

KEITH D. GREMBAN, Ph.D.

Ann and H.J. Smead Aerospace Engineering Sciences
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AREAS OF EXPERTISE

Software Engineering
Systems Engineering

Spectrum Science and Policy

Program Management
Wireless Communications

EDUCATION

- ◆ Ph.D., Computer Science, Carnegie Mellon University
- ◆ M.S., Computer Science, Carnegie Mellon University
- ◆ M.S., Applied Mathematics, Michigan State University
- ◆ B.S., Mathematics, Michigan State University

PROFESSIONAL SUMMARY

I am a proven senior professional with a track record of leadership and success in research, development, management, and transition of high-risk, high-payoff technology. I have generated research results that have made programs successful, led software and systems engineering efforts for complex systems, and repeatedly demonstrated the ability to carry technology across the “valley of death” between laboratory research and incorporation into real-world systems. I have led technology development and systems development efforts ranging from small projects (\$100,000) to major systems programs (\$500,000,000+). Additionally, I have experience in government procurement from conceptual development of programs, through source selection and contracting, to management and transition to operational use.

PROFESSIONAL EXPERIENCE

Research Professor, A. J. Smead Aerospace Engineering Sciences	2019-present
Senior Fellow, Silicon Flatirons Center	2020-present
Co-Director Spectrum Policy Initiative, Silicon Flatirons Center	2021-present
University of Colorado Boulder	
Boulder, CO	

Performed research in the area of radio frequency (RF) noise measurement and spectrum sharing. Organized conferences and workshops in the areas of spectrum vulnerability, spectrum science, and spectrum sharing.

Highlights and Significant Achievements

- ◆ Awarded a \$1.4M National Science Foundation (NSF) grant as Principal Investigator (PI) to research mechanisms to enable spectrum sharing between passive and active radio frequency (RF) systems, such as radio astronomy and telecommunications.
- ◆ Awarded a \$300K NSF grant as Co-PI to develop a plan for a Spectrum Innovation Center.

Program Manager, 5G-to-NextG Initiative	2020-2021
Office of the Undersecretary of Defense for Research and Engineering	
U. S. Department of Defense	

Temporary one-year assignment from the University of Colorado Boulder to the Department of Defense. Program Manager for Tranche 1 of the DoD 5G-to-NextG Initiative. Managed a \$500M+ effort to design and install at-scale 5G testbeds at four military bases across the continental United States. The objective of the 5G-to-NextG Initiative is to stimulate the U.S. 5G ecosystem and advance U.S. 5G technology by developing challenging applications enabled by 5G.

**Editor-in-Chief, Internet of Things Magazine
Institute of Electrical and Electronics Engineers**

2018-2020

Founding Editor-in-Chief (EiC) of the Internet of Things Magazine (IoT_M), a publication of the Institute of Electrical and Electronics Engineers (IEEE). The IEEE is the world's largest technical/professional organization with over 400,000 members in more than 160 countries. IoT_M publishes peer-reviewed articles on end-to-end IoT solutions. IoT_M articles are written by and for practitioners and researchers interested in practice and applications, such as corporate engineers working to design and deploy IoT applications every day. The technical focus of IoT_M is the multi-disciplinary, systems nature of IoT solutions.

Highlights and Significant Achievements

- ◆ Defined the scope, budget, and target audience for IoT_M, and presented the magazine proposal to the publications committee.
- ◆ Upon approval, recruited an editorial board and stable of reviewers, created an editorial calendar and Call for Articles, and began publishing on a quarterly basis.

**Director, Institute for Telecommunication Sciences
National Telecommunications and Information Administration
U.S. Department of Commerce
Boulder, CO**

2015-2019

Directed the Institute for Telecommunication Sciences (ITS), the research and engineering laboratory for the National Telecommunications and Information Administration (NTIA). ITS performs advanced communications research to inform spectrum policy and develop capabilities to solve emerging telecommunications issues. ITS works to continually advance the state of the art in radio frequency (RF) propagation measurement, RF propagation modeling, spectrum monitoring and enforcement, electromagnetic compatibility analysis, interference mitigation strategies, evaluation of end-user experience, and engineering analysis of evolving technologies to manage and share spectrum efficiently.

Highlights and Significant Achievements

- ◆ ITS performed the certification testing for the Federal Communications (FCC) on the components of the 3.5 GHz Citizen's Broadband Radio Service (CBRS). Both the Spectrum Access System (SAS) and Environmental Sensing Capability (ESC) were tested at ITS. The focus of testing was to ensure that the CBRS could share the 3.5 GHz band with U.S. Navy radars without interference.
- ◆ ITS performed electromagnetic compatibility analysis for the National Oceanographic and Atmospheric Administration (NOAA) to support spectrum sharing between satellite up/down links and cellular systems in the AWS-3 bands.
- ◆ ITS performed periodic propagation measurement campaigns for the U.S. Department of Defense (DoD) Spectrum Sharing Test and Development (SST&D) program. As requested by DoD, ITS developed and published a report on best practices in RF propagation measurement.

**Founder, Shavano Systems LLC
Highlands Ranch, CO**

2014-2015

Provided consulting services in program management and technology development for corporate clients in aerospace and telecommunications.

**Program Manager, Strategic Technologies Office
Defense Advanced Research Projects Agency (DARPA)
Arlington, VA**

2011-2014

Responsible for conceiving, developing, managing, and transitioning research and development projects in the areas of wireless communications and electronic warfare. Assumed management of several existing programs, and started one new major program and several seedling projects.

Highlights and Significant Achievements

- ◆ Created the Content-Based Mobile Edge Networking (CBMEN) program to enable efficient content distribution in a mobile ad hoc network (MANET). I conceived the program, wrote the procurement, led the source selection, and currently manage the efforts of 5 technology developers and 2 system integrators.
- ◆ Developed technology to enable precise communications jamming. The Precision Electronic Warfare (PREW) program utilized robust, low cost, small size, weight and power distributed electronic warfare (EW) platforms to allow the warfighter to disrupt and impede an adversary's communication network
- ◆ Developed technology to enable heterogeneous groups of radios to be integrated into a heterogeneous network tolerant to high latency and packet loss. The Mobile Ad hoc Interoperability Network GATEway (MAINGATE) program permits affordable, tactical, real-time, high fidelity video, data and voice services to be deployed in a networked environment to support tactical operations.
- ◆ Developed concepts for, and initiated seedling projects in foliage propagation modeling, extended range communications, heterogeneous wireless networking, resilient networking, and design for autonomy.

**Director, Computer Systems Research
Director, Denver Advanced Technology Division
SET Corporation, an SAIC Company
Greenwood Village, CO**

2009 - 2010

2007 - 2009

Leadership responsibility for a team of senior engineers and scientists engaged in activities ranging from basic research, through technology development, to deployment and maintenance of operational systems. Technical responsibility for systems engineering and software engineering on several advanced systems developed for deployment with operational units of the U.S. military. Additional responsibility for developing new business, including concept development and proposal preparation.

Highlights and Significant Achievements

- ◆ Led SET's entry into the human socio-cultural modeling domain. Selected as the featured scientist for the Spring 2010 issue of the Human Social Cultural Behavioral (HSCB) Modeling Program Newsletter. Program manager for the Socio-Cultural Analysis Tool (S-CAT) project, funded by the HSCB Modeling Program. S-CAT was recognized for Outstanding Technical Performance at HSCB Forum 2010.
- ◆ Led software engineering for the initial development of CounterBomber®, a standoff suicide bomber detection system. CounterBomber® was deployed and operated in Afghanistan. Also performed algorithm development and analysis, and performed system sensitivity analysis for detection algorithms.
- ◆ Led the systems engineering effort for the DARPA Human Explosive Detection Stand-off System (HEDSS). Developed multiple, alternative concepts of operation, and performed detailed quantitative analyses of resulting system performance.

Assistant Vice President and Division Manager
Senior Scientist
Science Applications International Corporation (SAIC)
Englewood, CO

2006 - 2007
2002 - 2006

Managed the Intelligent Systems Applications Division, which specialized in command and control decision aids, robotics, and autonomous systems. Leadership responsibility for a team of engineers and scientists performing applied research and technology development. Additional responsibility for developing new business, including proposal preparation.

Highlights and Significant Achievements

- ◆ Grew the Colorado office of Intelligent Systems Applications from a one-man office to over 25 people doing \$10,000,000 of annual business.
- ◆ Assumed leadership of the DARPA Individual Force Protection System (IFPS) project, and orchestrated a successful demonstration leading to a transition agreement with the United States Marine Corps.
- ◆ Software Integration Lead for the \$140,000,000 Future Force Warrior (FFW) Advanced Technology Demonstration (ATD). FFW was a U.S. Army program to develop the technology for a next-generation wearable soldier system, and featured a mobile computing environment supporting command-and-control, navigation, and visualization applications.
- ◆ Supervised several unmanned systems projects, including a robot snake, an optionally piloted aircraft, and research in human-robot interaction.
- ◆ Co-inventor of “hand-free, eyes-free” technology to enable robots to collaborate effectively with individual humans or small teams. A patent application was filed in 2006, and awarded in 2013.

Senior Research Engineer
SRI International
Englewood, CO

1998 - 2002

Performed research in efficient information dissemination over wireless networks. Led technical teams performing software development and systems engineering on a variety of research projects.

Highlights and Significant Achievements

- ◆ Led design and development of the Situation Awareness and Information Management (SAIM) subsystem of the DARPA Small Unit Operations Situation Awareness System (SUO SAS). SAIM comprised the applications and middleware for a distributed information system running on a mobile, ad-hoc wireless network.

Senior Systems Engineer
Computing Devices International (CDInt)
Englewood, CO

1997 - 1998

Performed detailed technical work and provided technical leadership for programs involving decision aids and soldier systems.

Highlights and Significant Achievements

- ◆ Led the CDInt team on a DARPA Small Unit Operations Situation Awareness Systems phase 1 project. The project required concept development of the hardware, software, communications, and human-machine interface required to enable robust situation awareness for dismounted warfighters. The CDInt team received the top score of the five competing teams.

Senior Scientist
CTA Incorporated
Englewood, CO

1995 - 1998

Performed detailed technical work and provided technical leadership for programs involving decision aids and process automation.

Highlights and Significant Achievements

- ◆ Led design and development of an integrated process modeling, simulation, and workflow management system under the DARPA Agile Manufacturing program. The system was installed and used at a functioning shipyard to manage repair and refurbishment processes.

Graduate Student and Research Assistant
School of Computer Science
Carnegie Mellon University
Pittsburgh, PA

1988 - 1995

Performed research in scientific computing, graph theory, and computer vision. Thesis title: *Combinatorial Preconditioners for Large, Sparse, Positive Definite Linear Systems.*

Highlights and Significant Achievements

- ◆ Performed research on the application of graph theory to the solution of large linear systems. Developed a new family of preconditioners, called support tree preconditioners, which accelerate the iterative solution of large sparse linear systems. Support tree preconditioners are easy to compute, have very regular structure, and are suitable for parallel implementation. Research on support tree preconditioners has been continued at Xerox PARC, Sandia, and the University of Colorado Boulder, among other institutions.
- ◆ Developed a vision algorithm compiler, a knowledge-based program that produced executable object recognition programs given CAD-based models of objects and models of image processing and feature detection operators.

Staff Engineer
Martin Marietta Corporation
Denver, CO

1980 - 1988

Performed research and development in computer vision and robotics.

Highlights and Significant Achievements

- ◆ Lead engineer for the development of the vision system for the DARPA Autonomous Land Vehicle (ALV). The ALV was the first robot vehicle to successfully demonstrate autonomous road following.

PROFESSIONAL ACHIEVEMENTS

Patents

- ◆ US8346391B1, Methods and systems for an autonomous robotic platform, Inventors: David Anhalt and Keith D. Gremban

Awards

- ◆ 1988 Author of the Year (co-recipient); Martin Marietta Information and Communications Systems
- ◆ 1984 Inventor Award (2); Martin Marietta Denver Aerospace

Professional Activities

- ◆ Co-Organizer, Silicon Flatirons Conference, "Frontiers in Spectrum Sharing," September 2021
- ◆ Technical Advisory Committee Member, 2020 International Symposium on Advanced Radio Technology
- ◆ Co-organizer, Silicon Flatirons Conference, "Evidence Based Spectrum Policy," October 2020
- ◆ Co-organizer, Silicon Flatirons Conference, "Saving our Spectrum: Handling Radio Layer Vulnerabilities in Wireless Systems," October 2019
- ◆ Co-Organizer, Silicon Flatirons Roundtable, "Spectrum Vulnerabilities," March, 2019

- ◆ Founding Editor-in-Chief, IEEE Internet of Things Magazine, 2018-2020
- ◆ Co-Chair of Track 6, Special Topics in Communications, IEEE MILCOM 2012, 2013

Significant Publications

- ◆ Strayer, T., Nelson, S., Caro, A., Khoury, J., Tedesco, B., DeRosa, O., Clark, C., Sadeghi, K., Matthews, M., Kurzer, J., Lundrigan, P., Kawadia, V., Ryder, D., Gremban, K., Phoel, W., Content sharing with mobility in an infrastructureless environment. **Computer Networks**, 144:1-16, October 2018.
- ◆ Sanders, F. H., Davis, K., and Gremban, K. D., "A 53 Year History of Spectrum Efficiency Studies and Recommended Future Directions," National Telecommunications and Information Administration, **NTIA Report 18-530**, 2018
- ◆ K. Murray, J. Lowrance, K. Sharpe, D. Williams, K. Gremban, K. Holloman, C. Speed, and R. Tynes, "Toward Culturally Informed Option Awareness for Influence Operations with S-CAT," **4th International Conference on Social Computing, Behavioral-Cultural Modeling and Prediction (SBP11)**, Springer, vol. 6589, pp. 2-9, March 2011.
- ◆ K. Murray, J. Lowrance, K. Sharpe, D. Williams, K. Gremban, K. Holloman, and C. Speed, "Capturing culture and effects variables using structured argumentation." **1st International Conference on Cross-Cultural Decision Making**, 2010.
- ◆ K. Sharpe, K. Gremban, and K. Holloman, "Evaluating the impact of culture on planning and executing multinational joint force stability, security, transition and reconstruction operations," **5th International Conference on Knowledge Systems for Coalition Operations**, 2007.
- ◆ F. Hinchion, P. Mulgaonkar, K. Gremban, K. Nicewarner, D. Wilkins, and S. Galuga, "Peer to peer information management for tactical situation awareness systems," **IEEE Military Communications Conference**, 2003.
- ◆ K. D. Gremban, G. L. Miller, and S-H Teng, "Moments of inertia and graph separators," **Journal of Combinatorial Optimization**, 1(1):79-105, 1997
- ◆ K. D. Gremban, "Combinatorial preconditioners for large, sparse, positive definite linear systems." Ph.D. thesis, available as technical report CMU-CS-96-123.
- ◆ B. A. Anderson, K. D. Gremban, and B. Young, "Shipyard operational improvement through process management." **1997 Ship Production Symposium**, 1997.
- ◆ K. D. Gremban, G. L. Miller, and M. Zaghera, "Performance evaluation of a new parallel preconditioner." **9th International Parallel Processing Symposium**, 1995
- ◆ K. D. Gremban and K. Ikeuchi, "Planning multiple observations for object recognition." **The International Journal of Computer Vision**, 12(2/3): 137-172, 1994
- ◆ K. D. Gremban and K. Ikeuchi, "Appearance-based vision and the automatic generation of object recognition programs." **Three-Dimensional Object Recognition Systems**, A. K. Jain and P. J. Flynn (editors), Elsevier Science Publishers, 1993
- ◆ M. A. Turk, D. G. Morgenthaler, K. D. Gremban, and M. Marra, "VITS - A vision system for autonomous land vehicle navigation." **IEEE Transactions on Pattern Analysis and Machine Intelligence**, vol. T-PAMI 10(3): 342-360, 1988