Systems Engineering Research Center (SERC)

Executive Overview

Dr. Dinesh Verma

November, 2016

This material is based upon work supported, in whole or in part, by the U.S. Department of Defense through the Systems Engineering Research Center (SERC) under Contract H98230-08-D-0171. The SERC is a federally funded University Affiliated Research Center (UARC) managed by Stevens Institute of Technology consisting of a collaborative network of over 20 universities. More information is available at www.SERCuarc.org

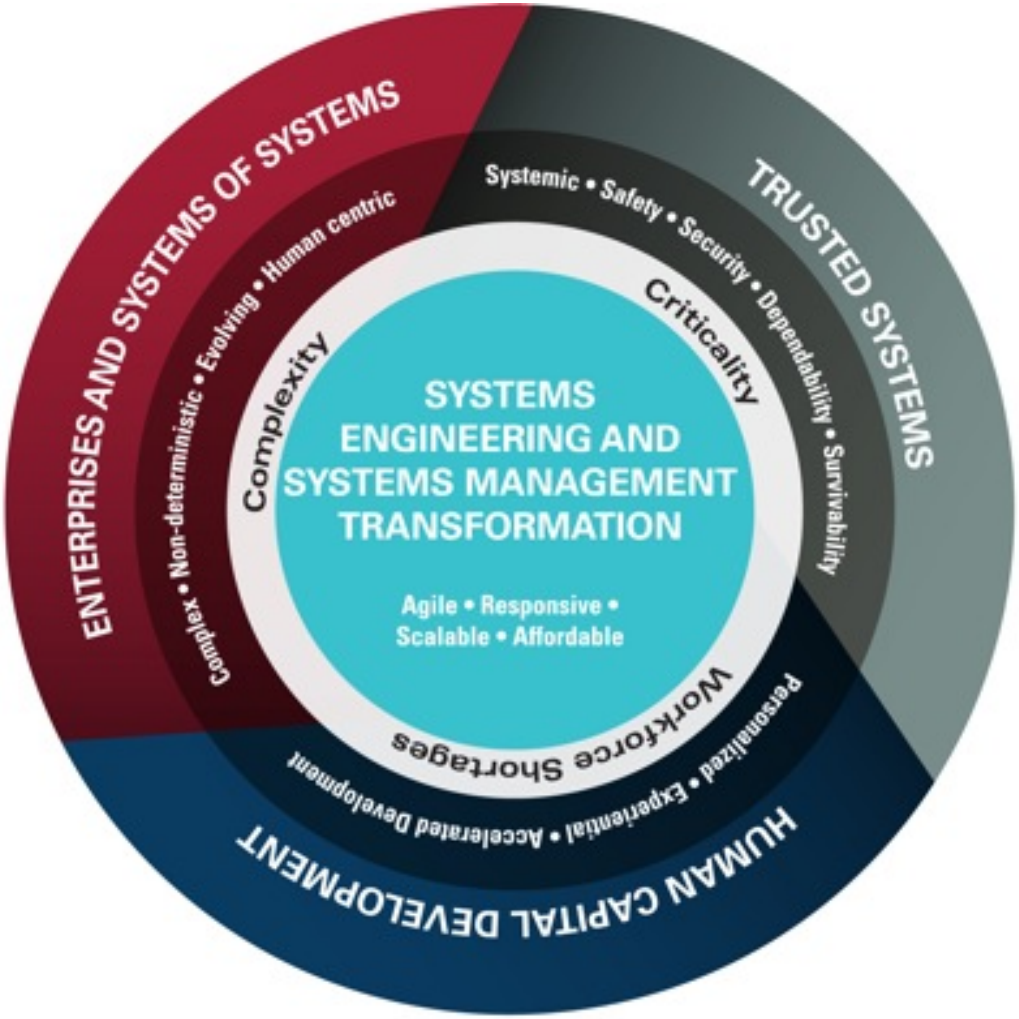
SERC Network of Over 20 Collaborators

SERC leverages expertise of over 450 researchers across the United States

University or Research Organization

1. Stevens Institute of Technology
2. University of Southern California
3. Air Force Institute of Technology
4. Auburn University
5. Carnegie Mellon University
6. Georgetown University
7. Georgia Institute of Technology
8. Massachusetts Institute of Technology
9. Missouri University of Science and Technology
10. Naval Postgraduate School
11. North Carolina Agricultural & Technical State University
12. Pennsylvania State University
13. Purdue University
14. Southern Methodist University
15. Texas A&M University
16. Texas Tech University
17. University of Alabama in Huntsville
18. University of California - San Diego
19. University of Maryland
20. University of Massachusetts Amherst
21. University of Virginia
22. Wayne State University

SERC Research Thematic Areas



Enterprises and SoS

- *Enterprise Analysis*
- *System of Systems Modeling and Analysis*

Trusted Systems

- *Systemic Security*
- *Systemic Assurance*

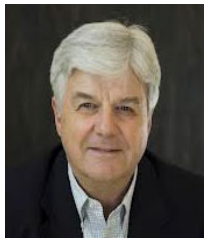
Human Capital Development

- *Evolving Body of Knowledge*
- *Experience Acceleration*
- *SE and Technical Leadership Education*

SE & Systems Mgmt Transformation

- *Affordability and Value in Systems*
- *Quantitative Risk*
- *Interactive Model-Centric Systems Engineering*
- *Agile Systems Engineering*

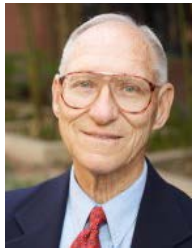
Research Council Members



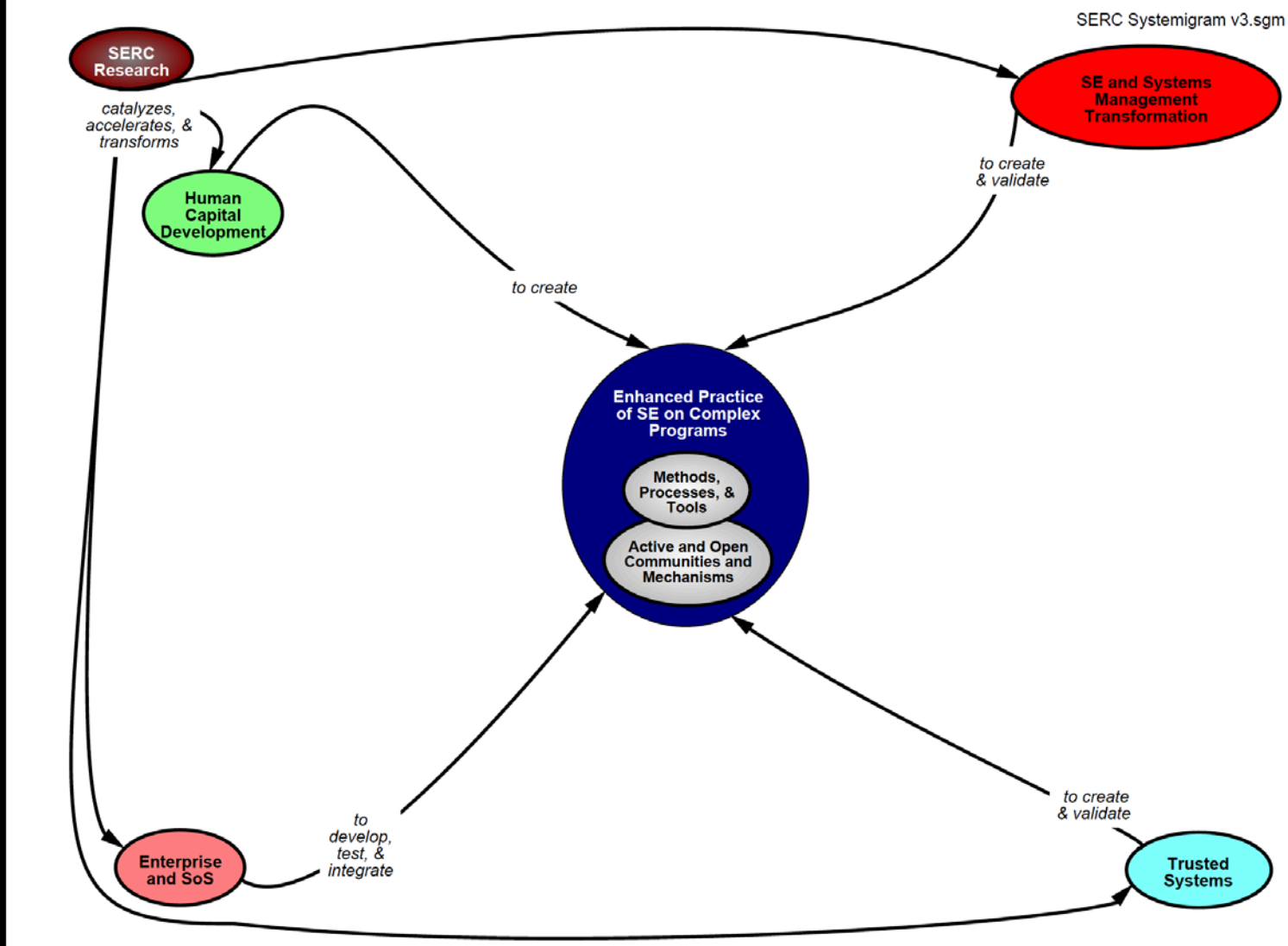
- **Enterprise Systems and Systems of Systems**
  - *Dan DeLaurentis, Purdue*
  - *Jo Ann Lane, USC*
  - *Bill Rouse, Stevens (NAE)*

- **Trusted Systems**
  - *Barry Horowitz, UVA (NAE)*
  - *Bill Scherlis, CMU*
  - ***Kevin Sullivan, UVA***

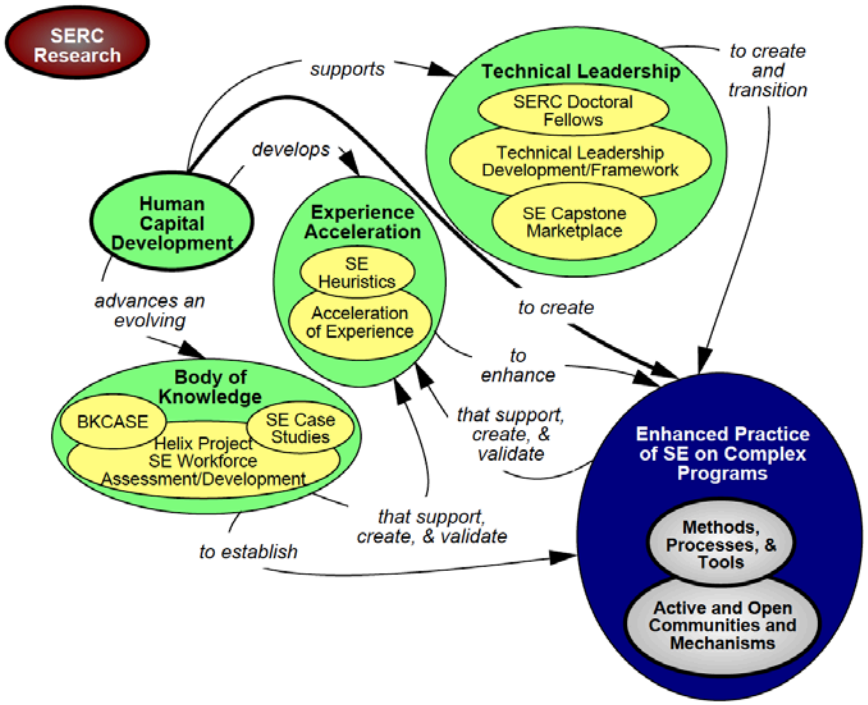
- **Human Capital Development**
  - *Tom McDermott, GA Tech*
  - *Jon Wade, Stevens*



- **Systems Engineering and Systems Management Transformation**
  - ***Mark Blackburn, Stevens***
  - *Barry Boehm, USC (NAE)*
  - *Paul Collopy, UAH*

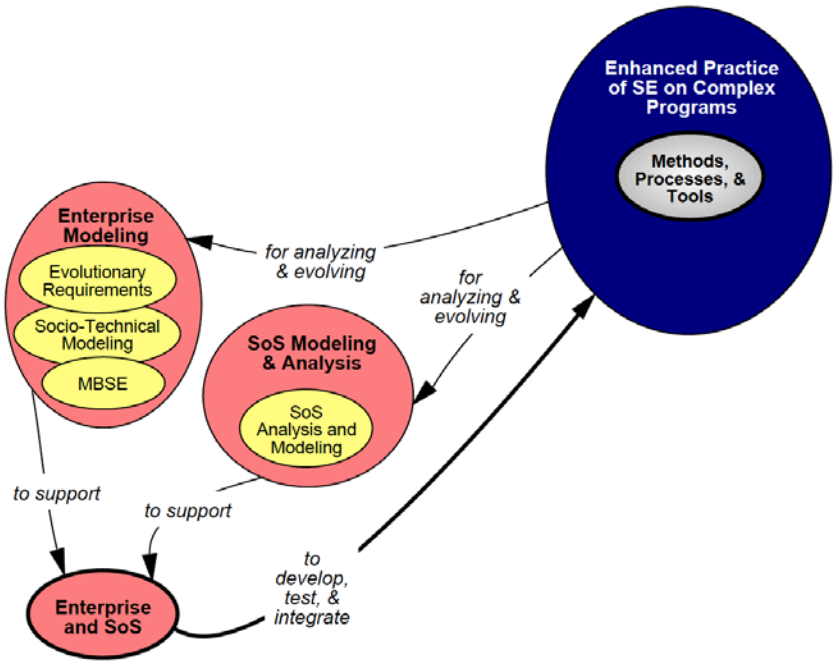

SERC Systemigram v3.sgm
SERC Research
catalyzes, accelerates, & transforms
Human Capital Development
SE and Systems Management Transformation
to create & validate
to create
Enhanced Practice of SE on Complex Programs
Methods, Processes, & Tools
Active and Open Communities and Mechanisms
to develop, test, & integrate
Enterprise and SoS
to create & validate
Trusted Systems

SERC Systemigram v3.sgm



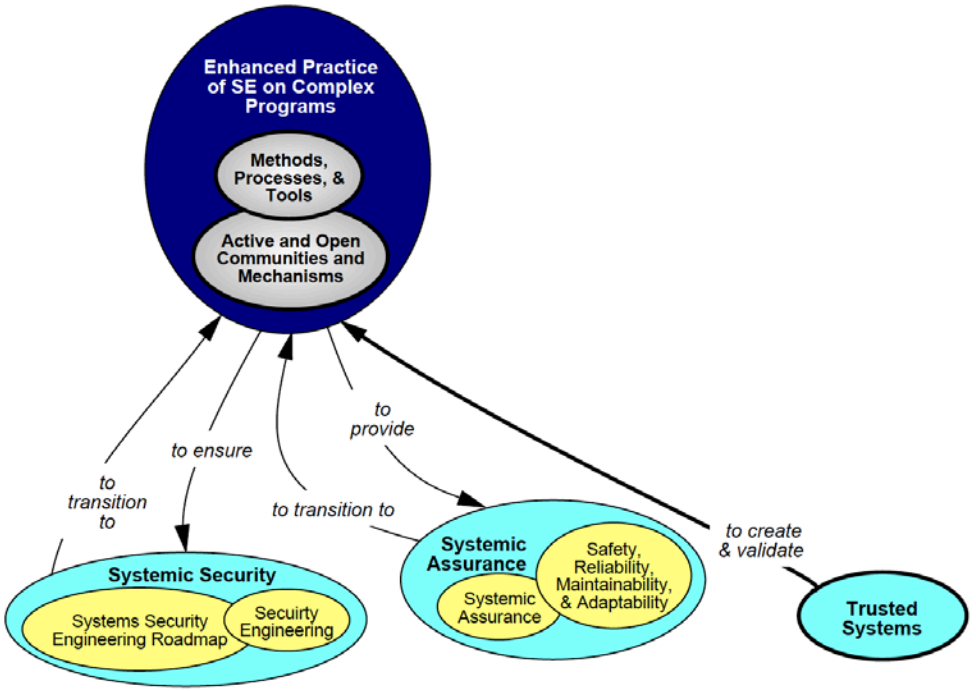
SERC Research

SERC Systemigram v3.sgm

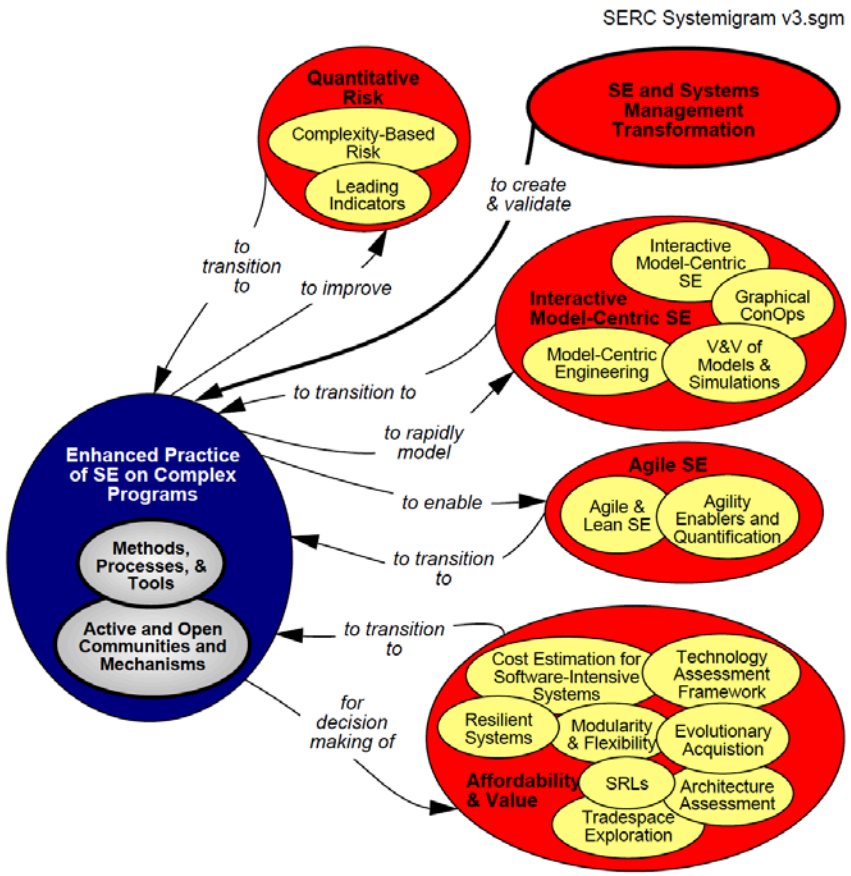


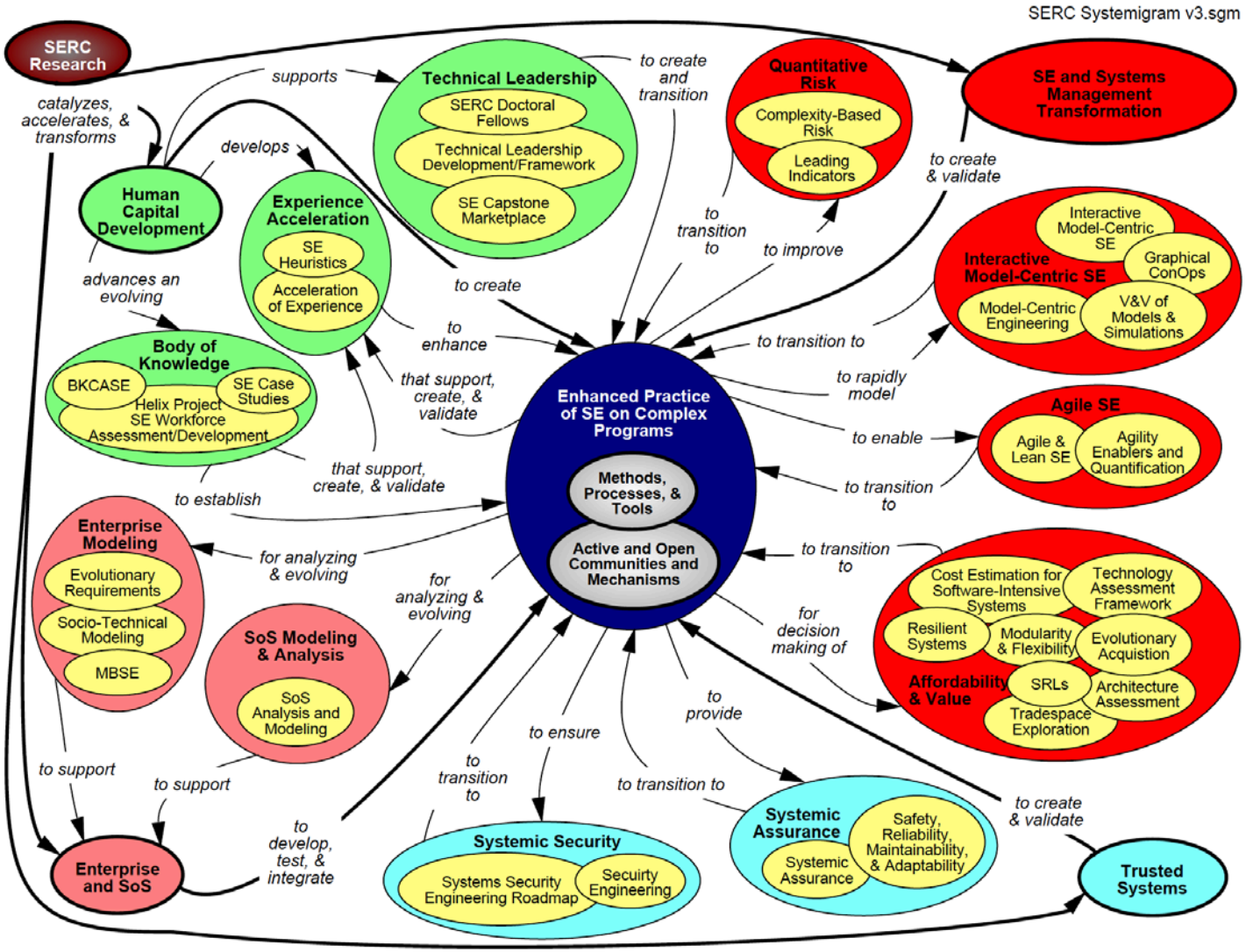
SERC Research

SERC Systemigram v3.sgm



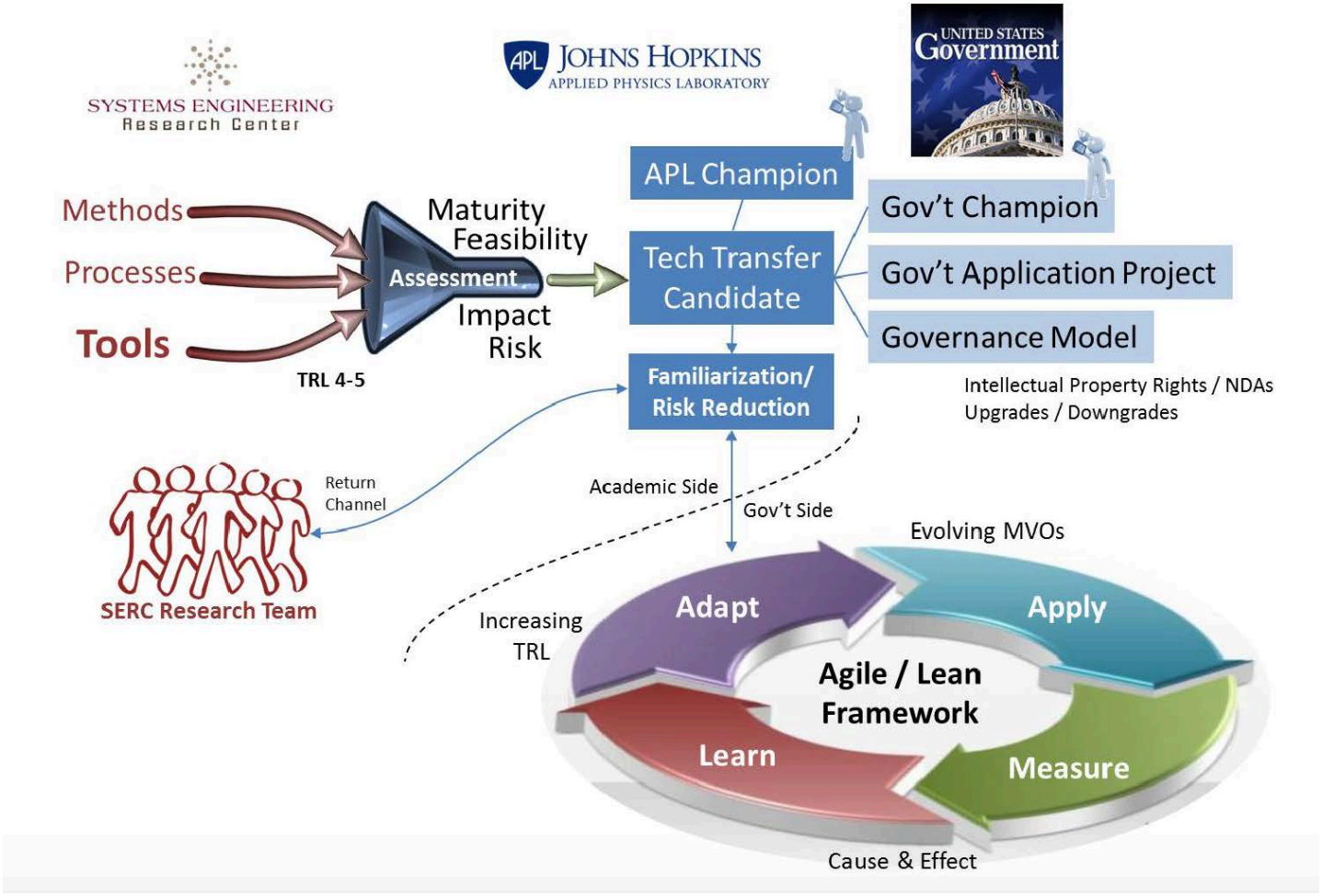
SERC Research




SERC Systemigram v3.sgm
SERC Research
catalyzes, accelerates, & transforms
supports
develops
Human Capital Development
Technical Leadership
SERC Doctoral Fellows
Technical Leadership Development/Framework
SE Capstone Marketplace
Experience Acceleration
SE Heuristics
Acceleration of Experience
to create and transition
Quantitative Risk
Complexity-Based Risk
Leading Indicators
SE and Systems Management Transformation
to create & validate
to transition to
to improve
advances an evolving
to create
to enhance
Body of Knowledge
BKCASE
SE Case Studies
Helix Project
SE Workforce Assessment/Development
that support, create, & validate
Enhanced Practice of SE on Complex Programs
Methods, Processes, & Tools
Active and Open Communities and Mechanisms
Interactive Model-Centric SE
Interactive Model-Centric SE
Graphical ConOps
Model-Centric Engineering
V&V of Models & Simulations
to transition to
to rapidly model
to enable
Agile SE
Agile & Lean SE
Agility Enablers and Quantification
to transition to
to establish
Enterprise Modeling
Evolutionary Requirements
Socio-Technical Modeling
MBSE
for analyzing & evolving
for analyzing & evolving
SoS Modeling & Analysis
SoS Analysis and Modeling
to transition to
Cost Estimation for Software-Intensive Systems
Technology Assessment Framework
Resilient Systems
Modularity & Flexibility
Evolutionary Acquistion
Affordability & Value
SRLs
Architecture Assessment
Tradespace Exploration
for decision making of
to support
to support
to develop, test, & integrate
to transition to
to ensure
to provide
to transition to
Systemic Security
Systems Security Engineering Roadmap
Secuirty Engineering
Systemic Assurance
Systemic Assurance
Safety, Reliability, Maintainability, & Adaptability
to create & validate
Enterprise and SoS
Trusted Systems

Key Transition Activities

- SoS Analytic Workbench – APL for DoD; MITRE for multiple
  - —Purdue University
- Modeling Framework for SoS and Enterprise Systems – MITRE for the Veterans Administration, and others
  - —Stevens Institute of Technology
- TRLs to SRLs – DoD
  - —Stevens Institute of Technology
- Multiple HCD Projects with significant impact within the DoD to the DAU and the Systems Community in general
  - —Georgia Tech; USC; Purdue University; Stevens Institute of Technology, NPS
- System Aware Security – ARDEC, potentially others
  - —University of Virginia


SYSTEMS ENGINEERING
Research Center
APL JOHNS HOPKINS
APPLIED PHYSICS LABORATORY
UNITED STATES
Government
APL Champion
Gov't Champion
Methods
Processes
Tools
Maturity
Feasibility
Assessment
Impact
Risk
TRL 4-5
Tech Transfer
Candidate
Gov't Application Project
Governance Model
Intellectual Property Rights / NDAs
Upgrades / Downgrades
Familiarization/
Risk Reduction
Return
Channel
SERC Research Team
Academic Side
Gov't Side
Evolving MVOs
Increasing
TRL
Adapt
Apply
Agile / Lean
Framework
Learn
Measure
Cause & Effect

Transition of the SERC Analytic Workbench Technology into Government Service by JHUAPL

14 November 2016

The Johns Hopkins University Applied Physics Laboratory (JHUAPL) is a University-Affiliated Research Center (UARC) and a non-profit organization with a long tradition of serving the US Government as a trusted agent. This role has enabled JHUAPL to develop extensive knowledge and relationships in multiple operational and security domains. JHUAPL is working with a government sponsor in one such domain to identify technology transition opportunities from research projects being conducted by the Systems Engineering Research Center (SERC). The SERC is also a UARC, consisting of a network of academic researchers across many US universities who primarily perform unclassified fundamental research on systems engineering methods, processes, and tools (MPTs). As mature SERC technology and appropriate government programs are identified, JHUAPL will work as a trusted technology transfer agent of the government, incorporating the technology and ensuring its benefits are realized in areas where the SERC has limited access to government programs and information.

Figure 1 represents an overview of the process by which JHUAPL will transfer technologies being developed by the SERC into use by government programs. Beginning on the left side of the figure, the process starts with the SERC producing MPTs across a spectrum of research interests. JHUAPL performs initial assessments of these MPTs to identify potential candidates, favoring more mature tools in a Technology Readiness Level (TRL) 4-5 range, as guided by government sponsorship. The process of identifying technology transfer candidate tools includes the identification of an APL technology transfer champion, a government project champion, a receptive government project, and a governance model to ensure attention to such things as intellectual property rights and security issues.

MITRE

Research Workshops in 2016

Industry-Government Forum: Model Centric Engineering

INDUSTRY AND GOVERNMENT FORUM

MODEL CENTRIC ENGINEERING

May 26, 2016

WASHINGTON, DC

Creating a New Culture and Ecosystem for Coordination and Collaboration with Model-Centric Design and Acquisition

INTENT:

A discussion between key stakeholders and thought leaders on challenges, issues, concerns, and enablers for a transformation towards model-centric engineering.

A platform to share ideas on how we could collectively operate in a transformed world of model centric engineering in acquisition.

Presentations and demonstrations to reflect on enabling tools, technologies and concepts for new business models within such an ecosystem that facilitates coordination and collaboration.

INTRODUCTION, BACKGROUND, AND CONTEXT:

Model-centric engineering can be characterized as an overarching digital and visual approach to engineering. It also involves integrating different model types with simulations, surrogates, systems and components at different levels of abstraction and fidelity across disciplines throughout the system or solution lifecycle. The use of such digital engineering technologies and model-centric engineering practices are advancing, and adoption is accelerating. While this is happening, a number of technical and business/acquisition model challenges remain. The current business models may not be appropriately aligned for acquisition in such a model-centric ecosystem. We as a community must discuss approaches to allow better collaboration, while nurturing competition with appropriate approaches to address Intellectual Property Protection, Government Data Rights, and a Collaborative Environment.

These digital technologies are changing how organizations are conceptualizing, architecting, designing, developing, producing, and sustaining. Some use model-centric environments for customer engagements, as well as design engineering analyses and review sessions. Some are integrating mission and system-level modeling and simulations originally created for design and development and expanding them into new cloud-like services enabled by the industrial Internet. Most organizations today have a unique capability realized by integrating commercial technologies and tools with their own innovations.

We need insights from key stakeholders in the "user community" on how to transform our engineering and acquisition culture in light of these advancements, how to align engineering and business/acquisition models. We want to explore ideas and concepts to improve the efficiencies and speed development, deployment, and sustainment of needed capabilities to the warfighter.

The purpose of this workshop is for key stakeholders in industry, government, and academia to converge and identify high-value "air gaps" that remain as hurdles in model-centric engineering, and that can be addressed through focused research and policy.

Industry-Government Forum: Model Centric Engineering

AGENDA - SERC INDUSTRY & GOVERNMENT FORUM ON MODEL CENTRIC ENGINEERING

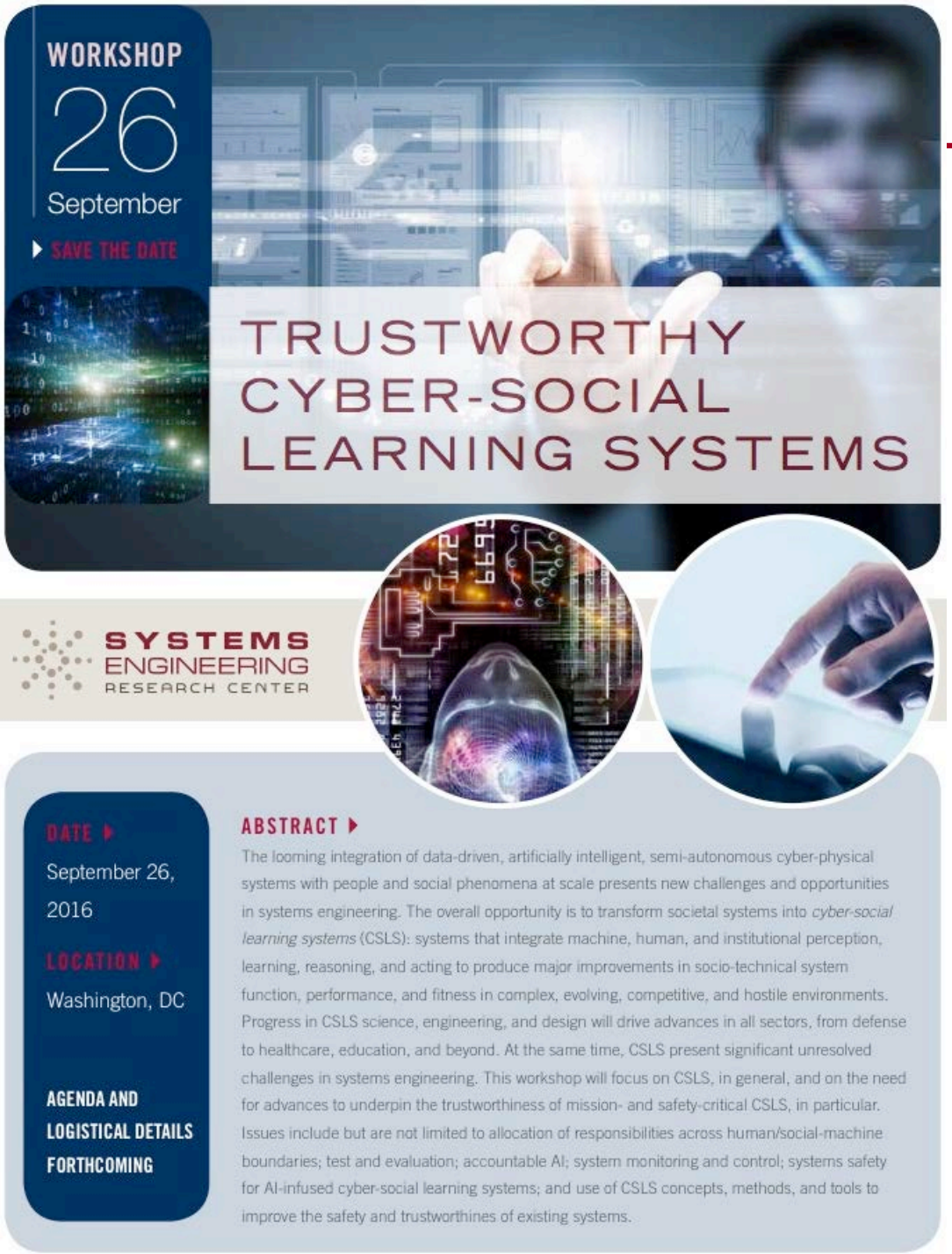
THURSDAY, MAY 26, 2016

8:00	Registration - Continental Breakfast	
8:30	Welcome & Announcements	
9:00	Forum Shaping Remarks (Ms. Kristen Baldwin)	
9:45	The Need for a Transformation - A Government Perspective (Mr. Dave Cohen)	
10:15	Break	
10:30	The Need for a Transformation - An Industry Perspective (Dr. Nicholas G. Paraskevopoulos)	
11:15	Panel: How Government Can Work Differently	
12:00	Lunch	
1:00	**Breakout Session 1:** A Collaboration Operational Model between Industry and Government (Moderated by Dr. Donna Rhodes, MIT)	**Breakout Session 2:** Roadmap of Technologies to Support a New Operational Paradigm in Model Centric Engineering (Moderated by Dr. Jon Wade, Stevens)
2:45	Break	
3:00	Current State of Research and Development in Support of Engineered Resilient Systems (ERS) (Dr. Jeff Holland, Chief Scientist, ERDC)	
3:45	Break	
4:00	Tools and Infrastructure in support of Model Centric Engineering - a Tool Vendor Perspective (Moderated by Mr. David Long, CEO, ViTech and Former President, INCOSE)	
5:00	Open Microphone and Additional Actions	
5:30	Social and Networking Session	

SYSTEMS ENGINEERING RESEARCH CENTER

SYSTEMS ENGINEERING RESEARCH CENTER

September 26, 2016;
Invitation only attendance, limited to 35



SYSTEMS ENGINEERING RESEARCH CENTER

October 5, 2016;
Invitation only attendance, limited to 35

ABSTRACT:

As the DoD strives to affordably address emerging threats, it is challenged by issues such as component obsolescence, loss of critical suppliers, and planning technology insertion and upgrades for tightly coupled, highly integrated systems. The Office of the Deputy Assistant Secretary of Defense for Systems Engineering (ODASD(SE)) Modular Open Systems Approach (MOSA) initiative seeks to balance the business objectives with the technical means to meet these challenges through a modularization approach under the auspices of open systems architecture OSA. In this context, a critical set of new questions arise, at the holistic and localized levels that involve a diverse set of stakeholders across the acquisition life cycle.

Example questions include how to: 1) define modularity and openness contexts (technical and programmatic) in an ecosystem; 2) quantify the costs, benefits, and risks of modularization across multiple dimensions through tradespace exploration; and 3) identify compatible policies that can be used to capitalize on the positive aspects of modularization. Progress on these questions will ultimately provide decision-makers within the defense acquisition system to clearly identify opportunities for modularization, identify compatible architectural alternatives, promote system level innovations, reduce costs, and, most importantly, execute these within a decision-maker friendly framework that does not encumber the overall acquisition process with undue complexity.

This workshop will focus on exploring these questions. Participants will actively contribute to in-depth discussions on 1) defining, quantifying and assessing modularity and openness; 2) generating candidate strategies, cognizant of current barriers and potentially useful incentives; 3) synthesizing a key list of stakeholder needs and/or concerns across a MOSA ecosystem; and 4) mapping beneficial elements of modularization strategies to appropriate acquisition processes that encourage adoption. Participants will also assist in developing a useful repository of case studies (government/industry), including anecdotal evidence and lessons learned in the implementation of modular strategies.

WORKSHOP - OCTOBER 5, 2016

8am – 5pm • Stevens Institute of Technology, Ronald Reagan Building, Washington D.C.

Workshop attendance is by invitation only.

SYSTEMS ENGINEERING RESEARCH CENTER

A U.S. DEPARTMENT OF DEFENSE UNIVERSITY AFFILIATED RESEARCH CENTER

www.sercuarc.org

LEADS:

Dr. Daniel DeLaurentis
– Purdue University

Dr. Mitchell Kerman
– Stevens Institute of Technology

SERC Executive Director:
Dr. Dinesh Verma, Stevens

SERC Chief Scientist:
Dr. Barry Boehm, USC

Potential Research Workshop Topics - 2017

Model Based Testing

Security at Design Time

Program and Acquisition Risk

Future Areas of SERC Research - DRAFT

SERC Research Future Impact Areas

- SE and SE Management Transformation
  - Model Centric Engineering
  - Flexible and Adaptive Systems
  - Architecting and Verification of Cyber-Human Learning Systems
  - Team Effectiveness
- Trusted Systems
  - **Hard: Flexible Systems Architectures and Designs**
  - **Wicked: Cyber Resilient Weapon Systems**
  - **Scary: Autonomous Systems with varying levels of Cognition**
- Leveraging MOSA to enhance the innovation ecosystem supporting the DoD, Modeling the Defense Innovation System
  - Understand enterprises and SoS to improve uptake of digital engineering/MCE and awareness of individual system developments
- Human Capital Development
  - Competency Identification
    - Mission Engineering Competencies
    - Competencies to support evolution of CPS and Autonomous Systems and MCE/Digital Engineering

SERC Doctoral Fellows Program

Human Capital Development: SERC Doctoral Fellows Program

- Started in 2012 as an evolution of SERC's unique research collaboration model
- Allows Ph.D. students at participating organizations to access our Collaborator Universities' leading systems thinkers as research advisors
- A key component of the SERC's human capital development mission in training the next-generation of our government and industry systems engineering thought leaders
- Current participants
  - First Commercial Organization: Boeing
  - First FFRDC: MITRE
  - First Warfare Center: ARDEC-Picatinny Arsenal

SYSTEMS ENGINEERING RESEARCH CENTER

SERC TALKS

UPCOMING TOPICS:

SERC Talks features researchers from our Systems Engineering community sharing their insights on various questions relevant to Systems Engineering and its evolution. This series, stemming from the technical presentations which took place periodically during our SERC Collaborator WebEx meetings, will continue to grow and touch on other subjects and aspires to create an ongoing and more collaborative dialogue between academia, government and industry sectors. As always, SERC strives to grow Systems Engineering research into areas which can transition into impact.

What Lives at the Intersection of MOSA and Set-Based Design?
Gary Witus, Wayne State
October 5 | 1:00 pm ET

Why is Human-Model Interactivity Important to the Future of Model-Centric Systems Engineering?
Donna Rhodes & Adam Ross, MIT
December 7 | 1:00 pm ET

SERC TALKS

UPCOMING TOPICS:

2017

What is the Self?
Grady Booch, IBM Research
February 1 | 1:00 pm ET

Can Graphical Models Provide a Sufficient Basis for General Intelligence?
Paul S. Rosenbloom, University of Southern California
April 5 | 1:00 pm ET

What Are Cyber-Social Learning Systems And How Will We Form Them?
Kevin Sullivan, University of Virginia
June 7 | 1:00 pm ET

Thanks!