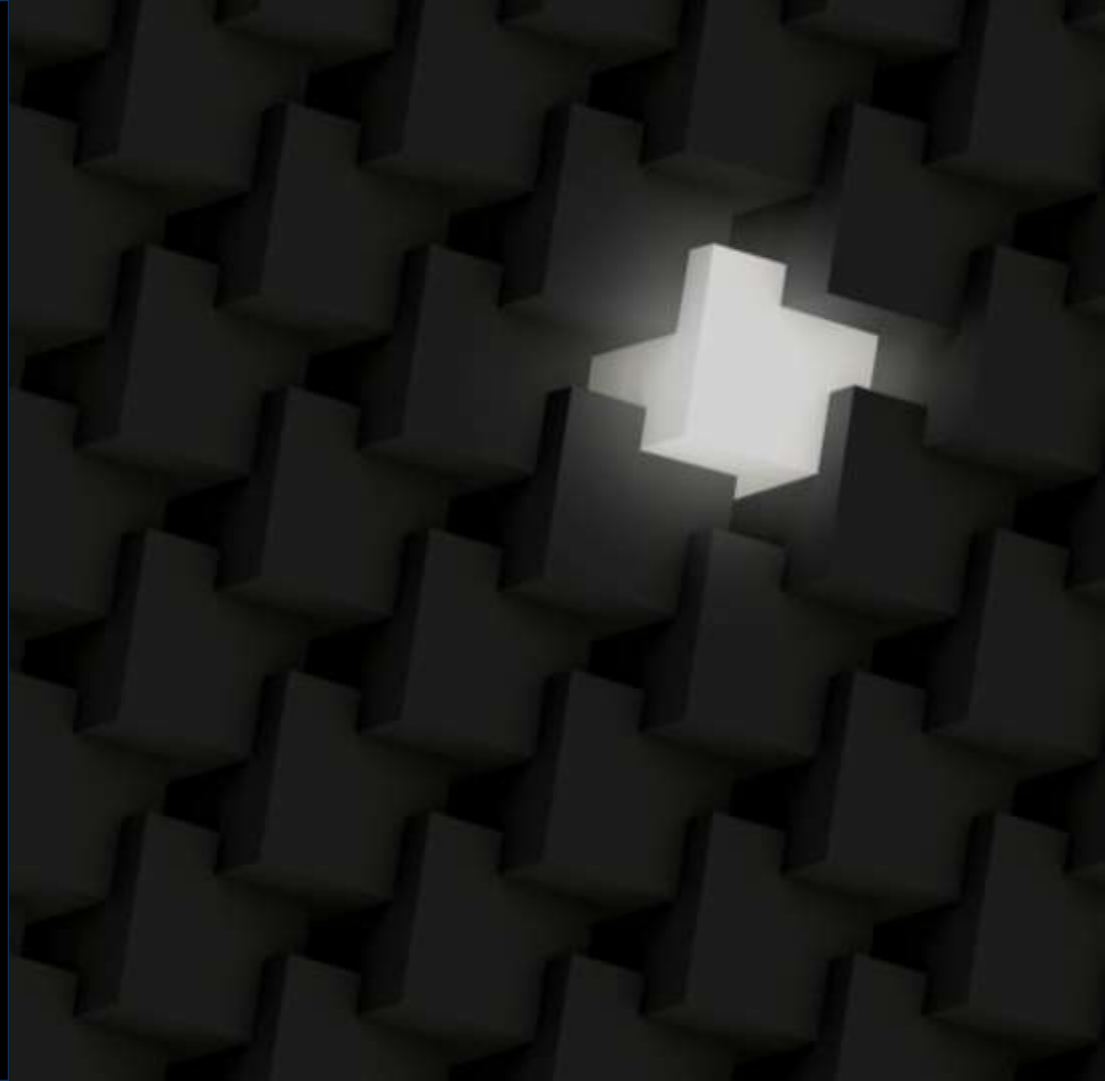**Carnegie Mellon University**
Software Engineering Institute

RESEARCH REVIEW 2020

Software Engineering's Grand Challenges:
Voices from Visionaries

Anita Carleton, Panel Chair

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Software Engineering's Grand Challenges: Voices from Visionaries

In this showcase, experts from industry and government will discuss major open problems and grand challenges in software engineering.

Each participant will talk about software engineering's "grand challenges" as they relate to their field of work, including space exploration, supercomputing, AI, and future battle systems.

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Voices from Visionaries

Ms. Anita Carleton

Dr. Deb Frincke

Dr. Michael McQuade

Mr. Vint Cerf

Mr. Tim Dare

Mr. Jeff Dexter

Ms. Sara Manning Dawson

Dr. William Scherlis

Dr. Will Roper

Dr. Victoria Coleman

Mr. Nand Mulchandani

"How will software engineering enable our visions for the future?"

Ms. Anita Carleton (Panel Chair)

Carnegie Mellon University, Software Engineering Institute, Software Solutions Division Director

Ms. Anita Carleton is Division Director of the Software Solutions Division at the Carnegie Mellon University Software Engineering Institute where she has more than 30 years of technical and senior leadership expertise in the software engineering industry designing, building, and deploying advanced software technologies for national security.

She leads the software engineering research, development, and transition strategy for the SEI with the specific goal of making software a strategic advantage for the Department of Defense. Carleton is currently leading an SEI effort to engage the broad software engineering community to define a national agenda for software engineering research and development for the next decade.

Carleton serves on the *IEEE Software* Advisory Board and is a Senior Member of the IEEE Computer Society. She is the recipient of the MIT Sloan Leadership Fellowship and has received awards for her work in support of U.S. Air Force programs, from the *Journal of the Quality Assurance Institute* for her leadership in software measurement, and for her leadership in defining the SEI Core Measures/measurement program for the DoD.

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Game Plan

11:30-11:40 am   Welcome, Introduce Session, Introduce Visionaries

11:40-12:25 pm   Visionary Showcase (5 minutes per person lightning talk based on question posed)

- Dr. Deb Frincke, Associate Laboratory Director for National Security Sciences, Oak Ridge National Laboratory
- Dr. Michael McQuade, Carnegie Mellon University Vice President for Research
- Mr. Vint Cerf, Vice President and Chief Internet Evangelist for Google
- Mr. Tim Dare, Deputy Director for Prototyping and Software, Office of the Under Secretary of Defense for Research and Engineering
- Ms. Sara Manning Dawson, General Manager, Microsoft Critical Infrastructure Engineering
- Mr. Jeff Dexter, Senior Director of Flight Software & Cybersecurity, SPACEX
- Dr. William Scherlis, Director DARPA Information Innovation Office
- Mr. Nand Mulchandani, Chief Technology Officer, Joint Artificial Intelligence Center (JAIC)
- Dr. Will Roper, Assistant Secretary of the Air Force for Acquisition, Technology, and Logistics

12:25-12:35 pm   Questions From Research Review Attendees

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Question: At Oak Ridge, I'm sure you face many "grand challenges" related to your areas of focus: advanced materials, supercomputing, and nuclear science. Software engineering should be an enabler to meeting those challenges—not a barrier. How can software engineering enable or accelerate progress in one of your "grand challenge" areas?

Dr. Deborah Frincke, the Associate Laboratory Director for National Security Sciences at Oak Ridge National Laboratory, guides the research and development of science-based solutions to complex threats that put public safety, national defense, energy infrastructure, and the economy at risk. Leveraging the broad science foundation at ORNL, she oversees the work of multi-disciplinary research teams who apply signature capabilities in nuclear and uranium science, high-performance computing, geographical information science, cyber and data science, applied materials, and advanced manufacturing to counter national security challenges.

Deborah joined ORNL from the National Security Agency (NSA), where she served in three roles between 2011 and 2020. Most recently as director of research at NSA from 2013 through early 2020, she led what is perhaps the largest in-house research organization in the U.S. Intelligence Community. She also was a founding member of the NSA Board of Directors, served as the agency's Science Advisor, and was the first NSA Innovation Champion.

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Dr. Michael McQuade | Carnegie Mellon University, Vice President for Research

Question: As the Vice President for Research at Carnegie Mellon University and a Defense Innovation Board Co-Chair, can you please describe the challenges you see in bringing research to practice, and discuss ways that we could bridge this gap including strategic partnerships with industry, government, academia, and research labs?

Dr. J. Michael McQuade is Carnegie Mellon University's vice president for research, providing leadership for the university's research enterprise and advocating for the role that science, technology and innovation play nationally and globally.

From 2006 to 2018 he served as senior vice president for Science & Technology at United Technologies Corporation (UTC). At UTC, McQuade's responsibilities included providing strategic oversight and guidance for research, engineering and development activities throughout the business units of the corporation and at the United Technologies Research Center, focused on a broad range of high-technology products and services for the global aerospace and building systems industries.

McQuade served as a member of the President's Council of Advisors on Science and Technology and of the Secretary of Energy Advisory Board and is a member of the Defense Innovation Board.

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Mr. Vint Cerf

Vice President and Chief Internet Evangelist for Google
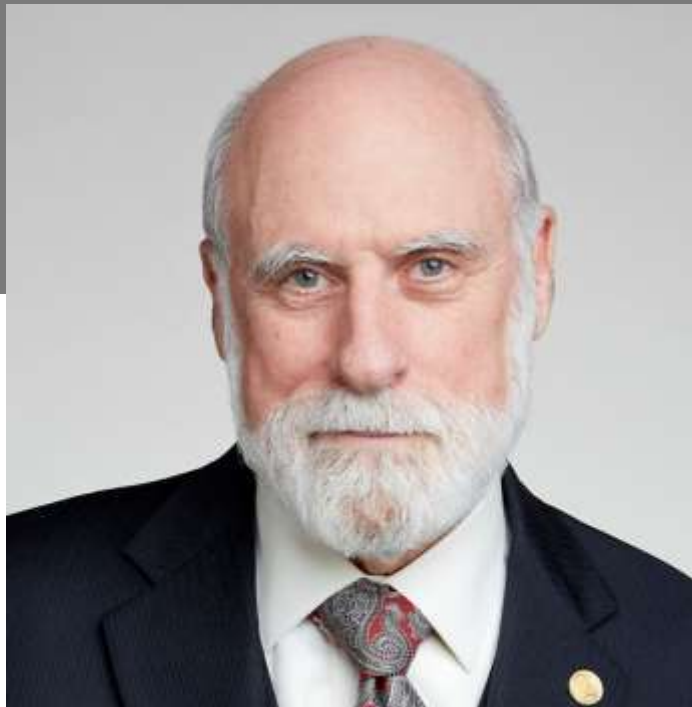
Question: You are known as the "father of the internet" for the design of the TCP/IP protocols and the architecture of the Internet. TCP/IP offered just enough constraint for standardization and just enough freedom to foster proliferation. What's the equivalent of TCP/IP for engineering large-scale software-enabled socio-technical ecosystems?

Mr. Vinton G. Cerf, Internet Hall of Fame Pioneer, is widely known as a "Father of the Internet," Cerf is the co-designer of the TCP/IP protocols and the architecture of the Internet. In December 1997, President Bill Clinton presented the U.S. National Medal of Technology to Cerf and his colleague, Robert E. Kahn, for founding and developing the Internet. In 2004, Cerf was the recipient of the ACM Alan M. Turing award (sometimes called the "Nobel Prize of Computer Science") and in 2005 he was given the Presidential Medal of Freedom by President George Bush.

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Mr. Tim Dare

Deputy Director for Prototyping and Software, Office of the Under Secretary of Defense for Research and Engineering

Question: In your role with OSD R&E, you have responsibility for a range of software and systems engineering activities. What is the grand challenge in rapidly developing and deploying software-reliant systems based on user intent versus user instruction?

Mr. Timothy S. Dare is the Deputy Director for Developmental Test, Evaluation and Prototyping within the Office of the Under Secretary of Defense for Research and Engineering. Mr. Dare is the principal advisor on developmental test and evaluation (DT&E) to the Secretary of Defense, Under Secretary of Defense for Research and Engineering, and the Director of Defense Research and Engineering for Advanced Capabilities. Mr. Dare is responsible for DT&E policy and guidance in support of the acquisition of major Department of Defense systems, and for providing advocacy, oversight, and guidance to the DT&E acquisition workforce.

Mr. Dare held a senior position for program management and capture at Lockheed Martin Space, overseeing the capture and execution phases of multiple Intercontinental Ballistic Missile programs for the Minuteman III missile.

Ms. Sara Manning Dawson | General Manager, Microsoft Critical Infrastructure Engineering

Question: We can't discuss grand challenges or grand opportunities without focusing on the primacy of data. In your work in cloud and AI security engineering, what advances are you working on that will enable the kinds of data protection, storage, and sharing that are a necessity for any advancement of software engineering?

Ms. Sara Manning Dawson is a Partner General Manager at Microsoft, specializing in cloud infrastructure security. She leads the Critical Infrastructure (CI) Engineering team, working across engineering, industry and government to design and deliver a Microsoft cloud platform and services that meets the high security and resilience needs of CI sectors. Prior to her work in CI, Sara led the team that secured the Azure and Office 365 cloud infrastructure including Red Team and penetration testing, code integrity, hardware and firmware security, security assurance, anti-fraud, and hardware and software supply chain security. Her team also built security tooling for customers including Secure Score, Customer Lockbox, device management capabilities, and user access auditing.

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Mr. Jeff Dexter

Senior Director of Flight Software & Cybersecurity, SPACEX

Question: SPACEX has grand plans for the future of space travel and habitation, including sending humans to Mars and developing colonies on the moon. Would you have confidence and assurance in the many software-reliant systems needed to sustain human life on the moon and Mars? What software engineering breakthroughs are needed to provide confidence and assurance?

Mr. Jeffery Dexter is the Senior Director of Flight Software and Cybersecurity at SpaceX. He is responsible for all software for SpaceX's launch vehicles, spacecraft and ground systems. Jeff began his tenure at SpaceX in 2014 as the manager for the Falcon program during the early rocket booster landing campaign, which led to the first-ever successful booster landing in December 2015. Since the initial landing, he has led the development of the next generation of astronaut Crew Displays for SpaceX's Dragon vehicle and has been instrumental in the vehicle certification for NASA-crewed missions. Prior to SpaceX, Jeff was the program manager for international expansions of Amazon's digital stores. He lives on the west side of Los Angeles with his wife and their Labrador retriever, Kayla.

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Dr. William Scherlis | Director, DARPA Information Innovation Office

Question: At DARPA, you lead program managers in the development of programs, technologies, and capabilities to ensure information advantage for the United States. How extensively does "information advantage" overlap with "software engineering advantage," and what are the primary software-related areas you feel will lead us to advantages in both realms?

Dr. William Scherlis assumed the role of office director for DARPA's Information Innovation Office in September 2019. In this role he leads program managers in the development of programs, technologies, and capabilities to ensure information advantage for the United States and its allies, and coordinates this work across the Department of Defense and U.S. government. Scherlis joined DARPA from Carnegie Mellon University (CMU), where he is a professor of computer science. He is a fellow of the IEEE and a Lifetime National Associate of the National Academy of Sciences.

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Mr. Nand Mulchandani | Chief Technology Officer, Joint Artificial Intelligence Center (JAIC)

Question: The DoD considers AI to be one of the keys to national security. What are the key AI engineering challenges that must be solved so that AI can live up to this role?

Mr. Nand Mulchandani serves as the Acting Director of the U.S. Department of Defense Joint Artificial Intelligence Center. He brings more than 25 years of experience in the technology industry as a serial entrepreneur and senior executive in the enterprise infrastructure and security software industries to his service in the government to help transform the Department of Defense in adopting next-generation AI and software technologies.

Prior to government service, Mulchandani was at the Harvard University John F. Kennedy School of Government and Stanford University's Graduate School of Business, and remains a non-resident Fellow at Harvard's Belfer Center for Science and International Affairs.

Mulchandani holds a Bachelor's degree in Computer Science & Mathematics from Cornell University, a Master in Science in Management from the Stanford University Graduate School of Business, and a Master of Public Administration from the Kennedy School of Government at Harvard University.

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Dr. Will Roper | Assistant Secretary of the Air Force for Acquisition, Technology, and Logistics

Question: You've already brought big changes to the way the DoD acquires and fields software. What do you see as the biggest software engineering challenges remaining for reaching the vision you have for the future of battle systems?

Dr. Will Roper is the Assistant Secretary of the Air Force for Acquisition, Technology and Logistics. As the Air Force's Service Acquisition Executive, Dr. Roper is responsible for and oversees Air Force research, development and acquisition activities totaling an annual budget in excess of $60 billion for more than 550 acquisition programs. In this position, Dr. Roper serves as the principal adviser to the Secretary and Chief of Staff of the Air Force for research and development, test, production and modernization efforts within the Air Force.

Prior to his current position, Dr. Roper was the founding Director of the Pentagon's Strategic Capabilities Office. Established in 2012, the SCO imagines new—often unexpected and game-changing—uses of existing government and commercial systems: extending their shelf-life and restoring surprise to the military's playbook. During his tenure as SCO Director, Dr. Roper served on the Department's 2018 National Defense Strategy Steering Group, Cloud Executive Steering Group and Defense Modernization Team.

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