

## PROFESSIONAL BEARING

Leadership and research that seeks advances in theory/practice for scalable and trustworthy computing and communications systems that meet *critical* national needs.

## EDUCATION

### University of Texas at Arlington, College of Engineering

Ph.D. in Computer Science

May 1996

MS in Computer Science

August 1988

### University of Minnesota, Institute of Technology

Bachelor of Science in Computer Science

December 1983

### University of Minnesota, College of Biological Science

Bachelor of Science in Microbiology

June 1977

## EMPLOYMENT

### Oak Ridge National Laboratory, Computational Science and Engineering Division

 From: 09/02 – Present  
*Senior Research Scientist (Q), Cyberspace Sciences & Information Intelligence Research (CSIIR) Group*

With 29+ years of experience in the fields of software engineering and computer science Sheldon has been more recently focused on cybersecurity. He has held faculty appointments, including R&D positions at three fortune 100 companies and was a postdoc/visiting scholar at NASA LaRC and ARC/Stanford. He has published over 100 papers and edited six books concerned with developing and validating models, applications, methods and tools for the creation of safe, secure and dependable systems; Co-inventor on several patent pending, a Sr. Member of the IEEE, received a Sigma Xi outstanding dissertation award including key contributor & several significant event awards from UT-Battelle. He played various roles including PI and deputy program management and numerous PD efforts, an evangelist for identifying collaborators and securing funding sources (see [proposals](#) section); facilitation/participation in national R&D thrusts including keynote, presentations, panel moderator/panelist, PC member and attendance at numerous conferences and meetings including bringing leading researchers and key corporate and government officials to ORNL toward building a network of collaborators and sponsors; He has chaired a very successful series of [cyber security and information intelligence research workshops](#), [town-hall meeting](#) and [conference mini-tracks](#) and participated on numerous program review committees (see [awards and recognition](#) and [inventions](#) sections).

Externally funded projects (selected): Small Island World gaming platform (spatial/temporal intelligence analysis), Decision Support System Component (DSSC) for Dynamic Data Driven Applications Systems (DDDAS)-based Resilient Cyberspace (DRCS), Supply Chain Integration for Integrity (SCI-FI), [Cyber Sciences Laboratory](#) (CSL), [National Electric Sector Cybersecurity Organization and Resource \(NESCOR\)](#), [Centralized Cryptographic Key Management for Energy Delivery Systems](#), [Group Violent Intent Modeling GYIM \[DHS funded\]](#), [Automated In-Motion Vehicle Evaluation Environment/Weigh-In-Motion](#) (see [WIM](#) [DoD funded] and the [related factsheets](#)) and [Trusted Corridor](#) [ONR/DHS/EPA funded] as well as managed affiliations with [Cyber Security Research Alliance](#) (CSRA), NSF Cyber Trust Centers: [TRUST](#) [UCB led] and [TCIPG](#) [UIUC led]. Collectively, during ORNL tenure, Sheldon has PI/Co-PI'd 70+ full proposals and 28+ white papers including 11 IP disclosures, 60 conference papers, 9 Editorships and 17 journal articles.

Mentored fifteen faculty, graduate and undergraduate students: as part of the DHS [scholars/fellows](#), RAMS/SULI and the higher education research experience ([HERE](#)) programs at ORNL (see [advisees](#) and [copyright software](#) below).

### DaimlerChrysler (RIC/AS): Research Information & Communication / System Safety

 Period: 07/01 – 08/02

*Stuttgart:* Applied research in specification and modeling for logical/statistical verification/validation of safety properties (hazard analysis) and stochastic performance analysis (including diagnostics and performance measures) for vehicle hardware/software systems with [Stefan A. Greiner](#), Ph.D.

### Washington State University, College of Engineering and Architecture

Period: 06/99 – 09/02

*Assistant Professor, School of Electrical Engineering and Computer Science*

Lead for software engineering (SE) curriculum development, and chaired SE Endowed Chair search. Founded the [SEDS](#) (Software Engineering for Secure and Dependable Systems) Laboratory with funding from Intel/Microsoft (including 12 graduate students and two visiting faculty); spearheaded overhauling/diversification of the EECS web/mail server infrastructure, initiated R&D fast-track to FDA approval/certification using formal methods/testing strategy with [Physio-Control Inc.](#) See the [refereed software tools](#), [student advisees](#) and [course descriptions](#) sections below.

**University of Colorado, College of Engineering and Applied Science** Period: 08/96 – 06/99  
*Assistant Professor, Computer Science Department*  
See the [refereed software tools](#), [student advisees](#) and [course descriptions](#) sections below.

**National Research Council, NASA Langley Research Center** Period: 06/96 – 08/96  
*Research Associate (NRC Postdoc), Flight Electronics Technology Division:* Formal specification of stochastic properties for an integrated air/ground system to support low visibility landing and surface operations at commercial airports. Investigated advanced design techniques for ensuring that high-performance computing systems are produced in a timely fashion and meet stringent real-time reliability and fail-safe/security requirements (1993-95 was supported by [NASA Langley](#) during residency phase).

**University of Texas at Arlington, College of Engineering** Period: 01/93 - 05/96  
*Assistant Instructor, Computer Science and Engineering:* Taught Methods in Software Engineering, Discrete Structures in Computer Science (+Pascal lab) and Formal Methods for Software. Dissertation title: Specification and analysis of stochastic properties for concurrent systems expressed using CSP, developed a CSP (process algebra) to Stochastic Petri net translation tool and investigated automated techniques for decomposition/ composition of system models supported by [NASA LaRC GSRP](#) fellowship and UTA assistantship.

**Lockheed Martin Aeronautics Company** (formerly General Dynamics, FWD) Period: 01/90 - 01/93  
*Engineering Specialist (promoted 1992), Avionics R&D:* Secret clearance, PI for \$2-million GIMADS R&D project to define a generic Integrated Diagnostics (ID) Software Development Process to address problems associated with functional deficiencies of avionics software and software maturation using as a basis, the Software Development Integrity Program (Mil-Std-1803, plus Mil-Std-2167A, 2168, 1815 and 800-xx Series); developed a software engineering process model (to specify, develop and verify diagnostic software) and recommendations for updates to Mil-Std-1814; authored the Software Risk Management Practices and the YF-22 Software/System Engineering Environments prime requirements document (System Segment Specification), provided tools training and participated on various proposal writing teams.

**Lockheed Martin Aeronautics Company** (formerly General Dynamics, FWD) Period: 10/88 - 01/90  
*Senior Engineer, Advanced Avionics Development:* Secret clearance, FS/X Japan tailoring F-16 derivative avionics systems components. [YF-22 VMS Kernel](#) lead and prime author: software requirements specification. Collaborated on the stores management OFP, built-in-test, software development plan, computer resource integration, processing architecture evaluations and white papers, computer data security, and communication interfaces. Developed memory usage estimation algorithm to compare various Ada compilers.

**Raytheon** (formerly Texas Instruments, DSEG) Period: 9/87 -10/88  
*Test Engineer (promoted 1987), Test Automation Department:* Secret clearance, on loan to Military Computer Systems as designer for built-in-test software on the Multipurpose Interface module for the Advanced Tactical Fighter (YF-22) Mission Display Processor using DoD-STD-2167.

**Raytheon** (formerly Texas Instruments, DSEG) Period: 7/84 -09/87  
*Software Design Engineer, Avionics Systems/Radar Division:* Secret clearance, designer for hardware fault diagnostic, built-in-self-test, calibration and acceptance test software for the Tornado Nose Radar. Various functionalities included terrain following/ ground mapping radar/ ECCM and the infrared imaging Lantern pod.

## ACCOLADES

- 2013 Cloud & Autonomic Computing Center. [Spring. 2012 Workshop](#), Keynote and Panelist, Univ. Florida Gainesville, 14 June 2012.
- 2013 Cloud & Autonomic Computing Center. [Spring. 2012 Workshop](#), Keynote and Panelist, Univ. Florida Gainesville, 14 June 2012.
- 2013
- 2012 Cloud & Autonomic Computing Center. [Spring. 2012 Workshop](#), Keynote and Panelist, Univ. Florida Gainesville, 14 June 2012.
- 2012 National Laboratories Panelist: Ideation Session of the [Cyber Security Research Institute \(CSRI\) Workshop](#), CSRI Founders Group (Intel, AMD, LMCO, Honeywell and EMC) 19 Apr 2012
- 2011 Invited Seminar Speaker: “[Emerging Cyberspace R&D Themes Toward Trustworthy Systems III](#)” (November 4: [IUPUI, Department of CIS](#))
- 2011 Significant Event Award (SEA) UT-Battelle FUSEnet Team: [Foresight and Understanding from Scientific Exposition](#) (September: [project description](#), see [invention disclosures](#) 2583 and 2584) in recognition for contribution to the *Design and Implementation of the Virtual Computing Environment for Scientific Experimentation*.
- 2011 Significant Event Award (SEA) UT-Battelle in recognition for contribution to the *ORNL Response to the April 2011 Advanced Persistent Threat Cyber Attack*.
- 2011 Invited Speaker: [TexSAW](#) at the [UTD Cyber Security Research Center](#) “[Emerging Cyberspace R&D Themes Toward Trustworthy Systems II](#)” (18-21 October 2011: [Univ. of Texas at Dallas](#))

- 2011 Invited Speaker: [4th International Symposium on Resilient Control Systems](#), “[Adaptive Bio-Inspired Resilient Cyber-Physical Systems: R&D Prospective](#),” (Track 2 Cyber Awareness, Boise, ID, August 9-11, 2011: [Symposium Presentations](#))
- 2011 [TRUST Security Seminar Speaker](#), “[Emerging Cyberspace R&D Themes Toward Trustworthy Systems](#)” (Apr. 14: [UC Berkeley](#))
- 2011 National Laboratory Panelist, [Cyber Security and Information Intelligence Wkshp](#) (October 12-14)
- 2005-11 General/Program Chair: Cyber Security and Information Intelligence Research Workshop ([CSIIRW](#))
- 2011 [HICSS](#) Mini-track Chair: Information Security and Cyber Crime Mini-track ([ISCCM](#)) in Decision Technologies and Service Sciences Track
- 2011 Program Committee, [IEEE Symp. Computational Intelligence in Cyber Security](#) (Apr. 11-15: Paris)
- 2010 Program Committee, [Annual Computer Security and Applications Conference](#) (Dec. 6-10: Austin)
- 2010 Keynote, 3rd Annual [Cyber Security Expo at the FedEx Institute of Technology](#), “[Moving Toward Trustworthy Systems: Historical Federal Policy Perspective and Emerging Cyberspace R&D Themes](#),” hosted by U. of Memphis Center for Information Assurance (Oct. 15: Memphis, TN)
- 2010 Keynote, [10<sup>th</sup> Anniversary Celebration Symposium](#): Center for Research in Wireless Mobility and Networking ([CReWMaN](#)) “Trustworthy Systems: R&D Essentials: A Historical Federal Policy Perspective” (Oct. 8: Arlington, TX)
- 2010 Keynote, [First Int’l Conf. on Electronic Management](#), “A Vision for Scalable Trustworthy Computing: [Emerging Cyberspace R&D Themes](#)” (June 3: Tripoli, LY)
- 2010 Executive Program Committee, [Int’l Conf. on i-Warfare and Security](#) (Apr. 8-9: WPAFB)
- 2010-11 [UTA/CSE Industry Advisory Board](#) member
- 2010 [HICSS](#) Minitrack Chair: Cyber Security and Information Intelligence Research in Decision Technologies and Service Sciences Track
- 2009-11 IEEE Technical Expert (Safety, Reliability, Cyber Security and Critical Infrastructure Survivability)
- 2009 Technical Program Committee: Wkshp on Assurable & Usable Security Configuration ([SafeConfig](#)), Co-located with 16<sup>th</sup> ACM Conf. on Computer and Communications Security ([CCS](#)), Chicago
- 2009 UT-Battelle [Key Contributor Award](#), ([Federal Laboratory Consortium Award](#), [ETT](#)) Sept. 10
- 2009 Panelist, [Talaris Grassroots Roundtable on Cyber Security](#) (Participation by SNL, PNNL, LLNL, LANL, ANL, ORNL, DARPA, UW, CMU, SRI and others; Seattle, Aug. 27-28)
- 2009 Executive Facilitator [National Cyber Leap Year Summit](#), Wash. DC Aug. 16-21; [Chairs](#) and [Participants](#) reports presented to President Obama by Mr. Aneesh Chopra, [Federal CTO](#)
- 2009 [HICSS](#) Minitrack Chair: Cyber Security and Information Intelligence Research in Decision Technologies and Service Sciences Track (*Best attended mini-track 2009*)
- 2009 Keynote Speaker, Evaluating Security Controls Based on Key Performance Indicators & Stakeholder Mission, [IEEE Intelligence and Security Informatics](#) (ISI) Conf., Dallas (June 11)
- 2009 National Laboratory Panelist, 13<sup>th</sup> Colloquium for Information Systems Security Education ([CISSE](#)) Seattle (June 1-3)
- 2009 [FLC Technology Transfer Award for Southeast Region](#) for WIM/AIMVEE
- 2008 ORNL Significant Event [Award for Excellence in Technology Transfer](#) for commercialization of the Weigh-In-Motion (WIM) and the Automated In-Motion Vehicle Evaluation Environment ([AIMVEE](#)) for both military and civilian use
- 2008 Selected as Chief Architect/Software Engineer for the AFSPC [TSAT program](#)
- 2008 Program Chair: [2<sup>nd</sup> DOE Grassroots Cybersecurity Community Town Hall Meeting](#) at ORNL
- 2008 Invited Lecturer: [Sixth Semester of UNESCO Chair](#): Discrete Mathematics and Logic: Foundations and Applications in Software Specification, Analysis and Design (*Week 9: [Cyber Security and Infrastructure Protection](#)*)
- 2008 Invited participant: [DHS S&T Cyber Security Research Roadmap](#) Workshop to expand the INFOSEC Research Council Hard Problem List, sponsored by DHS conducted at SRI International
- 2008-9 Invited participant: Department of Homeland Security and Kauffman Foundation [IT Security Entrepreneurs' Forum](#) (ITSEF conducted at the Arrillaga Alumni Center, Stanford University)
- 2007 [ACSAC](#) Security Engineering Training and Certification
- 2007 UT-Battelle Project Management Training and Certification
- 2004 Elected Senior Member IEEE
- 2000 Participant: [System Safety for Software-Intensive Systems Course](#) ([Nancy Leveson](#))
- 2000 Participant: 5<sup>th</sup> NASA Langley Formal Methods ([LFM2000](#)) Workshop (13-15 June: Williamsburg)
- 2000 European Edu Forum School Participant: Formal Methods & Performance Analysis ([FMPA2000](#))
- 1997-98 [ASEE Fellowship](#): Stanford/NASA Ames Summer Faculty Research Associate/Visiting Scholar
- 1996-97 Outstanding UTA Ph.D. Dissertation Award from UTA Chapter for the [Society of Sigma Xi](#)
- 1995-6 [UTA College of Engineering, Dept. of CSE](#): Outstanding Research by a Ph.D. Student
- 1996 IEEE First Place Graduate Technical Paper Contest (Ft. Worth Sec) [IEEE Region 5](#) cash award
- 1996 [DARPA SBIR](#) with UniSoft Inc., based on Sheldon’s Ph.D. Dissertation (\$100,000)
- 1996 [National Research Council Associateship](#) Awardee at NASA/LaRC (\$84,000)

- 1994 University of Texas at Arlington's ACM Programming Contest Team Coach
- 1993 Runners-Up Best Paper at the Fourth Int'l Conf. on Applications of Software Measurement
- 1993-95 [NASA Graduate Student Researchers Fellowship](#) Recipient at LaRC (\$66,000)
- 1988 Member of Upsilon Pi Epsilon Honor Society in the Computing Sciences
- 1986 Member of Tau Beta Pi International Engineering Honor Society

#### REFEREED JOURNAL AND MAGAZINE ARTICLES

1. Sheldon, F. T. and J. Todd McDonald, "[Introduction to the Special Issue on Cyber Security and Management](#)," [Journal of Information Systems and e-Business Management](#), Springer Berlin (1617-9846).
2. Sheldon, F. T., Webber, J. M., Yoo, S-M and Pan, W. D., "[Insecurity of Wireless Networks](#)," [IEEE Security and Privacy Magazine](#) Special Issue on Internet Infrastructure Security, 10:4, pp. 54-61, July/August 2012.
3. R. K. Abercrombie, L.M. Hively, S.J. Prowell, B.G. Schlicher and F.T. Sheldon, "[Forewarning of Failure in Complex System](#)," [Journal of Homeland Security](#), 5:1, pp. 1-16, June, 2011 ([PDF](#)).
4. A. B. Aissa, R. K. Abercrombie, F. T. Sheldon, and A. Mili, "[Defining and Computing a Value Based Cyber-Security Measure](#)," [Information Systems and E-Business](#), Springer London: April 23, 2011 ([DOI:10.1007/s10257-011-0177-1](#), [Online First](#)).
5. Hively, L.M., **Sheldon, F.T.** and Squicciarini, A., "[A Vision for Scalable Trustworthy Systems](#)," [IEEE Security and Privacy](#), 9:3 July/Aug 2011.
6. **Sheldon, F.T.**, and Vishik, Claire, A., "[Moving Toward Trustworthy Systems: R&D Essentials](#)," [IEEE Computer](#) 43:9, 31-40, September 2010.
7. Aissa, Anis Ben, Abercrombie, Robert K., Y., **Sheldon, F.T.** and Mili, Ali, "[Quantifying Security Threats and Their Impact: Theory and Practice](#)," [Innovations in Systems and Software Engineering](#), (Springer, London: DOI: 10.1007/s11334-010-0123-2) 6:4, 269-281, March 2010 ([Online First](#)).
8. Kanamori, Y., Yoo, S-M, Gregory, D.A. and **Sheldon, F.T.**, "Authentication Protocol using Quantum Superposition States," [Int'l Journal of Network Security](#), (DOI: 10.1.1.159.4531), 9:2, 101-108, September 2009.
9. **Sheldon, F.T.**, and Chung, Hong, "Measuring the Relations Among Class Diagrams to Assess Complexity," [Jr. of Software Maintenance and Evolution: Research and Practice](#), 18:5, 333-350 Sept./Oct. 2006.
10. Kanamori, Y., Yoo, S-M, and **Sheldon, F.T.**, "A Short Survey on Quantum Computers," [Int'l Jr. of Computers and Applications](#), [ACTA Press Calgary](#) 28:3, 227-233, 2006.
11. Mili, A., **Sheldon, F.T.**, Jilani, L.L., Vinkurov, A., Thomasian, A. and Ayed, R.B., "Modeling Security as a Dependability Attribute: A Refinement Based Approach," [Innovations in Systems and Software Engineering](#), (Springer London, DOI: 10.1007/s11334-006-0023-7) 2:1, 9-48, March 2006.
12. Abercrombie, R.K., **Sheldon, F.T.**, Schlicher, R.G. and Daley, K.M., "Development of the Joint Weigh-In-Motion (WIM) and Measurement Reach Back Capability – The Configuration and Data Management Tool" [SOLE Logistics Spectrum Magazine](#), 38:4, pp. 4-9, Dec. 2005.
13. Mili, A., **Sheldon, F.T.**, Mili, F. and Desharnais, J., "Recovery preservation: a measure of last resort," [Innovations in Systems and Software Engineering](#), (Springer London, DOI: 10.1007/s11334-005-0004-2), Vol. 1, No. 1, pp. 54-62, Apr. 2005.
14. **Sheldon, F.T.**, Potok, T.E., Krings, A. and Oman, P., "Critical Energy Infrastructure Survivability, Inherent Limitations, Obstacles and Mitigation Strategies," [Int'l Jr. of Power and Energy Systems –Special Theme Blackout](#), [ACTA Press](#), pp. 86-92, PowerCon Special Issue 2004
15. **Sheldon, F.T.**, Potok, T.E. and Kavi, K.M., "Multi-Agent System Case Studies in Command and Control, Information Fusion and Data Management," [Informatica Int'l Journal](#), Vol. 28, pp. 79-89, 2004.
16. **Sheldon, F.T.** and Kim, H.Y., "Testing Software Requirements with Z and Statecharts Applied to an Embedded Control System," [Software Quality Jr.](#), [Kluwer](#), Vol. 12, Issue 3, pp. 231-266, 2004.
17. **Sheldon, F.T.**, Jerath, Kshamta and Chung, Hong, "Metrics for Maintainability of Class Inheritance Hierarchies," [Jr. of Software Maintenance and Evolution](#), [John Wiley and Sons](#), 14:3, pp. 147-160, May/June 2002.
18. **Sheldon, F.T.**, Xie, Gaoyan, Pilskalns, Orest and Zhou, Zhihe, "Survey of Rigorous Software Specification and Design Tools," [Software Focus](#), [John Wiley and Sons](#), 2:4, pp. 140-150, Winter. 2001.
19. **Sheldon, F.T.** and Greiner, S.A., "Composing, Analyzing and Validating Software Models to Assess the Performability of Competing Design Candidates," [Annals of Software Engineering \(Spec. Issue Software Reliability, Testing and Maturity\)](#), [Kluwer](#), 8:1-4, pp. 239-287, 1999.
20. Kavi, K.M., **Sheldon, F.T.** and Reed, S.C., "Specification and Analysis of Real-Time Systems Using CSP and Petri Nets," [Int'l Journal of Software Engineering and Knowledge Engineering](#), June 1996.
21. **Sheldon, F.T.**, Kavi, K.M., Everett, W.W., Brettschneider, R., Yu, J.T., and Tausworthe, R.C., "Reliability Measurement: From Theory to Practice," [IEEE Software](#), pp. 13-20, July 1992.

## Patents Pending / Invention Disclosures

1. ID 201202785 Method to Evaluate Denial of Service Attacks Using MFC and ROI, F. T. Sheldon and A. Mili, January 22, 2012.
2. ID 201102583 and 201102584 Enhanced Methods for Normalizing Data for Analysis of Search Results, F. T. Sheldon and R.K. Abercrombie, April 11, 2011.
3. ID 201002343 Cyberspace Security Econometrics System (CSES) Expansion to Address Dependent Events, E.M. Ferragut, R.K. Abercrombie and F. T. Sheldon, August 1, 2010.
4. ID 201002482, DOE-S Number: S-115,TBA – Cyber Security Econometrics System (CSES) for Assessing/ Ranking Threats, F. T. Sheldon and R. K. Abercrombie, December 3, 2010.
5. ID 201002432, DOE-S Number: S-115,484 – Environment for Access Control Policy Analysis and Management of Sensors, F. T. Sheldon and R. K. Abercrombie, July 23, 2010.
6. "Portable Weighing System," R. K. Abercrombie, G. D. Richardson, M. B. Scudiere, and F. T. Sheldon, U.S. Patent Pending (March 26, 2010).
7. ID 200902353, DOE-S No. S-115,393 – Ontology-Based Probability Modeling for Distributed Real-Time Anomaly Detection, E. M. Ferragut, R. K. Abercrombie, B. J. Lagesse, F. T. Sheldon, G. A. Shue, C. T. Rathgeb, L. P. Wilder, December 28, 2009.
8. ID 200902343, DOE-S No. S-115,383 – Cyberspace Security Econometrics System (CSES) Expansion to Address Dependent Events, E. M. Ferragut, F.T. Sheldon and R. K. Abercrombie, November 30, 2009.
9. ID 200902254, "Heuristic Insider Threat Evaluation and Response (HITER)," Frederick T. Sheldon and Robert K. Abercrombie, May 7, 2009.
10. ID 1300002045, L.M. Hively, R. K. Abercrombie, and F. T. Sheldon, Failure Prediction of Complex Structures under Arbitrary Time-Serial Loading Condition, U.S. Patent Pending (August 26, 2009)
11. ID 1300001980, F. T. Sheldon, R. K. Abercrombie, and A. Mili, System and Method for Implementing and Monitoring a Cyberspace Security Econometrics System and other Complex Systems, U.S. Patent Pending (May 12, 2008) and Copy Rights assertion by DOE Office of Scientific and Technical Information ([OSTI](#)) January 2011.

## TUTORIAL BOOK / CHAPTERS

1. "Federal Cyber Security R&D Program Thrusts," Eds. **Sheldon, F.T.**, and Giani, A, *ACM Proc. 8<sup>th</sup> Ann. Cyber Security and Information Intelligence Research Workshop*, Oct. 29-Nov. 1, 2012 (ISBN 978-1-4503-1687-3). To be published November 2012.
2. "Special Issue on Cyber Security and Management," [Journal of Information Systems and e-Business Management](#), Springer Berlin (1617-9846), Guest Editor Frederick T. Sheldon, To Appear.
3. Hamed Okhravi, Fredrick T. Sheldon and Joshua Haines, "Using Data Diodes in Architectures to Support Trustworthy Physical Cyber Infrastructures" Chapter in [Systems and Optimization Aspects of Smart Grid Challenges](#), [Book Series](#), Springer, London, Submitted Feb. 15 2012 (In Review).
4. "Energy Infrastructure Cyber Protection," Eds. **Sheldon, F.T.**, Abercrombie, R.K. And Krings, A., *ACM Proc. 7<sup>th</sup> Ann. Cyber Security and Information Intelligence Research Workshop*, Oct. 12-14, 2011 (ISBN [978-1-4503-0945-5](#)).
5. "Cyber Security and Information Intelligence Challenges and Strategies," Eds. **Sheldon, F.T.**, Prowell, S.J., Krings, A. and Abercrombie, R.K., *ACM Proc. 6<sup>th</sup> Ann. Cyber Security and Information Intelligence Research Workshop*, Apr. 13-15, 2010 (ISBN [978-1-4503-0017-9](#))
6. "Cyber Security and Information Intelligence Challenges and Strategies," Eds. **Sheldon, F.T.**, Peterson, G.D., Krings, A., Abercrombie, R.K. and Mili, A., *ACM Proc. 5<sup>th</sup> Ann. Cyber Security and Information Intelligence Research Workshop*, Apr. 13-15, 2009 (ISBN [978-1-60558-518-5](#))
7. "Towards Comprehensive Strategies that Meet the Cyber Security and Information Intelligence Challenges Ahead," Eds. **Sheldon, F.T.**, Abercrombie, R.K., Krings, A., and Mili, A., *ACM Proc. 4<sup>th</sup> Ann. Cyber Security and Information Intelligence Research Workshop*, May 14-15, 2008 (ISBN [978-1-60558-098-2](#))
8. "Towards Comprehensive Strategies that Meet the Cyber Security Challenges of the 21<sup>st</sup> Century," Eds. **Sheldon, F.T.**, Krings, A., Yoo, Seong-Moo and Mili, A., *Proc. 3<sup>rd</sup> Ann. Cyber Security and Information Infrastructure Research Workshop*, [Publisher: Oak Ridge National Laboratory](#), May 14-15, 2007.
9. "Beyond The Maginot Line," Eds. **Sheldon, F.T.**, Krings, A., Yoo, Seong-Moo, Mili, A. and Trien, J., *Proceedings of the 2<sup>nd</sup> Ann. Cyber Security and Information Infrastructure Research Workshop*, [Publisher: Oak Ridge National Laboratory](#), May 10-11, 2006.

10. Kim, H.Y, Jerath, K. and **Sheldon, F.T.**, "Assessment of High Integrity Components for Completeness, Consistency, Fault-Tolerance and Reliability," Chapter in [Component-Based Software Quality: Methods and Techniques](#), a book edited by Alejandra Cechich, Mario Piattini, and Antonio Vallecillo, *Springer LNCS Vol. 2693, Heidelberg*, pp. 259-86, 2003.
11. Sheldon, F.T., Specification and Analysis of Stochastic Properties for Concurrent Systems Expressed Using CSP, Computer Science and Engineering Dept, The University of Texas at Arlington, 260 Refs., Ann Arbor, Michigan UMI Dissertation Services, May 1996.

#### SELECTED REFEREED PROCEEDINGS

1. R.K. Abercrombie, F.T. Sheldon, Katie R.Hauser, Margaret W.Lantz, and Ali Mili, "Risk Assessment Methodology Based on the NISTIR 7628 Guidelines" IEEE Proc. Of The Hawaii International Conference on System Sciences (HICSS-46), Maui HI, Jan 7-10 2013 (runners-up best paper).
2. Frederick Sheldon, Jingshan Huang, Jiangbo Dang, Daniel Fetzer, Stuart Goose, Jonathan Kirsch, David Manz, Thomas Morris and Dong Wei. "Intrinsically Resilient Energy Control Systems," ACM Proceedings 8th Annual Cyber Security and Information Intelligence Research Workshop, Oak Ridge, TN, Jan. 8-10, 2013 (to appear).
3. M. Duren, H. Aldridge, F.T. Sheldon, and R. K. Abercrombie, "Designing and Operating Through Compromise: Architectural Analysis of CKMS for the Advanced Metering Infrastructure" ACM Proceedings 8th Annual Cyber Security and Information Intelligence Research Workshop, Oak Ridge, TN Jan. 8-10, 2013 (to appear).
4. Robert K. Abercrombie, Frederick T. Sheldon, Katie R.Hauser, Margaret W.Lantz, and Ali Mili, "Failure Impact Analysis of Key Management in AMI Using Econometric Assessment" ACM Proceedings 8th Annual Cyber Security and Information Intelligence Research Workshop, Oak Ridge, TN, Jan. 8-10, 2013 (to appear).
5. Sheldon, Frederick; Fetzer, Daniel; Huang, Jingshan; Dang, Jiangbo; Wei, Dong; Manz, David; Morris, Thomas; Kirsch, Jonathan; and Goose, Stuart, "[Using Semantic Technologies to Develop Intrinsically Resilient Energy Control Systems.](#)" In [Proceedings of the 7th International Conference on Semantic Technologies for Intelligence, Defense, and Security \(STIDS 2012\)](#). Fairfax, VA, October 24-26. CEUR-WS.org, vol. 966, pp 96-103.
6. Hariri, Salim, Sheldon, Frederick T., and Eltoweissey, Mohamed, "Moving Target Defense Middleware for Intrusion Resilient Cloud Services," Chapter in National Symposium on Moving Target Defenses, Springer, London, Submitted April 2, 2012 (Accepted as a poster).
7. Kim, Yoohwan, Sheldon, Frederick T., and Hively, Lee M., "[Anomaly Detection in Multiple Scale for Insider Threat Analysis.](#)" ACM Proceedings 7th Annual Cyber Security and Information Intelligence Research Workshop, Oak Ridge, TN October 12-14, 2011 (Extended Abstract and Poster).
8. R. K. Abercrombie, F. T. Sheldon, H. Aldridge, M. Duren, T. Ricci, E. Bertino, A. Kulatunga, and U. S. Navaratne, "[Secure Cryptographic Key Management System \(CKMS\) Considerations for Smart Grid Devices.](#)" ACM Proceedings 7th Annual Cyber Security and Information Intelligence Research Workshop, Oak Ridge, TN October 12-14, 2011 (Extended Abstract and Presentation ).
9. Dasgupta, Dipankar, Ali, Mohammad Hassan, Abercrombie, Robert K, Schlicher, Bob G, Sheldon, Frederick T. and Carvalho, Marco, "[Secure VM for Monitoring Industrial Process Controllers.](#)" ACM Proceedings 7th Annual Cyber Security and Information Intelligence Research Workshop, Oak Ridge, TN., October 12-14, 2011 (Extended Abstract and Presentation).
10. Sheldon, F.T., Duren, M. and Bertino, E, "Prospectus: Adaptive Resilient Cryptographic Key Management System (CKMS) for Energy Delivery Systems (EDS)," [Smart Grid Cybersecurity Information Exchange](#), Chicago, [Abstract and Poster](#), August 23-24, 2011.
11. Sheldon, F.T., and Duren, M., "Key Management Challenges in the Smart Grid," [Extended Abstract Presented at Systems and Optimization Aspects of Smart Grid Challenges](#), University of Florida, Gainesville, FL, April 28-30, 2011.
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#### PROPOSALS ([P] Pending | [F] Funded | [NF] Not Funded)

1. Siometrics for Supply Chain Risk Management (SCRM), Solicitation # [DE-FOA-0000797](#) Innovation for Increasing Cybersecurity for Energy Delivery Systems, 5 Apr. 2013 \$4M: 36 mos., Sypris Electronics Lead, ORNL PIs: F. Sheldon and R. Abercrombie [P]

2. Survivable SCADA, Solicitation # [DE-FOA-0000797](#) Innovation for Increasing Cybersecurity for Energy Delivery Systems, 5 Apr. 2013 \$1.5M: 24 mos., Siemens Corp. Research Lead, ORNL PI: F. Sheldon [P]
3. A Semantic Framework for Representing Data, Querying Global/Local Temporal Ontologies and Linking Published Data Sources, Solicitation # [ICPDP-2013-0001](#) Area 12.18: Mapping Semantic Times onto Place Names, 18 Jan. 2013, \$240,000: PoP 24 mos., F. Sheldon (PI), J. Huang (Co-PI) [P].
4. Investigating Online Stimuli of Influence and Persuasion within Social Structures Using a Small World Simulation Tool, Solicitation # [ICPDP-2013-0001](#) AREA 12.5: How Will They React and Who Are They?, 18 Jan. 2013, \$240K: PoP 24 mos., F. Sheldon (PI), J. Stoll (Co-PI) [P].
5. RECON: REsearch on COMplex Networks: Uncovering Latent Anomalies in Dynamic Graphs, [Network Science Division](#) (R. Erbacher ) Army Research Laboratory (ARL), 15 Sept. 2012, PIs: F. Sheldon (ORNL), M. Langston (UTK), PoP 12 Months, \$0.230M requested [NF].
6. EDS Security Econometrics System (ESES), [New AOP FY13 Frontier Project](#): \$200K FY 2013, F Sheldon and R. Abercrombie (and industry partners) [NF].
7. Byzantine Resilient Controls (BRC), [New AOP FY13 Frontier Project](#): \$200K FY 2013, F. Sheldon, with Siemens and USA partners), [NF].
8. InTRECS: InTrinsically Resilient Energy Control System, Submitted July 3, 2012 to Department of Energy Office of Electricity ([RC-CEDS-2012-02](#)) Project Area 2, PIs F. Sheldon and D. Fetzer (ORNL), D. Manz, (PNNL), J. Huang, U. So. Alabama, T. Morris, MSU, and D. Wei, J. Dang, J. Kirsch, and S. Goose, Siemens Corporate Research; PoP 36 Months, \$2.975M [NF].
9. **SCI-FI: Supply Chain Integration For Integrity**, Submitted July 2, 2012 to Department of Energy Office of Electricity ([RC-CEDS-2012-02](#)) Project Area 3, PI David Manz, Co-PIs Josef Allen, Ph.D. And Frederick Sheldon Ph.D. (ORNL), Dan Quinlan, Ph.D. (LLNL), Ken Masica (LLNL), Jessica Smith (PNNL); PoP 36 Months, \$3M Requested [F].
10. Ensemble: Advanced Cyber Defensive (ACD) Tools-kit for Strengthening Underlying Foundational Research in Insider Modeling/Assessment, Intrusion Detection and Econometric Ranking, 20 May 2012, [Network Science Division](#), US Army Research Laboratory (ARL) PI Frederick Sheldon, Co-PI Lee Hively ORNL and Robert Erbacher ARL; PoP 15 Months, \$0.525M requested [NF].
11. Cyber-Intelligence for Smart Grid Transmission Systems, [DE-FOA-0000698](#) ([LAB 12-698](#)) 2012 Mathematical Multifaceted Integrated Capability Centers (MMICCs), 30 April 2012; Ganesh Kumar Venayagamoorthy, Richard Brooks and Amy Apon, Clemson U.; Asok Ray and Shashi Phoba, PSU; and F. Sheldon and M. (Arjun) Shankar ORNL; PoP 5Yrs \$2M/yr (\$5M/yr to ORNL) \$10M Requested [NF].
12. **DDAS-based Resilient Cyberspace** (DRCS) [Dynamic Data Driven Applications Systems], Full proposal in response to [BAA-AFOSR-2011-01](#) (PM Dr. Frederica Darema, AFOSR/RSE), University of Arizona Primed Proposal, Submitted 1 March 2012, PoP 48 mos., Start Oct. 1, 2012, Salim Hariri, Youssif Alnashif, Mohamed Eltoweissy and Ricardo Valerdi PIs at the Univ. of AZ , *F.T. Sheldon PI ORNL*, (\$200,000 ORNL Part \$1.2M Total Request [F]).
13. **Island World: A Small World Simulation Tool in a Virtual Community for Evaluating Environmental Stressors**, Submitted to: Research Solicitation # ICPDP-2012-0001 AREA 12.32. Cyber Space Derivation of Social Patterns with Respect to Stressors, Submitted 24 Jan. 2012, \$239,808: PoP 24 mos., F. Sheldon (PI), R. Abercrombie (Co-PI) and M. Campbell (Co-PI) [F].
14. **Cyber Sciences Laboratory (CSL) Implementation**, NNSA OCIO request for DOE National Laboratory Cyber Security Grassroots Support for 8 DOE Laboratories and CSIIR/CSL Workshop (PM/NNSA-CIO Robert Osborn), ORNL Lead, 19 Dec. 2011, PoP 12 mos., Started March 1, 2012, *F.T. Sheldon, Joe Trien, Dick Davis, Dick Webber PIs ORNL*, (\$1,300,000 [F]).
15. **Cyber Security and Information Intelligence Workshop** (7<sup>th</sup> Annual Oct. 12-14), Submitted June 2011, PoP 9 mos., Start July 1, 2011, *F.T. Sheldon and J.P. Trien, PIs ORNL*, (\$150,000 [F]).
16. Cyber Security Econometrics System (CSES) for Assessing/Ranking Threats, Full proposal in response to [DARPA ADAMS BAA 11-04 Extended](#) (PM Rand Waltzman), ORNL Primed Proposal, Submitted 1 Jul. 2011, PoP 24 mos., Start Oct. 1, 2011, *F.T. Sheldon PI ORNL*, (\$670,000 ORNL Part [NF]).
17. Cyber Metrics Research to Support the Gulf of Mexico Research Initiative, [GRI RFP-1](#): Selection of Research Consortia for GRI Years 2–4 (1 June 2011 – 31 May 2014), Alec Yasinsac, Univ. of Southern Alabama, Prime PI, 7 July 2011, PoP 36 mos., F. Sheldon and S. Prowell Co-PIs ORNL (\$2,500,000 [NF]).
18. Cyber Security Research Supporting a Teaming Agreement for BAA DHS 11-02 TTA-2 Enterprise-Level Metrics, Proposal to [DHS Cyber Security R&D](#), Sonalysts Inc. Prime, 7 July 2011, PoP 36 mos., O. McCusker, PI Sonalysts, F. Sheldon, PI ORNL, J. Williams PI MIT, (\$465,000 [NF]).
19. Cyber Security Econometrics System (CSES) for Assessing/Ranking Threats, Full proposal in response to [DARPA ADAMS BAA 11-04](#) (PM Rand Waltzman), BAE Primed Proposal Entitled: Anomaly Detection at Multiple Scales ([ADAMS](#)) System, Submitted 09 Dec. 2010, PoP 24 mos., Start Mar. 1, 2011, *Majid*

- Zandipour and Bradley Rhodes, Co-PIs, BAE Systems National Security Solutions, Inc., F.T. Sheldon PI ORNL, Mike Langston and Doug Birdwell, UTK/EECS, (\$679,821 ORNL Part [NF]).*
20. Autonomic Management of Software Faults in HPC, Solicitation # [DE-FOA-0000413](#) SBIR/STTR – CFDA Number: 81.049, *Topic 40h: Software Fault Detection*; DOE/ASCR, 15 Nov. 2010, PoP 12 mos., SOC 6-2011, T. Kim, PI, Ridgetop Group Inc., F.T. Sheldon, Co-PI, ORNL. (\$100K, ORNL \$25K [NF]).
  21. Techniques for Integration and Interactive Visual Analysis of Multidisciplinary Scientific Data, Solicitation # [DE-FOA-0000413](#) SBIR/STTR – CFDA Number: 81.049, *Topic 41e: Techniques for Integration and Interactive Visual Analysis of Multi-Disciplinary Scientific Data*; Advanced Scientific Computing Research, Submitted 15 Nov. 2010, PoP 12 mos., SOC June 2011, Tim Kim, PI Ridgetop Group Inc., F.T. Sheldon, Co-PI ORNL. (\$100K, ORNL \$15K [NF]).
  22. Trusted Computing, Full proposal in response to NSF 10-575 *Cross Cutting Programs in Trustworthy Computing and Network Science and Engineering program* (PM: Samuel Weber) Submitted 28 Nov. 2010, PoP 36 mos., Start June 1, 2011, Ali Mili PI NJIT, F. Sheldon and R. Abercrombie Co-PIs ORNL (\$500,000 ORNL Part [NF]).
  23. Data Exfiltration and Loss Prevention (DELP): Canonical Use Cases from Empirically Based Observables and Mission-Tailored Technical Countermeasures to Insider Threat, Full proposal in response to DARPA Cyber Insider Threat ([CINDER](#)) BAA 10-84 (PM: P. Zatzko), Submitted 27 Oct. 2010, PoP 14 mos., *F.T. Sheldon PI, Richard Brooks Co-PI Clemson, Dawn Capelli, Co-PI SEI/CERT, Andrew Potter, Co-PI Sentar Inc.*, (\$3,279,000 Total [NF]).
  24. EXAM-EDS: An Environment for Access Control Policy Analysis and Management for Energy Delivery Systems (Project #2: Management of Access Control), Full Proposal in Response to DOE [RC-CEDS-2010](#) Technical Support for Cybersecurity for Energy Delivery Systems, Submitted 28 July 2010, PoP 24 mos., *F.T. Sheldon PI ORNL, Elisa Burtino Co-PI Purdue, Jorge Lobo Co-PI IBM T. J. Watson Research Center, Sami Ayyorgun Co-PI Telcordia, including N. Li, Purdue; M. (Arjun) Shankar, A. D. Dimitrovski, Stacy Prowell ORNL; Suresh Chari and Pau-Chen Cheng IBM T. J. Watson Research Center* (\$3M Total [NF]).
  25. Application for Centralized Cryptographic Key Management, Full proposal in response to Funding Opportunity Number: [DE-FOA-0000359](#), Innovation for Increasing Cyber Security for Energy Delivery Systems (I2CSEDS), (FWP# CETD101 Submitted 9 July 2010), PoP 36 mos., *Hal Aldridge and Mike Duren PIs Sypris Electronics, LLC, F.T. Sheldon and R. K. Abercrombie Co-PIs ORNL, Elisa Burtino Co-PI Purdue* (ORNL: \$706,000; Purdue: \$350,000; Sypris: \$2,000,000; \$3.056M Total [F]).
  26. Highly Assured Data Collection, Situation Awareness (HADSAs) Visualization Tool for Energy Delivery Systems (EDS), Full proposal in response to Funding Opportunity Number: [DE-FOA-0000359](#), Innovation for Increasing Cyber Security for Energy Delivery Systems (I2CSEDS), Submitted 9 July 2010, PoP 36 mos., *F.T. Sheldon PI, Elisa Burtino Co-PI Purdue, Paul Myrda, Co-PI EPRI, Chinni Ranganath, Co-PI Space-Time-Insight Inc., Dieter Gawlick, Oracle Corp., also including, Dr. Erik Ferragut, Dr. Mallikarjun Shankar, R. Abercrombie, A. D. Dimitrovski and Yilu Liu* (\$3,164,960 Total Fed+Non-Fed funds [NF]).
  27. Cyber Security for the Smart-Grid, Full proposal in response to ORNL LDRD Advanced Energy Initiative, 21 July 2009, PoP 24 mos., *F.T. Sheldon PI*, (\$ 750,000 Total [NF]).
  28. Studies to Improve the Precision and Accuracy of Network Tomography, Solicitation # [ICPDP-2010-0001](#) *AREA 12.47 Network Tomography: Logical and Physical Network Mapping*, 1 Jan. 2010, \$239,808: PoP 24 mos., Craig Shue (PI) and Frederick Sheldon (Co-PI) [NF].
  29. **Advanced Data Fusion Methods for Veracity Scoring**, Solicitation # [ICPDP-2010-0001](#) *AREA 12.16 Veracity Scoring and Data Fusion*, 1 Jan. 2010, \$239,808: PoP 24 mos., Erik Ferragut (PI) and Frederick Sheldon (Co-PI) [F].
  30. **Using Semantic Analysis to Detect and Classify Executables for Computer Forensics**, Solicitation # [ICPDP-2010-0001](#) *AREA 12.27. Advance Computer Media Forensics Capabilities for Extracting Forensic Artifacts*, 1 Jan. 2010, \$239,808: PoP 24 mos., S. Prowell (PI) F. Sheldon (Co-PI) [F].
  31. Brain-Wave Biometric from Scalp EEG, Solicitation # ICPDP-2010-0001 *AREA 12.5, 12.25, 12.46 (biometrics)*, 1 Jan. 2010, \$239,808: PoP 24 mos., Lee Lively (PI) and Frederick Sheldon (Co-PI) [NF].
  32. *NORAD: a Network Overlay for Resilient and Adaptive Defense* Full proposal in response to ONR BAA 10-004 Computer Network Defense, PoP 6 mos. (Phase II 36 mos.) \$1.2M Phase I, Hao Che (PI UTA), Frederick Sheldon (PI ORNL), Mohan Kumar (UTA Program Manager), Brent Lagesse (ORNL), Donggang Liu (UTA), Matthew Wright (UTA) [NF].
  33. Cyber Security for the Smart-Grid, Full proposal in response to ORNL LDRD Advanced Energy Initiative, 21 July 2009, PoP 24 mos., *F.T. Sheldon PI, S. Fernandez, Arjun Shankar, L. MacIntyre, J. Nutaro, T. Kuruganti, J. Stovall and T. Smith (ORNL) A. Giani and S. Sastry (UC Berkeley), W. Sanders and C. Gunter (UIUC) and T. Benzal (ISI/U. So. California)*, (\$ 750,000 Total [NF]).

34. Thwarting Online Deception and Phishing with Honeypots and DNS Analysis, Proposal S10-049 presented by C. A. Shue (CSED) including F. T. Sheldon (CSED), G. C. Hinkel (CCSD), M. Gupta (Indiana U), and A. J. Kalafut (Indiana U) were co-authors. PoP: 1 year starting: June 1, 2010 \$189,800 [F].
35. Defensive Cyber Security: Protecting Users and Critical Information from Phishing and Whaling Attacks, Full Proposal in response to ORNL LDRD Ultrascale Computing Initiative, 30 July 2009, PoP 24 mos., *Craig Shue PI, F.T. Sheldon Co-PI, Dave Richardson, Gregory Hinkel (ORNL) Minaxi Gupta (Indiana U.) and Calton Pu (Georgia Tech)*, (\$750, 000 Total) [NF].
36. Enhancing Cyber Security for Control Systems and the Smart Grid, Full Proposal in response to SERRI Expression of Interest, No. FY09 MRI-76-01, 13 July 2009, PoP 24 mos., *Yoginder S. Dandass and Rayford B. Vaughan (MSU), F.T. Sheldon & Frank DeNap (ORNL)*, (\$750,000 Total [\$250K ORNL]) [NF].
37. Highly Assured Data and Situation Awareness for Complex Interconnected Critical Infrastructure Systems, in response to DOE LAB 09-23 Mathematics for Complex, Distributed, Interconnected Systems, Office of Advanced Scientific Computing Research (ASCR) of the Office of Science (SC), 12 June 2009, PoP 24 mos., *F.T. Sheldon, PI (ORNL), Anna Squiccarini (PSU), Elisa Bertino and Hyo-Sang Lim (Purdue), Latifur Khan and Bhavani Thuraisingham (UTD), Annarita Giani and Shankar Sastry (UC Berkeley) and Chin-Tser Huang (U.S. Carolina)*, (\$1.867M Total) [NF].
38. Threat Assessment and Risk Analysis – Quantitative System, Full Proposal in response to BAA # 07-09 (TTA3) 27 June 2007, PoP 18 mos., *Beth Bidwell (LMCO), F.T. Sheldon (ORNL) Ali Mili (NJIT) and Brian Witten (Symantec)*, (\$1,500,000 Total) **Selected but not funded** [NF].
39. A Scalable Visual Analytics Toolset for Cyber Security, White Paper in response to BAA # 07-09 (TTA4) 27 June 2007, PoP 36 mos., *Mohamed Eltoweissy PI, Shawn A. Bohner, Denis Gracin, Chris North, Jung-Min Park (Virginia Tech.) and F.T. Sheldon (ORNL)*, (\$1,656,251 Total [NF]).
40. Composing Attributes for Scalable Security (CASS), White Paper in response to BAA # 07-09 (TTA2) 27 June 2007, PoP 36 mos., *F.T. Sheldon PI (ORNL) and Ali Mili (NJIT)*, (\$2,000,000 Total [NF]).
41. Maximizing Performance, Availability, Security and Survivability (MaxPASS) White Paper in response to BAA # 07-09 (TTA7) 27 June 2007, PoP 36 mos., *F.T. Sheldon PI (ORNL), Ali Mili (NJIT) and Axel Krings (Univ. of Idaho)*, (\$2,000,000 Total [NF]).
42. Multi-scope Anomaly Detection System (MADS), White Paper in response to BAA # 07-09 (TTA2) 27 June 2007, PoP 36 mos., *F.T. Sheldon PI (ORNL), Chin-Tser Huang and Yong-June Shin (Univ. of S. Carolina)* (\$1,316,609 Total [NF]).
43. Intrinsically Assurable Resource Aware MANET (IARA-MANET), Full Proposal in response to BAA # 07-32 (DARPA/STO) 26 June 2007, PoP 18 mos., *F.T. Sheldon PI (ORNL), Chin-Tser Huang (Univ. of South Carolina), Anish Arora (Ohio State Univ.), Sandeep Kulkarni (Michigan State Univ.), Axel Krings (Univ. of Idaho) and Itamar Elhanany (Univ. of Tennessee)*, (\$2,450,000 Total [NF]).
44. Crisis Early Warning using Gaming and Strategy Evaluation, Full Proposal in response to BAA # 07-10 (DARPA/IPTO) 20 Feb. 2007, PoP 60 mos., *F.T. Sheldon PI (ORNL), R.R. Brooks (Clemson), Christopher Griffin (ARL, Penn State U.), Steve Racunas (Stanford, ISLE)* (\$5,000,000 Total [NF]).
45. CPE Commander's Predictive Environment – Understanding the Battlespace, Full Proposal in response to BAA # 06-07-IFKA 15 Dec. 2006, PoP 12 mos., *Christopher Griffin (ARL, Penn State U.), R.R. Brooks (Clemson) F.T. Sheldon (ORNL)*, (\$400K Total [NF]).
46. PAINT Proactive Intelligence, Full proposal and briefing in response to AFRL BAA-07-01-IFKA (DEPV: a framework for dynamic intelligence gaming and strategy evaluation) 03 Dec. 2006, Period of performance: 31 Mar 2007 – 30 Sept. 2011, PI F.T. Sheldon (ORNL), Subcontractors: *Christopher Griffin (ARL, Penn State U.), R.R. Brooks (Clemson)*, Estimated Cost: \$500,000 per annum (\$2,250,00 Total [NF]).
47. TANGRAM Intelligence Extraction, White paper submitted in response to AFRL BAA-06-04-IFKA (GAP FILLING TECHNOLOGIES) 30 SEPT 2006, Period of Performance: 1 June 2007 - 31 May 2010 (12 Mos. Base + 24 Mos. Option) *Christopher Griffin (ARL, Penn State U.), R.R. Brooks (Clemson) and F.T. Sheldon*, Estimated Cost: \$550K/annum (\$1.65M Total [NF]).
48. Relationship Inference and Behavior Analysis through a Logic of Disputants, White paper submitted in response to BAA 06-016-Trust 2 Automated Information Integration, *Christopher Griffin (ARL, Penn State U.), R.R. Brooks (Clemson) and F.T. Sheldon*, (ROM estimated cost \$1.35M [NF]) July 2006.
49. Relationship Inference and Behavior Analysis through a Logic of Disputants, White paper submitted in response to BAA 06-010-Trust 2 Context Aided Inferencing, *Christopher Griffin (ARL, Penn State U.), R.R. Brooks (Clemson) and F.T. Sheldon*, (ROM \$1.9M Apr. 2006, ONR selected for presentation [NF]).
50. War Game Optimal Offensive Adversaries, White paper submitted in response to ONR solicitation 06-Q-5575 (BAA 06-Q-5570-TSWG), *Christopher Griffin (ARL, Penn State U.), R.R. Brooks (Clemson) and F.T. Sheldon*, (ROM estimated cost \$850K) June 2006 [NF].
51. A Tool for Online Security Management, White paper submitted to DHS TSA in response to TSRDOS-BAA RED028 *A. Mili (NJIT) and F.T. Sheldon*, August 2005 [NF].

52. Strategic COTS Program Situation Inference (SCPSI), Submitted in response to the NSF Cyber Trust (06-517) program, *R.R. Brooks (Clemson) and F.T. Sheldon*, Nov. 2005 [NF].
53. Strategic COTS Program Situation Inference, submitted in response to DARPA IPTO BAA 05-51 Application Communities, *R.R. Brooks, F.T. Sheldon, B. Schlicher (EigenSoft Inc.)* (Requested \$1.5M [NF]) Oct. 2005 [NF].
54. Novel Security Mechanisms for Mobile Code and Mobile Ad Hoc Network Environments, Proposal to the FY 2006 Director's R&D Fund, *M. Neergaard, F. Sheldon, R. Brooks (Clemson) and A. Mili (NJIT)*, (Requested \$435K), Sept. 2005 [NF].
55. **Weigh in Motion (WIM) and the Automated In-Motion Vehicle Evaluation Environment (AIMVEE)**, Proposal to USTRANSCOM (including CASCOM and TRADOC) *R. Abercrombie, L. Hively, G. David Richardson and F. Sheldon, Computational Sciences and Engineering; William Besancenez, Contracts; David Beshears, Measurement Science and Systems Engineering; Julius Coats Jr., National Security Directorate; Mark Reeves, Partnerships Directorate; Matthew Scudiere and Clifford White, Energy and Transportation Science*, (Requested \$7.5M see our award for Excellence in Technology Transfer Award [here](#)), October 2004 [F]
56. Verifiable Architectures for Space Assembly Systems, *Proposal to HR&T BAA TB-0402 (NASA HQ) (PI: J. Schumann<sup>1</sup>, A. Annaswamy<sup>2</sup> S. Dubowsky<sup>2</sup> R. Mahl and F. T. Sheldon<sup>3</sup>, [1. Automated Software Engineering Group, NASA ARC, 2. MIT/ Mech. Eng. 3. CSED, ORNL])* \$20M/4yrs. Requested (ORNL would get 650K), Sept. 2004 [NF].
57. Distributed SCADA Architecture for Advanced Power Grid Control, *Proposal to ORNL LDRD (Lab Directed R&D) (PI: S. Batsell<sup>1</sup>, Co-PIs: M. Shankar<sup>1</sup>, F. DeNap<sup>1</sup>, F. T. Sheldon<sup>1</sup>, and Massoud Amin<sup>2</sup> [1. CSED, 2. Elec. and Computer Engrng, Univ. of MN])* \$545,000 , June 2004 [NF].
58. Collaborative Research: Practical Rigorous Software Design, *Proposal to NSF/CISE (04-552)*, (PI: S. Prowell, U. Tenn. with Co-PI: **F.T. Sheldon** ORNL, M.A. Langston, and W.T. Swain U. Tenn., A. Esterline NCAT, J. Schumann NASA/ARC, and A. Hevner USF) \$1,921,081], May 19, 2004 [NF].
59. Critical Cyber-infrastructure Software for Security, Scalability and Survivability *Proposal to ONR* (in response to FY 2004 Special Competition for CIP/SW of the Multidisciplinary Research Program of the University Research Initiative BAA) (PI: M. Langston with Co-PI's **F.T. Sheldon** ORNL, D. Kafura Virginia Tech., and A. Esterline NCAT) \$1,000,000, Mar. 3, 2004 [NF].
60. Towards Refinement Based Verification of Online Adaptive Systems *Proposal to NSF/CISE (Highly Dependable Computing and Communications Systems Research program with NASA, nsf03-557)* (PI: **F.T. Sheldon**, with Co-PI's: M. Hinchey, NASA GSFC; A. Mili, NJIT) \$640,000, Feb. 27, 2004 [NF].
61. Autonomic Survivable Cyber-Secure Infrastructures *Proposal to NSF (Information Technology Research (ITR) program, nsf04012)* (Proposal #LOI2713), (PI: M. Langston U. Tenn. with Co-PI's: **F.T. Sheldon**, ORNL; A. Krings B. Johnson and P. Oman, U. Idaho; A. Domijan, U. Florida, and D. Kafura Virginia Tech.) \$4,000,000, Feb. 24, 2004 [NF].
62. A Risk-Based Decision Support Framework for Foreign Animal and Zoonotic Disease Defense *Proposal to DHS*, (PI: S.R. Thompson UTK, with Co-PI's: **F.T. Sheldon** ORNL, and a group from Virginia Tech.) \$5,400,000, Feb. 2004 [NF].
63. A Risk-Based Decision Support Framework for Foreign Animal and Zoonotic Disease Defense *Proposal to DHS*, (PI: S.R. Thompson UTK, with Co-PI's: **F.T. Sheldon** ORNL, and a group from Univ. of Maryland) \$3,550,000, Feb. 2004 [NF].
64. A Risk-Based Decision Support Framework for Foreign Animal and Zoonotic Disease Defense *Proposal to DHS*, (PI: S.R. Thompson UTK, with Co-PI's: **F.T. Sheldon** ORNL, and a group from Iowa State Univ.) \$2,415,000, Feb. 2004 [NF].
65. Self-Regenerative Cyber-Secure Infrastructure (SCI) Survivability Map, *Proposal to DARPA BAA03-44 (DOE Proposal # 1868-HH56-X1)*, (PI: **F.T. Sheldon**, ORNL, with Co-PI's: M. Langston, U. TN; A. Krings and P. Oman, U. Idaho) \$1,317,000, Nov. 25, 2003 [NF].
66. Shipboard Electronic Infrastructure Survivability Map *Proposal to ONR (National Naval Program for Naval Engineering – Modeling and Optimization BAA03-013a)* (DOE Proposal# 1866-S694-A1), (PI: **F.T. Sheldon**, with A. Krings Prof. UI and P. Oman, Prof. UI) \$1,598,000, August 28, 2003 [NF].
67. Energy Infrastructure Survivability (EIS) Map, *Proposal to DOE Office of Energy Assurance (FWP EAES016, Program Mgr. Donald W. Geiling, NETL)*, (PI: **F.T. Sheldon**, with A. Krings, Prof. UI and P. Oman, Prof. UI) \$498,000, July 23, 2003 [NF].
68. Assurance of Software Requirements using IEC 61508 Safety Integrity Levels *Proposal to NASA IV&V Center [Software Assurance Research NRA SARP 0301](#)*, (PI: **F.T. Sheldon**, with M. Hinchey, GSFC Director, and A. Mili Prof. NJIT) \$480,000, June 2003 [NF].

69. IAEA Consultancy Service for Software Quality Assurance Engineer *Proposal to IAEA*, DOE Proposal Number FERD-03-2261, for Software/Licenses, (PI: **F.T. Sheldon**, with: A. Stewart, T. Potok, and J. Treadwell) \$513,000, Feb. 2003 [NF].

#### Pre-Proposals / Proposal Abstracts and White Papers / Notices of Intent at ORNL

1. Secure Control Systems, 1 Mar. 2011, PIs Hal Aldridge (Sypris Electronics, Inc.), Frederick Sheldon (ORNL) and Mike Duren (Sypris Electronics, Inc.), Estimated Cost \$1,476,420, 2yr PoP, in response to DHS BAA 11-02, Type II: TTA-5 [Not Selected].
2. Behavioral Trust as a Metric Enabling Continuous Risk Assessment in Heterogenous Environments: Bridging Operational Risk Between the NOC and the Boardroom, 1 Mar. 2011, PIs Owen McCusker (Sonalist, Inc.), Frederick Sheldon (ORNL) and John Williams (MIT), Estimated Cost \$1,626,276, 3yr PoP, in response to DHS BAA 11-02, Type I: TTA-2 [**Selected**].
3. SWAMPnet, A National Networked Research Infrastructure Asset Enabling Software Quality Assurance, 1 Mar. 2011, ORNL PIs K. D. Sayre, F. Sheldon and R. Abercrombie, Estimated Cost \$10,000,000, 3yr PoP, in response to DHS BAA 11-02, Type I: TTA-14 [**Selected**].
4. Control Systems Security for Critical Infrastructure Protection, 1 Mar. 2011, PIs Adrian Perrig (CMU), Frederick Sheldon (ORNL) and Amit Vasudevan, (NoFuss, Inc.), Estimated Cost \$1,999,275, 3yr PoP, in response to DHS BAA 11-02, Type II: TTA-4 [Not Selected].
5. Resilient, Survivable, Secure Cloud Infrastructure for Hardware Enabled Trust, 1 Mar. 2011, PIs Richard Brooks (Clemson U.), Frederick Sheldon (ORNL), Benjamin Gittins, (CTO, Synaptic Labs Limited), Brian Snow (Former NSA Technical Director), Miles E. Smid (Pres., Orion Security Solns), Santosh Chokhani (Pres., CygnaCom Solns) and Axel Krings (U. of Idaho), Estimated Cost \$2,800,000, 3yr PoP, in response to DHS BAA 11-02, Type I: TTA-11 [Not Selected].
6. Resilient, Survivable, Secure Cloud Infrastructure for Insider Threat, 1 Mar. 2011, PIs Richard Brooks (Clemson U.), Frederick Sheldon (ORNL), Benjamin Gittins, (CTO, Synaptic Labs Limited), Brian Snow (Former NSA Technical Director), Miles E. Smid (Pres., Orion Security Solns), Santosh Chokhani (Pres., CygnaCom Solns) and Axel Krings (U. of Idaho), Estimated Cost \$2,800,000, 3yr PoP, in response to DHS BAA 11-02, Type I: TTA-4 [Not Selected].
7. Resilient, Survivable, Secure Cloud Infrastructure for Resilient Systems and Networks, 1 Mar. 2011, PIs Richard Brooks (Clemson U.), Frederick Sheldon (ORNL), Benjamin Gittins, (CTO, Synaptic Labs Limited), Brian Snow (Former NSA Technical Director), Miles E. Smid (Pres., Orion Security Solns), Santosh Chokhani (Pres., CygnaCom Solns) and Axel Krings (U. of Idaho), Estimated Cost \$2,800,000, 3yr PoP, in response to DHS BAA 11-02, Type I: TTA-5 [Not Selected].
8. Resilient, Survivable, Secure Cloud Infrastructure for Moving Target Defense, 1 Mar. 2011, PIs Richard Brooks (Clemson U.), Frederick Sheldon (ORNL), Benjamin Gittins, (CTO, Synaptic Labs Limited), Brian Snow (Former NSA Technical Director), Miles E. Smid (Pres., Orion Security Solns), Santosh Chokhani (Pres., CygnaCom Solns) and Axel Krings (U. of Idaho), Estimated Cost \$2,800,000, 3yr PoP, in response to DHS BAA 11-02, Type I: TTA-12 [Not Selected].
9. Detection of Malicious Insider Activity, 6 April 2011, PIs Lee Hively (ORNL) and Frederick Sheldon (ORNL) and Lynne Parker (UTK), Estimated Cost \$800K (2yr period of performance) in response to the ORNL LDRD [NF – deferred by Chief Scientist to wait for more results].
10. Cyberspace Security Econometrics System (CSES), 31 August 2009, PIs Frederick Sheldon (ORNL) and Annarita Gianni (UC Berkeley), Estimated Cost: \$1.06M (2 yr period of performance) in response to LMCO Shared Vision Call [NF].
11. Securing the National SCADA Infrastructure, 31 August 2009, PIs Frederick Sheldon (ORNL) and Robert Abercrombie (ORNL), Subcontractors Eric Fleischman (Boeing) and Charles Klabunde (Boeing) Estimated Cost: \$1.8M (2 yr period of performance) in response to LMCO Shared Vision Call [NF].
12. Highly Assured Data and Situation Awareness (HADSA) for Complex Interconnected Critical Infrastructure Systems, 31 August 2009, PIs Frederick Sheldon (ORNL) and Garet Moravec (LMCO), Estimated Cost: \$1.95M (2 yr period of performance) in response to LMCO Shared Vision Call [NF].
13. Empirical Evaluation of Information Security Defense Mechanisms, 31 August 2009, PIs Frederick Sheldon (ORNL) and Calton Pu (Georgia Tech), Estimated Cost: \$1.11M (2yr PoP) in response to LMCO Shared Vision Call [NF].
14. **Proactive Social Engineering Defenses**, 31 August 2009, PIs Craig Shue (ORNL), Garet J. Moravec (LMCO) and F.T. Sheldon (ORNL), Subs: M. Gupta (Indiana U.) and C. Pu (Georgia Tech), Estimated Cost: \$1.962M (2yr PoP) LMCO Shared Vision Call [**Funded internally with seed money \$200K**].
15. Proactive Anticipatory Anomaly Detection and Situation Awareness (PA2SD), 31 August 2009, PIs Frederick Sheldon (ORNL) and A. Gianni (UC Berkeley), Estimated Cost: \$1.06M (2yr PoP) in response to LMCO Shared Vision Call [NF].

16. Contextually Adaptive Insider Threat Detection & Response (CAIN), 31 August 2009, PIs Frederick Sheldon (ORNL), Subs: M. Kirkpatrick and E. Bertino (Purdue), Estimated Cost: \$0.95M (2yr PoP) in response to LMCO Shared Vision Call [NF].
17. Heuristic Identification and Tracking of Insider Threat (HIT-IT/ Silent Storm), PIs F. Sheldon, R. Abercrombie and C. Griffin, ONCIX, Requested \$484,000 (Dec. 29, 2008) [NF]
18. Predictive Framework for Dynamic Intelligence Gaming and Strategy Evaluation (DEPV), PIs F. Sheldon, R. Abercrombie and C. Griffin, ONCIX, Requested \$477,000 [NF] (Dec. 29, 2008)
19. Cyber Security Econometrics System, ONCIX, PIs Frederick Sheldon and Robert Abercrombie, ONCIX, Requested \$400,000 (Dec. 29, 2008) [NF]
20. PAINT Proactive Intelligence, White Paper submitted and accepted in response to AFRL BAA-07-01-IFKA (DEPV: a framework for dynamic intelligence gaming and strategy evaluation) 03 Dec. 2006, Period of performance: 31 Mar 2007 – 30 Sept. 2011, PI F.T. Sheldon (ORNL), Subcontractors: Christopher Griffin (ARL, Penn State U.), R.R. Brooks (Clemson), Estimated Cost: \$500,000/yr (\$2,250,00 Total) [NF].
21. Affordable V & V of Autonomous, Adaptive Systems (Boeing Lead, and co-investigator organizations: NASA Ames [Schumann, J., Gupta, P.], NASA JPL [Barhen, J.], New Jersey Institute of Technology, and UT-Battelle [Sheldon, F.]) \$5-15M potential funding. NOI Marked Excellent (2nd highest marking) by NASA HQ but denied [NF].
22. Automation of V&V, Safety Analysis, and Testing (Boeing Lead, and co-investigator organizations: NASA Ames, NASA JPL [Barhen, J.], New Jersey Institute of Technology [Mili, A.], and UT-Battelle [Sheldon, F.]) \$10-40M potential funding. NOI Marked Excellent (2nd highest marking) by NASA HQ but denied.
23. Affordable Fault Tolerance using Recovery Preservation (UT-Battelle Lead [Sheldon, F.], NASA Ames [Schumann, J., Gupta, P.], NASA JPL [Barhen, J.], New Jersey Institute of Technology [Mili, A.], U. of TN [Parker, L., and Langston, M.]) \$5-15M potential funding. NOI Marked Excellent (2nd highest marking) by NASA HQ but denied [NF].
24. Flexible Affordable Multi-Agent System Synthesis (UT-Battelle Lead [Sheldon, F.], NASA JPL [Barhen, J.], NASA Ames [Schumann, J., Gupta, P.], New Jersey Institute of Technology [Mili, A.], U. of TN [Parker, L.], U. of TX at Arlington [Kung, D] and U. of N. TX [Kavi, K]) \$5-15M potential funding. NOI Marked Excellent (2nd highest marking) by NASA HQ but denied [NF].
25. Intelligent Agent-Based Middleware and Synthetic Meaning for Knowledge Management of Sensor Network Data and Collateral Information, Proposal to DHS Threat and Vulnerability Testing and Assessment Sub-area (PI F.T. Sheldon, J. Strand, and P. Porreca Exemplar LLC) \$6.1M, July 2003 [NF].
26. Stochastic Modeling and Sensitivity for Critical Computer Networks Infrastructure, Proposal to TSWG-DAAD 03-T-0024 (R1087) (PI: F.T. Sheldon) \$340,000, June 2003 [NF].
27. Use Model Checkers to Analyze Semantic Graph Representations, Proposal to TSWG-DAAD 03-T-0024 (R1084) (PI: F.T. Sheldon) \$900,000, June 2003 [NF].
28. Statistically Significant Network Vulnerability Patterns, Proposal to TSWG-DAAD 03-T-0024 (R1086) (PI: F.T. Sheldon) \$950,000 June 2003 [NF].

### **Academic Funding Awards**

- SEDS Laboratory Infrastructure Equipment Request**, *Proposal to Intel Corporation*, (PI: **F.T. Sheldon**, SEDS Lab Director \$15,850 requested, \$10,850 awarded Mar'01) Nov. 2000.
- SEDS Laboratory Infrastructure Software Request**, *Proposal to Microsoft Research*, for Software/Licenses, (PI: **F.T. Sheldon**, SEDS Lab Director \$15,976 requested, \$15,976 awarded Apr'01) Nov. 2000.
- Software Engineering for Dependable Systems (SEDS) Laboratory**, *Startup funding and research assistantships* (PI: **F.T. Sheldon**, SEDS Lab Director, \$250,000 awarded Sept. '99 – June '02) Sept. 1999.
- Brake-Safe**, *Proposal to Daimler-Benz AG*, Model-based Specification and Analysis (safety and reliability) Using CSP and Stochastic Petri Nets, (PI: **F.T. Sheldon**: \$10,850 requested, \$10,850 awarded) Dec. 1998.
- Technical Distance Learning Courseware**, *Proposal to the Changing the Learning Paradigm through Technology Initiative (Source: Univ. of Colorado's Office of the President)*, (PIs: J. Alspecter, **F.T. Sheldon** and J. Haefner: \$15,500 requested, \$11,100 awarded) Mar. 1998.
- A Novel Approach to Model Based Validation of Fault Tolerant Systems**: *DARPA SBIR Proposal*, (PI: F.T. Sheldon: \$99,000 awarded) Sept. 1996.
- Formal Specification of Stochastic Properties for an Integrated Air/Ground System to Support LVLASO: Low Visibility Landing and Surface Operations** element of the Terminal Area Productivity program funded by the FAA: *Postdoc Proposal to the National Research Council Associateship Program at NASA Langley Research Center*, (\$42,000/yr for 3 yrs awarded) Feb. 1996.
- Simulation-Based Analysis for Real-Time Systems Development**, *Fellowship Proposal: NASA Graduate Student Researchers Program, Langley Research Ctr.*, \$22,000/yr for 3 yrs awarded Jan. 1993.

## Industry Research Funding Awards

**GIMADS (Task 29) Software**, Proposal to ID SPO WPAFB: researched, developed, coordinated, authored and promoted three CCP revisions (PI: **F.T. Sheldon** (Pgm. Mgrs Dick Clothier and Del Dos), \$2.1M Awarded, *General Dynamics FWD 1992*, PoP 16mos with Texas Instruments) [**F**].

## **TECHNICAL REPORTS**

1. Sheldon, F.T., Abercrombie, Robert K., Richardson, Gregory, Smith, Barton and Beshears, David L. "Weigh-in-Motion, Cube Measurement, and Marking User Manual 1.0," ORNL/TM-2010/126 [ID 24780]), 30 Sept. 2010.
2. Sheldon, F.T. Ferragut, Erik M, Wilder, Louis P., Lepro, Douglas R and MacIntyre, Lawrence Paul, "Preliminary Design: Real-time Assimilation and Fusion of Disparate Data (RAFD2)," ORNL/TM-2010/79 [ID 23851]), 21 June 2010.
3. Okhravi, H. and Sheldon, F.T., "Data Diodes in Support of a Power Grid Trustworthy Cyber Infrastructure," ORNL/TM-2010/73 [ID 23734], 10 May 2010.
4. L. M. Hively, R. K. Abercrombie, F.T. Sheldon and M. B. Scudiere, "Error Reduction in Portable, Low-Speed Weigh-In-Motion (WIM)," ORNL/TM-2008/004 [9777], November 2008.
5. R. K. Abercrombie, D. L. Beshears, L. M. Hively, M. B. Scudiere, F. T. Sheldon, J. L. Schmidhammer, J. Vanvactor, "Prototype Weigh-In-Motion Performance," ORNL/TM-2007/039 [ID 5887 ] (ORNL/TM-2005/164: revision update from June 2005), October 2006
6. Brake-Safe Analysis Final Report: Safety and Reliability Analysis Using Stochastic Petri Nets (Author: **F.T. Sheldon**, *DaimlerChrysler FT3/AS Final Report which included the CSPL Specified Models Software Toolkit*, June 2000).
7. Composing, Analyzing and Validating Software Models, (Author: **F.T. Sheldon**, *NASA ARC / Stanford – ASEE Final Report which included the CSPN Software Toolkit*, August 1998).
8. Specification Based Stochastic Analysis and Diagnostics of Concurrent Embedded Systems, (Author: **F.T. Sheldon**, *ASEE Final Report*, August 1997).
9. A Novel Approach to Model Based Validation of Fault Tolerant Systems: Addresses the limitations and issues for modeling methods and tools developed specifically for stochastic analysis, performability evaluation, and solution methods suited to systems with low latency requirements and rare events (e.g., single independent and multiple coincident failures). Goal: develop a methodology and toolset for *specification and stochastic and performability analysis* of vital DoD systems (Author: **F.T. Sheldon**, *DARPA SBIR Final Report*: May 1997).
10. Engineering Modernization: *Unix-Based Software Engineering Environment Feasibility Study* of OSF/1 Open Systems Technology for avionics software development including requirements/risk analysis, characterize critical capabilities, metrics, costs and performance criteria (Author: **F.T. Sheldon**, *General Dynamics FWD 1991*).
11. Domain Specific Software Architectures White-paper *DARPA Abstract Proposal* (Principal Author: **F.T. Sheldon**, *General Dynamics FWD 1991*).
12. Avionics Software Domain Analysis: *Engineering Modernization White Paper*: emerging technology as applied to Avionics software synthesis and reuse (Author: **F.T. Sheldon**, *General Dynamics FWD 1990*).

## **COLLOQUIUM**

Game Changing Cyber Security Research Prospectus, Tennessee Tech University (September 14, 2009) and Oak Ridge National Laboratory (September 15, 2009).

Verification and Validation of Mission / Safety Critical Software, 2002 Colloquiums: Free Univ. Bozen, Italy July 15 | Swansea Univ., Wales Jul 5 | Oak Ridge National Lab, Knoxville June 27 | Univ. Nebraska Univ., Omaha June 26 | Virginia Tech., Blacksburg June 24 | Univ. of Southampton June 19 | Univ. de Liege, Institut Montefiore, Belgium May 27 | Univ. of Houston, Clear Lake, TX May 8 | Wayne State Univ., Detroit May 6 | Rochester Inst. Of Technology, New York, May 3 | London City Univ., Apr. 16 | Univ. of North Texas, Denton Feb. 7 | Univ. of Texas at Dallas, February 5 | Center for Communications Research, San Diego, CA Feb. 4 | Naval Post Graduate School, Monterey, CA, Jan. 29.

Verification and Validation of Mission / Safety Critical Software, Invited Talk Institut für Informatik – FB Mathematik und Informatik, Freie Universität Berlin, Oct. 1, 2001.

Software Engineering: Where we have been and where we are going, Invited Talk at Spokane Intercollegiate Research and Technology Institute (SIRTI) for the Washington Software Assoc., Nov. 14, 2000.

Brake-Safe Report, DaimlerChrysler, Stuttgart Germany, Safety and Reliability Applied Research Grp, July 1, 2000.

Composing, Analyzing / Validating Software Models to Assess the Performability of Competing Design Candidates  
Department of Computer Science, Purdue University, W. Lafayette, IN, April 12, 1999.

Using Models of Software to Assess the Performability and Reliability of Competing Design Candidates, Summer  
Faculty Research Review NASA-ASEE Ames Research Center, Moffitt Field, CA, August 10, 1998.

Work-In-Progress Report: Toolkit for Composing and Analyzing Models of Software and Systems., Three Invited  
Talks at NASA Ames Research Center –Automated Software Engineering group, June-Aug. 1998 (included  
students Chuck Rodacker and Shane Holloway).

Work-In-Progress Report: Prototype Open Toolkit for Composing and Analyzing Models of Software and Systems.,  
Invited Talk at Fu Jen Catholic University, Taipei, Taiwan, April 1998.

Formal Specification Based Stochastic Analysis and Design of Safety-Critical Systems, Sponsored Talk at Mercedes  
Benz in Stuttgart, Germany, Jan. 1998.

Formal Specification Based Stochastic Analysis and Design of Safety-Critical Systems, Sponsored Talk at Technical  
Univ. of Berlin, Dept. of Computer Science, Germany, Dec., 1997.

Specification Based Stochastic Analysis and Diagnostics of Concurrent Embedded Systems, Invited Talk at NASA  
Ames Research Center, Moffitt Field, CA, 0.25 hrs., August 8, 1997.

Specification and Analysis of Stochastic Properties for Concurrent Systems Expressed Using CSP, Invited Talk at  
NASA Ames Research Center, Moffitt Field, CA, 1.0 hrs., July 2, 1997.

Specification and Analysis of Stochastic Properties for Concurrent Systems Expressed Using CSP, Sponsored Talk at  
University of Erlangen-Nurnberg, Modeling and Process Control Group, Department of Computer Science IV,  
Germany, 1.25 hrs, May 20, 1997.

Distributed Real-Time Systems Development: An Assessment, Sponsored Talk at Technische Universitat (TU)  
Clausthal, Institute fur Informatik, Germany, 0.75 hrs., May 20, 1993.

Software Reliability Modeling: A Case Study, *Proc. Integrated Diagnostics Design Technology Tools Conf.*, Ellicott  
City, Maryland, NSIA Sponsored, 0.75 hrs., pp. 146-159, May 3, 1991.

SOFTWARE RELIABILITY: Theory, Practice, and Controversy," *Proc. Joint Logistics Management Committee  
General Membership and Integrated Diagnostics Meeting*, San Diego, CA, NSIA Sponsored., 0.75 hrs., 23  
pages, Jan. 15, 1991.

Panel Moderator: "Software Reliability: Theory, Practice and Controversy," Panelists: Everett, W.W., AT&T Bell  
Labs; Yu, Jim, AT&T Bell Labs; Tausworthe, R., Jet Propulsion Lab; Brettschneider, R., Motorola; *ACM/IEEE  
Symposium on Applied Computing*, Fayetteville, AR, April, 1990.

Software Reliability and Quality Metrics, Invited Talk for *Dallas/Fort Worth Software Quality Association*, 1.5 hrs.,  
Sheldon, F.T. and Whitfill, W.A., General Dynamics, *FWD*, March, 1990.

Estimating Failure Rate Due to Residual Software Defects and Software Quality Metrics," Talk for *Dallas IEEE  
Reliability Society*, 1.5 hrs., Sheldon, F.T. and Whitfill, W.A., General Dynamics, Oct. 1989.

#### **REFEREED OR COPYRIGHT SOFTWARE TOOLS**

Cyber Security Econometrics System (CSES), Ben Aissa, A., Abercrombie, R.K., Sheldon, F.T., and A., Mili  
(*Copyright filing: DOE Case #: TBA, UT-Battelle Case #: TBA: January 2011*)

Integrating Message Sequence Charts (MSC) formalism into the Mobius Framework, developed by Zhihe "Bill"  
Zhou (for MS Thesis), and Frederick Sheldon at the Washington State Univ. (definition, design and  
implementation completed Spr. 2002).

Integrating Message Sequence Charts (MSC) formalism into the Mobius Framework, developed by Zhihe "Bill"  
Zhou (for MS Thesis), and Frederick Sheldon at the Washington State Univ. (definition and design planned  
completion in Spr. 2002).

The CSPL Graphic Editor (CGE): Implementation of Graph Layout Algorithms and CSPL Parser, developed by Wen  
Wei (for MS Thesis), David Dugan (for MS Thesis) and Frederick Sheldon as an extension of previous work by  
Norbert Gravelle at the Univ. of Colorado (planned release Ver. 2.0 in Spring 2002).

A Translation Tool (PCX) from PROMELA/Spin to C-Based Stochastic Petri Net Language (CSPL): developed by  
Shuren Wang (for MS Thesis) and Frederick Sheldon as an extension of previous work by Chuck Rodacker at the  
Univ. of Colorado (prototype Ver. 1.0 released June 12, 2001).

A Translation Tool (CSPN) from CSP to Stochastic Petri Nets (CSPL): developed by F.T. Sheldon (for PhD  
research) and Krishna Kavi (from Scratch) at the Univ. of Texas at Arlington (prototype Ver. 1.0 released Jan.  
1996, Ver. 2.0 released to NASA ARC ASE group Aug. 1998, and Ver. 3.0 released Dec. 1999).

#### **COURSE TITLES**

Software Specification and Analysis (CptS 580.1/483.1 – Spr00, Spr01)

Software Engineering Principles (CptS 422 – Fall99, Fall00)  
Software Engineering (CS 330 – Spr98, Fall98, Spr99)  
Software Requirements Analysis and Specification (CS 531 – Spr99)  
Formal Methods of Software Systems Engineering (CS 533 – Spr97, Spr99)  
Computer Architecture (CS 520/420 – Spr97, Fall97)  
Software Design (CS 532 – Fall96, Fall97, Fall98)  
Discrete Structures in Computer Science (CSE 2315/3315 was CSE 1442 – Fall93, Spr94, Fall94, Spr95)  
Formal Methods: Software Systems (CSE 5312 substitute lectures – Fall95, Spr96)  
Fundamentals of Software Engineering (CSE 3310 – Spr93)

## **COURSE DESCRIPTIONS** (see [courses](#) and [teaching statement](#))

### **Software Specification and Analysis** (CptsS 580.1/483.1 Taught on Wash. Higher Ed. Television – Spr00)

Introduction to formal methods used in software engineering: Formal mechanisms for specifying, validating and verifying the correctness, reliability and efficiency of software systems. The course will first introduce the broad area of formal methods including algebraic and model based specification techniques. The class will then focus on developing a working knowledge for using Z. A project will require the use of the Z language in developing a formal specification of a particular real world requirements specification. Outside readings are assigned that report on a range of independent experiments devoted to broadening the link between theory and practice (i.e., in the application of theories on an industrial scale) including case studies. Prerequisites include knowledge of modern programming languages, data structures, algorithms and discrete mathematics. There are two exams, a term paper and term project. Distribution of all required course materials will be via the web. Texts: *Using Z: Specification, Refinement, and Proof*, by Woodcock, J., and Davies, J. PH, 1996, and *Specification Case Studies (2<sup>nd</sup> Ed)*, by Hayes, I., PH, 1993.

### **Software Engineering Principles** (CptsS 422 – Fall99)

See the objectives for “Software Engineering” as specified below.

### **Software Engineering** (CS 330 – Spr98, Fall98, Spr99)

Course Objectives include understanding and knowing: (1) appropriate terminology and the process of developing a large software system. (2) factors that govern the selection of a process model and that affect process maturity, (3) concepts underlying the goals of all major software development and management activity, (4) how to use at least one technique applicable to every major software phase, and finally (5) the utilization of a various distance learning techniques to facilitate the above objectives. A Term project involves development teams of 4 - 7 participants including electronic (and hard copy) submission of software life-cycle artifacts (Software Requirements Specification, Preliminary and Critical Design Reviews, Design Notebook, Test Report, Users Manual and Product Demonstration). There are three exams, several quizzes and article reading homeworks that supplement lecture coverage and distribution of all required course materials will be via the web. Teams submit weekly progress reports via Email. Texts: Sommerville, I., *Software Engineering*, 5th ed., 1996, and Brooks, F. P. Jr., *The Mythical Man-Month: Essays on Software Engineering*, Ann. Ed., 1995.

### **Software Requirements Analysis and Specification** (CS 531 – Spr99)

Students participate in a project involving the analysis and specification of major software. Coverage includes methods, techniques and tools that support various languages, notations and formalizations for composing and evaluating specification properties (unambiguous, completeness, consistency, etc.) Students are evaluated on their project work (initiative, innovativeness, etc.), and oral presentations (scored on individual and team basis using self and objective assessment methods), homeworks and exams. Prerequisite: Working knowledge of modern programming languages, data structures, algorithms and discrete mathematics. Texts: *Requirements Engineering: Processes and Techniques* by Gerald Kotonya / Ian Sommerville, (John Wiley) Sept. 1998, and *Requirements Engineering: A Good Practice Guide* by Sommerville, Ian and Sawyer, Pete (John Wiley) 1997.

### **Software Systems Engineering Project Lab** (CS 539 designed, never taught due to low enrollment)

Students participate in a project involving the development and production of a software system intended for external distribution and use. Duties include requirements and specification analysis and design, implementation, testing, quality assurance, configuration management and documentation. Projects come from the university and from outside sources. Students are evaluated on their project work (initiative, innovativeness, etc.), and oral presentations (scored on individual and team basis using self and objective assessment methods). Capstone course for the Masters of Software Engineering.

### **Formal Methods of Software Systems Engineering** (CS 533 – Spr99)

Elements of discrete mathematics, formal mechanisms for specifying and verifying the correctness, reliability and efficiency of software systems, finite state machines, regular expression, assertions, algebraic and model based specification techniques including case studies (prerequisites include knowledge of modern programming languages, data structures, algorithms and discrete structures) Texts: *Using Z: Specification, Refinement and Proof* by Woodcock, J. and Davies, J. (Prentice Hall, Int'l 1996), *Specification Case Studies* by Ian Hayes 2<sup>nd</sup> ed. (Prentice Hall, Int'l 1993 - Opt'l), *Application of Formal Methods* by Hinchey, M.G., and Bowen, J.P. (Prentice

Hall, Int'l 1995 - Opt'l) Formal Methods for Real-Time Computing Edited by C. Heitmeyer and D. Mandrioli (John Wiley, 1996 - Opt'l).

**Formal Methods of Software Systems Engineering** (CS 533 – Spr97)

Elements of discrete mathematics, formal mechanisms for specifying and verifying the correctness, reliability and efficiency of software systems, finite state machines, regular expression, algebraic and operational specification techniques, Petri nets and Markov modeling (prerequisites include knowledge of modern programming languages, data structures, algorithms and discrete structures) Text: Linz, P., An introduction to Formal Languages and Automata, Ross, S.M., Introduction to Probability Models, Marsan, A., et. al., Modeling with Generalized Stochastic Petri Nets.

**Computer Architecture** (CS 420/520 – Spr97, Fall97)

Specification and logical design of digital computer systems. Examines the functional basis of structures including control, memory hierarchy, *real* instruction set architectures, processor design (pipelining, microprogramming, arithmetic), I/O and peripherals, communications and networking. Text: Heuring, V.P., and Jordan, H.F., Computer Systems Design and Architecture.

**Software Design** (CS 532 – Fall96, Fall97, Fall98)

Covers principles underlying a variety of methodologies and tools for design of sequential, parallel and distributed software systems, design language, viewpoints, graphical representations, data abstraction, data dictionaries, data flow analysis and structured design, and object-oriented design. Text: Witt, B.I., et. al., Software Architecture and Design; Budgen, D., Software Design; Rumbaugh, J., et. al., Object-Oriented Modeling and Design.

**Fundamentals of Software Engineering** (CSE 3310 – Spr93)

Software engineering principles, processes and techniques; software development approaches focusing on functional analysis and functional design methods; configuration management, implementation strategies, and testing; team project involving reverse engineering and forward engineering of a discrete event simulation environment. Text: Chris Gane and Trish Sarsen, Structured Systems Analysis: Tools and Techniques; Alan M. Davis, Software Requirements: Objects, Functions and States; selected videos and periodical articles.

**Discrete Structures in Computer Science** (CSE 2315/3315 [originally 1442] Fall93, Spr94, Fall94, Spr95)

Propositional and predicate logic, mathematical proof techniques, sets, combinatorics, functions and relations, Boolean algebra, graphs, graph algorithms, finite state machines, regular expressions, automata and formal languages, computability, complexity. A weekly three hour compulsory programming laboratory meets for implementation of a requiring assignment associated with the lecture topics. Text: Judith L. Gersting, Mathematical Structures for Computer Science.

**Formal Methods: Software Systems** (CSE 5312 substitute lectures 1995-6)

Abstractions used to build correct, reliable, and efficient systems. Formal techniques for specifying abstractions and for defining hierarchies of computation, regular expressions and context-free languages; formal logic and proof techniques as they relate to computer science. Texts: Sudkamp, Languages and Machines: An introduction to the Theory of Comp. Sci.; R. E. Davis, Truth, Deduction and Computation: Logic and Semantics for CS.

**ADVISEES**

**Mentoring** (Oak Ridge National Laboratory)

Jennifer Stoll, Postdoc (graduated Georgia Tech, School of Computing) Topic: Island World: A Small World Simulation Tool in a Virtual Community for Evaluating Environmental Stressors, 2yr appointment.

**Faculty HERE Program**

Jingshan Huang, Associate Professor (University of South Alabama) Topic: InTrinsically Resilient Energy Control System, Summer 2012

Yoowhan Kim, Associate Professor (University of Nevada, Computer Science) Topic: Anomaly Detection in Multiple Scale for Insider Threat Analysis, Summer 2011.

Seong Moo Yoo, Associate Professor (University of Alabama at Huntsville, Computer Science) Topic: Developed Bayesian Rule-based Snort Plug-in, Summer '05

Ali Mili, Professor (New Jersey Institute of Technology, College of Computer Science) Topic: Cyber Security Threat Assessment and Risk Analysis Tool, Summer '05

**Graduate HERE Program**

Michael Kirkpatrick, Ph.D. Candidate (Purdue University, Computer Science, Advisor Elisa Bertino): Topic: Dynamic Context Based Access Control, Summer '09

Akan Udoeyop, M.S. Candidate (University of Tennessee, EECS, Advisor Greg Peterson): Topic: Heuristic Insider Threat Identification and Tracking, Summer '09 – '10

Steven McKinney Ph.D. Candidate (North Carolina Sate University, Computer Science, Advisor Douglas Reves): Topic: User Identification Via Process Profiling, Summer '07-'08

Joseph A. Calandrino Ph.D. Candidate (Princeton University, Computer Science, Advisor Ed Felton):  
Topic: Detection of Undesirable Insider Behavior, Summer '07

Jeff A. VanVector, MS Statistics (University of Tennessee), Ongoing '04-'05

#### **Undergraduate RAMS / SULI / DHS HS-STEM Program**

Kaylee Justice, Mathematics Sr. at Eastern Illinois University, Supply Chain Integration for Integrity (SCI-FI), Summer 2013.

Ian Malave, Comp. Sci. Senior at University of Southern California, *Island World: A Small World Simulation Tool in a Virtual Community for Evaluating Environmental Stressors*, Summer 2013

Katie Roseline Hauser, Senior at Harvey Mudd College, *Risk Assessment Methodology Based on the NISTIR 7628 Guidelines*, Summer 2012.

Margret Lantz, Senior at James Madison University, *Failure Impact Analysis of Key Management in AMI Using Cybernomic Situational Assessment (CSA)*, Summer 2012.

Veronica Young, Accepted for MS (Graduate School at George Washington University for MS in Biostatistics), ORNL Topic: Profiling Users: Insider Threat Detection and Prevention, Summer '09

Laura Schaffnit, Accepted for Ph.D. program (University of California at Irvine, Dept. of Mathematics, Advisor TBD), ORNL Topic: Cyber Security Econometrics Implementation and Validation, Spring '09

Symeon Hunter, Undergraduate (Southern University and A&M College, Computer Science), Summer '05

Cindy J. Lopez, Undergraduate (voted best oral presentation) (York College-City University of New York), Summer '05

#### **Major Advisor (WSU)**

David Dugan (Co-Advisor with Anneliese Andrews) – MS: (Graduated Spr05]) eCGE: A Multi-Platform Petri Net Editor

Kshamta Jerath – MS: Reliability Analysis of an Anti-lock Braking System Using Stochastic Petri Nets Incorporating Coincident Failures (Spr01 – Spr02])

Zhihe “Bill” Zhou – MS: Integrating the Message Sequence Charts (MSC) Formalism into Mobius Framework for Performability Analysis (Sum00 – Dec02)

Hye Yeon Kim – MS: Validation of Guidance Control Software Requirements Specification for Reliability and Fault-Tolerance (Fall00 – Spr02)

Rick Mahoon – MS Project (Tricities): Formal Verification of discrete Relay Ladder Logic Programs Using PROMELA (Fall00 – Spr01])

Shuren Wang – MS: PCX A Tool for Translating PROMELA Specified Models into SPNs (Spr00- Spr01])

Wen Wei – MS Software Engineering: Adaptation and Implementation and Integration of Graph Layout Algorithms for a Petri Net Graphical Editor (Fall99 - graduated Spr01)

Stefan Greiner – PhD (Co-advisor): Univ. of Erlangen, Germany, SW Performance Modeling (Wtr00)

#### **Major Advisor (UCCS)**

Norb Gravelle – MS Software Systems Engineering: Petri Net Graphical Editor for C-Based Stochastic Petri net Lang. (CSPL) (Spr98-Spr99)

David Owens – MS Software Systems Engineering: Design for Data Integrity for a Distributed Database System (Spr99-Spr98)

#### **Committee Member**

Mohamed Abdelgalil Imam – PhD: Physical Modeling and Characterization of Sub-micron SOI and Bulk MOSFET Devices (F00).

Myron Berg – MS: Pattern Detection of TINA’s Canonical Representation (used Petri Nets) (Spr98)

Dixon L. Miller – MS: Software Cost Estimation (Spr98)

John Robert Billups IV – MS: Identification and Visualization of Emotions in Music (F97)

Ann Zweig – MS: Language-Independent Requirements Language Displayer (F97)

Doug Collins – MS: Off Board Simulator (OBSim): Object Oriented Design (Spr97)

Monica L. Midkiff IV – MS: SW System in C/Unix Comparison with one in Foxbase/PC (Spr97)

William B. Camp – MS: Execution Mechanism for a Train Intersection (Spr97)

### **PROFESSIONAL SERVICE ACTIVITIES**

#### **Service Activities and Material Gifts**

- Computer Science Host for Visiting Prospective Graduate Students (2001) WSU
- Computer Science CSAB Accreditation Committee Participant and Pullman POC (2000) WSU
- Computer Science Strategy and Planning Committee Secretary (2000) WSU
- Huie-Rogers Endowed Chair Search Committee Chair (2000- 2001) WSU
- Computer Science Search Committee (2000) WSU
- Computer Science Curriculum Committee (2000) WSU
- School of EECS Liaison to Owen Science and Engineering Library (2000) WSU

- Computer Engineering Curriculum Committee (1999-2000) WSU
- Transportation and Traffic Committee member (1997-98) UCCS
- Obtained \$20,000 Software Gift-in-Kind from Mercedes Benz (1998) UCCS
- CS Undergraduate curriculum and SSE graduate curriculum committee (1996-97) UCCS
- Computer Science Newsletter: *Cyberdog*, Editor (1996 and 97) UCCS
- Active participant in the Dean's (on campus) Advisory Committee Meetings (1996-97) UCCS
- Very active participant in the *Software Engineering Series Certificate Program* (taught Introduction to S/E, Software Design and helped with Configuration Management) for Spr.'97 UCCS
- Obtained \$16,000 donation of UltraSparc1 Workstation from Sun / UniSoft Consult Fall'96 UCCS
- Obtained \$2,000 donation of reference books from O'Reilly and Associates, Inc. (Sept. '96) UCCS

#### **Reviewer**

Air Force Research Laboratory  
 National Science Foundation  
 IEEE HICSS  
 NASA Postdoctoral Program 2009  
 Workshop on Assurable & Usable Security Configuration 2009  
 International Journal of Electronic Business (IJEB)  
 IEEE Transactions on Computers  
 IEEE Computer  
 IEEE Software  
 IEEE Security and Privacy  
 Proceedings of the IEEE  
 Journal of Systems and Software  
 IEEE Transactions on Aerospace and Electronic Systems  
 Design Automation for Embedded Systems  
 Kluwer Academic Publishers  
 IEEE Int'l Symposium on Software Reliability Engineering  
 IEEE Pacific Rim Int'l Symposium on Fault Tolerant Systems  
 Society for Computer Simulation

#### **Editorships**

2010 Guest Editor, Information Systems and e-Business Management ([ISeB](#)) Journal, [Special Issue on Cyber Security Management](#), Springer, Berlin.  
 2005-2013 [Editor, ACM Proceedings, Annual Cyber Security and Information Intelligence Workshop](#)  
 2004-2007 [Associate Editor](#), Int'l Journal of Power and Energy Systems, IASTED, Calgary Canada  
 1997 [Software Reliability Engineering Case Studies](#), Book published by IEEE CS Press, distributed at the Int'l Symposium on Software Reliability Engineering, November

#### **Program Committee Member**

2005–Present: PC Chair: Ann. Cyber Security and Information Intelligence Research Workshop ([CSIIRW](#))  
 2010-11 PC Chair ([42](#) | [43](#)), IEEE Hawaii International Conference on System Sciences ([HICSS](#))  
 2011 Program Committee, [IEEE Symp. Computational Intelligence in Cyber Security](#) (Apr. 11-15: Paris)  
 2010 Program Committee, [Annual Computer Security and Applications Conference](#) (Dec. 6-10: Austin)  
 2010 Executive Program Committee, [Int'l Conf. on i-Warfare and Security](#) (Apr. 8-9: WPAFB)  
 2001 IEEE Pacific Rim Int'l Symposium on Dependable Computing (PDRC)  
 1997 IEEE Int'l Symposium on Software Reliability Engineering, Session Chair (Process/Quality Track)  
 1996 IEEE High-Assurance Systems Engineering Workshop  
 1996 IEEE 3rd Symposium. on the Assessment of Software Tools

#### **Professional Organization Membership**

[IEEE Senior Member](#)  
[IEEE Computer Society](#) (since 1985)  
[IEEE Technical Committee on Software Engineering](#) (since 1995)  
[IEEE Reliability Society](#) (since 1987)  
[Association of Computing Machinery](#) (since 1995)  
[American Institute of Aeronautics and Astronautics](#) (since 1992)  
[Dallas/Fort Worth Association for Software Engineering Excellence](#) *Founder* (since 1988)  
[Sigma Xi Scientific Research Society](#) (since 1996)

## **LANGUAGES**

English and basic German