
- **Research, Demonstration, Test and Evaluation Support** (2011-2012) – US Department of Transportation, $220k over 1 year. Project is *ongoing*, but has been handed off to the new Center for Trustworthy Embedded Systems.

- **Ultrascale Algorithms for Verification of Security Properties** (2010-2012) – ORNL internally funded effort, $600k over 2 years.
- **Using Semantic Analysis to Detect and Classify Executables for Computer Forensics** (2010-2012) – US Federal Sponsor, $240k over 2 years.
- **Host Based Malware Detection**, Technology Forecast (2011-2012) – US Federal Sponsor, $120k.
- **Function Extraction Research Support** (2010-2011) – MITRE, $300k.

Co-PI:

- **Research, Development, Technology Assessment, Integration, and Implementation** (2011-Present) – US Army Space and Missile Defense Command.

July 2010 – Present: *Associate Professor* (Dual Appointment with ORNL), Department of Electrical Engineering and Computer Science, The University of Tennessee. http://www.eecs.utk.edu/

Assisted in the development of a curriculum for a Cyber Security Emphasis in the EECS department.

Assisted in the development of a new Ph.D. program in data science offered through UT's Bredesen Center.

Engaged in efforts to create a Center for Cybersecurity Research as a collaborative investment among multiple parties including the University and local and national businesses.

August 2005 – December 2009: *Chief Scientist*, CERT STAR*Lab, Software Engineering Institute, Carnegie Mellon University. http://www.sei.cmu.edu/
Joint Faculty, Information Networking Institute, Carnegie Mellon University. http://www.ini.cmu.edu/

Chief Scientist: CERT STAR*Lab (Security Technology Automation and Research). http://www.cert.org/sse/starlab.html STAR*Lab is a CERT laboratory for developing proof-of-concept automation to solve challenge problems in software security. Projects include: Function Extraction, Computational Security Attributes, Automated Correctness Verification, Automated Component Composition, Flow-Service-Quality Engineering.

Principal Investigator:

- **Automated Structuring for Understanding Legacy Software** – Support analysis of malicious code by automatically determining correct program control flow in the presence of obfuscation.
- **Flow-Service-Quality (FX) Engineering** – Provide abstractions to anchor the specification, development, deployment, and maintenance of large network-centric systems.

- **CTC CAMP Project** – Review of static analysis tools for use by US Gov't.

Team Lead and Architect: Function Extraction (FX) project. Developed software to allow automated analysis of malware by computing the full functional effect of binary code.

April 2004 – August 2005: *Visiting Scientist*, Software Engineering Institute, Carnegie Mellon University. http://sei.cmu.edu

January 1999 – August 2005: *Research Associate Professor*, Department of Computer Science, The University of Tennessee. http://www.utk.edu/

Principal Investigator: Software Assurance for the Spallation Neutron Source (ORNL SNS), $200k over 2 years.

External Collaborator: Feasibility Study of Automated Program Behavior Computation for Next-Generation Software Engineering, $120k over ten months – The Boeing Company.

Manager: Experimentation, Simulation, and Prototyping (ESP) Project, Software Quality Research Laboratory. Created tools to support transfer of testing and specification technologies. Testing tool (JUMBL) is presently in use by 30+ organizations.

Research: Conducted research on requirements engineering and software assurance in collaboration with NORTEL (1999-2004), CTI-PET Systems (1999-2004), Raytheon (2001), and Alpine Engineered Systems (2000).

October 1998 – August 2005: *Adjunct Assistant Professor*, Computer Science, The University of Tennessee. http://www.utk.edu/

May 2004 – December 2011: *Founder and Member*, Software Silver Bullets, LLC. Rigorous model-based automated software testing.

April 2000 – October 2000: *Consultant*, NexWare, Inc. Embedded systems design and implementation, including set-top boxes and internet appliances.

May 1998 – January 1999: *Consultant*, Q-Labs, Inc. Business area development for rigorous methods training, coaching, and tools.

May 1995 – May 1998: *Computer Scientist*, Software Engineering Technology, Inc.

Academic Service

Conferences and Workshops

- General Chair, CISR Conference (April 2016).
- Judge, CodeTN Competition (http://codetn.org, November 2015).
- General Chair, CISR Conference (April 2015).
- Judge, CodeTN Competition (November 2014).
- General Chair, CISR Conference (April 2014).

- Program Co-Chair, 8th Annual CSIIRW (January 2013).
- Minitrack Co-Chair, Dynamic Analysis of Software Systems, HICSS-44 (January 2012).
- Program Co-Chair, 7th Annual CSIIRW (October 2011).
- Minitrack Co-Chair, Assurance Research for Dependable Software Systems, HICSS-43 (January 2011).
- Program committee member on numerous conferences and workshops.

Doctoral Committee Member

- Jarylin Hernández Jiménez (advisor: Katerina Goseva-Popstojanova), Ph.D. Computer Science, expected 2017, West Virginia University.
- Wesley Jin (advisor: Dr. Priya Narasimhan), Ph.D. Computer Science, awarded 2014, Carnegie Mellon University
- Chris Symons (advisor: Dr. Greg Peterson), Ph.D. Computer Science, awarded 2013, The University of Tennessee
- Balajee Kannan (advisor: Dr. Lynne Parker), Ph.D. Computer Science, awarded 2006, The University of Tennessee
- Lan Lin (advisor: Dr. Jesse Poore), Ph.D. Computer Science, awarded 2006

Masters Committee Member

- David Heise (advisor: Dr. Michael Thomason), MS Computer Science 2013, The University of Tennessee
- Carrie Black (co-advisor with Dr. Dawn Song), MS Computer Science, 2006, Carnegie Mellon University
- Carla Sparks, MS Computer Science, 2004, The University of Tennessee
- Damodar Balgi, MS Computer Science, 2004, The University of Tennessee
- Michael Corum, MS Computer Science, 2003, The University of Tennessee
- Michael Campfield, MS Computer Science, 2002, The University of Tennessee
- Jay Patel, MS Computer Science, 2001, The University of Tennessee
- Janet Seib, MS Computer Science, 2001, The University of Tennessee
- David Pearson, MS Computer Science 2001, The University of Tennessee

Open Source Projects

See my open source report card here: https://osrc.dfm.io/sprowell/, assuming OSRC is working. I routinely write solid, scalable, fast code in C, C++, Python, Java, Scala, and sometimes assembly. I am currently working on an HPC project using Rust.

- **Elision**, a fast term rewriter that merges the type and term spaces allowing for higher-level rewriting. See: http://elision.github.com. Elision is used in static analysis of programs, and is written in Scala. A new version is being written in Rust.

- **Pico**, an elastic platform for safe malware handling and malware analysis. See: http://mons-pico.github.com. The Pico encoding and reference are open source; a populated malware platform using HBASE and HADOOP is available at Oak Ridge National Laboratory. There are C, Java, and Python implementations of the Pico encoding.
- **He4** is a fixed-memory, open addressing hash table with linear probing and LRU deletion, designed for embedded applications. See: https://github.com/sprowell/he4
- **SPSPS** is Stacy's Pathetically Simple Parsing System, a tiny framework in vanilla C for writing parsers along with fast mutable and immutable strings and a fast JSON parser. See: http://github.com/sprowell/spsps.

Patents

- S. J. Prowell, "Performing Hierarchical Analysis of Markov Chain Usage Models," US Patent 7,219,049, filed September 15, 2003.
- S. J. Prowell and C. Rathgeb, "Statistical Fingerprinting for Malware Detection and Classification," US Patent 9,135,440, filed July 31, 2013.
- P. Evans, N. Paul, S. Prowell, "System and Method for Key Generation in Security Tokens," US Patent 9,172,698, filed October 11, 2013.
- S. J. Prowell and K. D. Sayre, "Automated Clustering of Malware Variants Based on Structured Control Flow," Provisional Patent #62/170,758, filed June 4, 2015.

Recent Articles

- R. Abercrombie, L. Hively, S. Prowell, B. Schlicher, and F. Sheldon, "Forewarning of Failure in Complex Systems," *Journal of Homeland Security*, v. 5, n. 1, June 2011, pp. 1-16.

- L. Lin, S. Prowell, and J. Poore, "An Axiom System for Sequence-Based Specification," *Theoretical Computer Science*, v. 411, n. 2, February 2010, pp. 360-376.

- L. Lin, S. Prowell, J. Poore, "The Impact of Requirements Changes on Specifications and State Machines," *Software Practice & Experience*, v. 39, n. 6, June 2009, pp. 573-610.

- S. Prowell and J. Poore, "Computing System Reliability Using Markov Chain Usage Models," *Journal of Systems and Software*, v. 73, n. 2, September 2004, pp. 219–225.

- S. Prowell and J. Poore, "Foundations of Sequence-Based Software Specification," *IEEE Transactions on Software Engineering*, v. 29, n. 5, May 2003, pp. 417–429.

Invited Talks

- S. Prowell, Invited Talk: "Security and Privacy for Vehicle Systems and Systems of Vehicles," DHS Automotive Cybersecurity R&D Showcase, Volpe Center, Cambridge, MA, October 17, 2016.

- S. Prowell, Invited Talk: "Vehicle Security," Minnesota State University, Student IEEE Section, Mankato, MN, October 3, 2016.

- S. Prowell, Invited Talk: "Vehicle Security," Southern Minnesota IEEE Chapter, Rochester, MN, October 3, 2016.

- S. Prowell, Invited Talk: "Vehicle Security," Exploring Cybersecurity Challenges in Electrified Transportation: A Focused Workshop (IEEE), Howard University, Washington, DC, February 24, 2016.

- S. Prowell, Keynote Talk: "Security, Verification, and the IoE," Program Protection and Reverse Engineering Workshop (PPREW), Los Angeles, CA, December 8, 2015.

- S. Prowell, Plenary Talk: "Let's Instrument Everything – And Trust It," Future of Instrumentation and the Internet Workshop, Arlington, VA, May 4-6, 2015. On web: http://goo.gl/avgydd (retrieved August 4, 2015).

- S. Prowell, Keynote Talk: "Verification and Security," *Midwest Verification Days*, University of Missouri, October 3-4, 2015.

- S. Prowell, Invited Talk: "Enabling Insecurity: Bringing the Tools and Techniques from IT to Control Systems," TCIPG Lecture Series, University of Illinois, December 6, 2013.
  On web: https://goo.gl/SQ1sIf (retrieved August 4, 2015).

- S. Prowell, Invited Talk and Panelist: Capitol Hill Briefing on "Cybersecurity and Smart Infrastructure," *Science and the Congress Project*, sponsored by the American Chemical Society (ACS), Washington, DC, April 19, 2012.

- S. Prowell, Invited Talk: "Insecurity in Cyberspace," Howard Baker Center, Knoxville, TN, October 19, 2010.

- S. Prowell, Invited Talk: Dagstuhl Seminar 04371, "Perspectives on Model-Based Testing," Germany, September 2004.

Books

- S. Prowell, R. Kraus, M. Borkin, *Seven Deadliest Network Attacks*, Syngress: Boston, MA, 2010.

- S. Prowell, C. Trammell, R. Linger, and J. Poore, *Cleanroom Software Engineering: Technology and Process*, Addison-Wesley: Boston, MA, 1999.

Chapter and Reports

- J. Hernandez, L. Hively, E. Downing, A. Ferber, S. Prowell, R. Wagner, "Beholder: Phase-Space Detection of Cyber Events," ORNL Technical Report ORNL/TM-2013/294, 2013.

- N. Paul, L. Hively, S. Prowell, "Host-Based Malware Detection," (awaiting distribution), ORNL Technical Report ORNL/TM-2013/231, 2013.

- A. Hevner, R. Linger, M. Pleszkoch, S. Prowell, G. Walton, "Flow-Service-Quality (FSQ) Systems Engineering: A Discipline for Developing Network-Centric Information Systems," *Systems Analysis and Design: Techniques, Methodologies, Approaches, and Architectures*, R. Chiang, K. Siau, and B. Hardgrave, eds., M. E. Sharpe: New York, NY, April 2009.

- A. Hevner, R. Linger, R. Collins, M. Pleszkoch, S. Prowell, and G. Walton. "The Impact of Function Extraction Technology on Next Generation Software Engineering," SEI Technical Report CMU/SEI-2005-TR-015, Software Engineering Institute, 2005.

- S. Prowell and J. Poore, "Reliability Computation for Usage-Based Testing." *Modern Statistical and Mathematical Methods in Reliability* (Volume 10: Series on Quality, Reliability and Engineering Statistics, A. Wilson, N. Limnios, S. Keller-McNulty, and Y. Armijo, eds.). Hackensack, NJ: World Scientific Publishing, 2005.

- R. Linger and S. Prowell, "Developing Secure Software with Cleanroom Software Engineering," *Improving Security Across the Software Development Lifecycle*, (Task Force Report, Volume II, National Cyber Security Summit, S. Redwine and N. Davis, eds.). March 2004.

- S. Prowell, "Computations for Markov Chain Usage Models," UT Technical Report UT-CS-03-505, the University of Tennessee, 2003.

Peer-Reviewed Conference Presentations

- S. Prowell, "One Step Removed (1SR) Concept Overview," *DOE Cyber Conference*, Atlanta, GA, September 19-22, 2016.

- J. M. Hernández, A. Ferber, S. Prowell, L. Hively, "Phase-Space Detection of Cyber Events," *Proc. of the 10th Annual Cyber and Information Security Research (CISR) Conference*, Oak Ridge, TN, April 7-9, 2015.

- J. Stoll, S. Prowell, J. Goodall, R. Stewart, D. White, B. Bhaduri, "GEOINT for Cybersecurity," GEOINT Summit, Washington, DC, June 2013.

- J. Hernández, L. Pouchard, J. McDonald, S. Prowell, "Developing a Power Measurement Framework for Cyber Defense," CSIIR Workshop, Oak Ridge, TN, January 2013.

- R. Linger, M. Pleszkoch, S. Prowell, K. Sayre, and T. Ankrum, "Computing Legacy Software Behavior to Understand Functionality and Security Properties: An IBM/370 Demonstration," CSIIR Workshop, Oak Ridge, TN, January 2013.

- S. Prowell, M. Pleszkoch, K. Sayre, and R. Linger, "Automated Vulnerability Detection for Compiled Smart Grid Software," IEEE PES Innovative Smart Grid Technologies Conference, January 2012.

- R. Linger, M. Pleszkoch, S. Prowell, and K. Sayre, "Behavior Computation for Smart Grid Software Analysis," CSIIR Workshop, Oak Ridge, TN, October 2011.

- R. Abercrombie, L. Hively, S. Prowell, R. Schlicher, and F. Sheldon, "Forewarning of Failure in Complex Systems," DHS Science Conference – 5th Annual University Summit, Washington, DC, April 2011.

- S. Fernandez, S. Prowell, and J. Nutaro, "Behavior-Based Anomaly Detection: Capabilities and Future Directions," CyberCap, Dallas, TX, August 2010.

- R. Bartholomew, L. Burns, T. Daly, R. Linger, and S. Prowell, "Function Extraction: Automated Behavior Computation for Aerospace Software Verification and Certification," AIAA Infotech@Aerospace 2007 Conference, Rohnert Park, CA, May 2007.

- A. Mili, T. Daly, M. Pleszkoch, and S. Prowell, "A Semantic Recognizer Infrastructure for Computing Loop Behavior," 40th Annual Hawaii International Conference on System Sciences (HICSS'40), Kona, HI, January 2007.

- S. Prowell, "Using Markov Chain Usage Models to Test Complex Systems," 38th Annual Hawaii International Conference on System Sciences (HICSS'38), Kona, HI, January 2005.

- F. T. Sheldon, S. G. Batsell, S. J. Prowell, and M. G. Langston, "Position Statement: Methodology to Support Dependable Survivable Cyber-Secure Infrastructures," 38th Annual Hawaii International Conference on System Sciences (HICSS'38), Kona, HI, January 2005.

- S. Prowell and W. T. Swain, "Sequence-Based Software Specification of Critical Software Systems," American Nuclear Society NPIC & HMIT, Columbus, OH, September 2004.

- S. Prowell and J. H. Poore, "Computing System Reliability Using Markov Chain Usage Models," Fourth International Conference on Mathematical Methods in Reliability, Santa Fe, NM, June 2004.

- S. Prowell, "A Cost-Benefit Stopping Criterion for Statistical Testing," 37th Annual Hawaii International Conference on System Sciences (HICSS'37), Kona, HI, January 2004.

Awards and Honors

- Selected as an IEEE Distinguished Lecturer by the Transportation Electrification Community (2016).
- 2016 ORNL Lab Director "Best SEED Money Fund Poster" Award (with Jeff Nichols, Bobby Bridges, and Jarylin Hernández).
- 2016 Federal Laboratory Consortium Excellence in Technology Transfer Award (with David Sims).
- 2015 R&D 100 Award (for Hyperion).
- 2015 UT-Battelle Technology Commercialization Award (for Hyperion Team).
- 2013 UT-Battelle Significant Event Award.
- 1992 Chancellor's Citation for Extraordinary Academic Achievement.

Education

B.S. (1992), M.S. (1995), and Ph.D. (1996), Computer Science, The University of Tennessee. Dissertation: "Sequence-Based Software Specification."

References

Available upon request.