Advancing Systems Engineering Practice within the Department of Defense: Overview of DoD's Newest University Affiliated Research Center (UARC)

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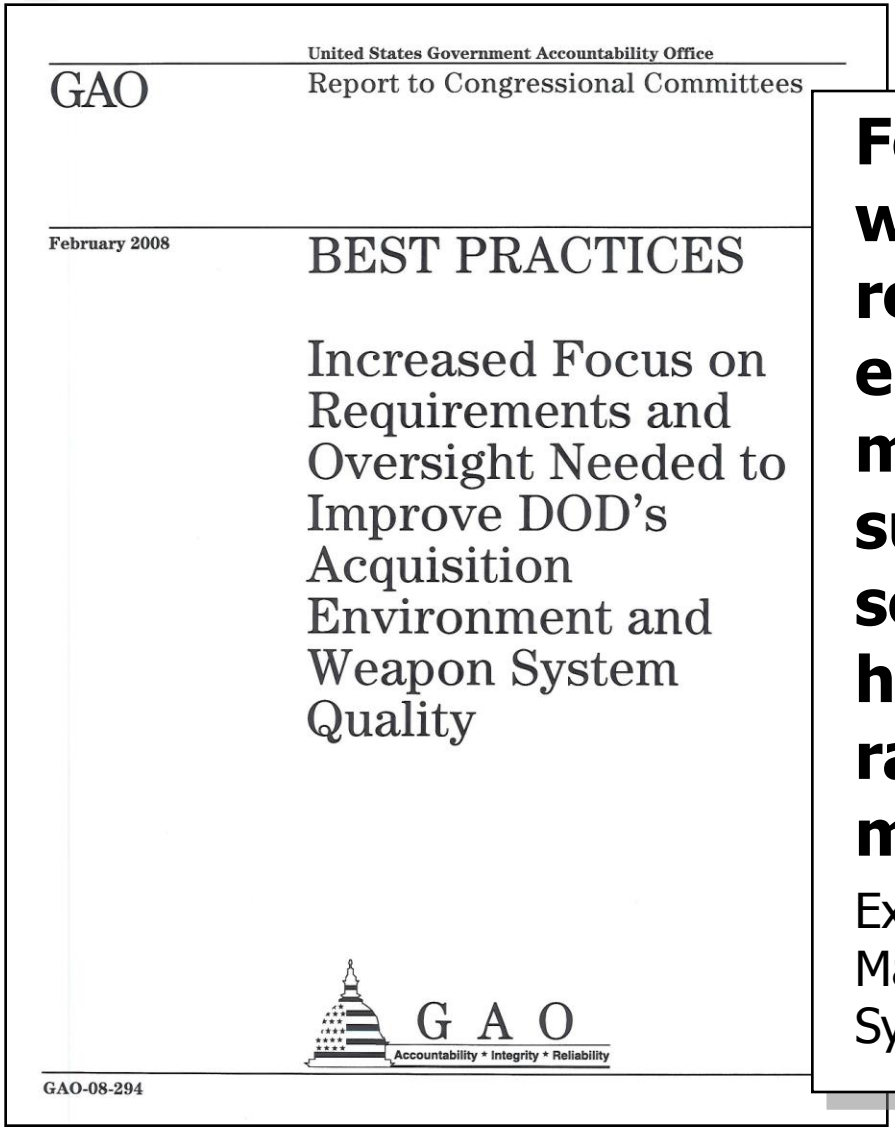
Outline

- Our Challenge
  - Today's Environment
  - The Problem – The Solution
  - Why a UARC?
- SER UARC at a Glance
  - Advancing SE Practice in DoD
  - Mission, Core Competencies and Structure
  - UARC Team and Capabilities
  - Initial Research
- Summary
- Vision for the DoD Acquisition Community

Today's Environment

It's unsafe. It can't shoot straight. It's already cost 30 lives and $20 billion. And now it's headed for Iraq. The long- sad tale of the V-22 Osprey.
-TIME, October 8, 2007

Today's Environment



United States Government Accountability Office

GAO

Report to Congressional Committees

February 2008

BEST PRACTICES

Increased Focus on Requirements and Oversight Needed to Improve DOD's Acquisition Environment and Weapon System Quality

GAO

Accountability * Integrity * Reliability

GAO-08-294

For 11 programs surveyed with quality problems related to systems engineering, manufacturing, and supplier quality, cost and schedule impacts ranged as high as $846M with delays ranging from several months to 5 years.

Extracted from GAO-08-294 DoD Quality Management, page 8, Figure 1 Weapon System Quality Programs and Impact

Today's Environment

Recommendations from National Academies Study of pre-Milestone (MS) B Systems Engineering (SE):

- SE engagement pre-MS A and pre-MS B is essential
- Early SE is dependent upon experienced engineers
- Govt/FFRDC/Industry must all engage
- Establish a Developmental Planning function in the Military Departments

The Need

- Current SE methods, processes, tools do not address the breadth, complexity, and tempo of today's development environment.
- Although systems engineering is recognized as key to delivering weapon systems, there is no single body leading the effort to advance SE methods, processes, and tools (MPTs) to support DoD challenges.
- There is an inadequate supply of systems engineers experienced with the breadth and complexity of DoD's current development environment.

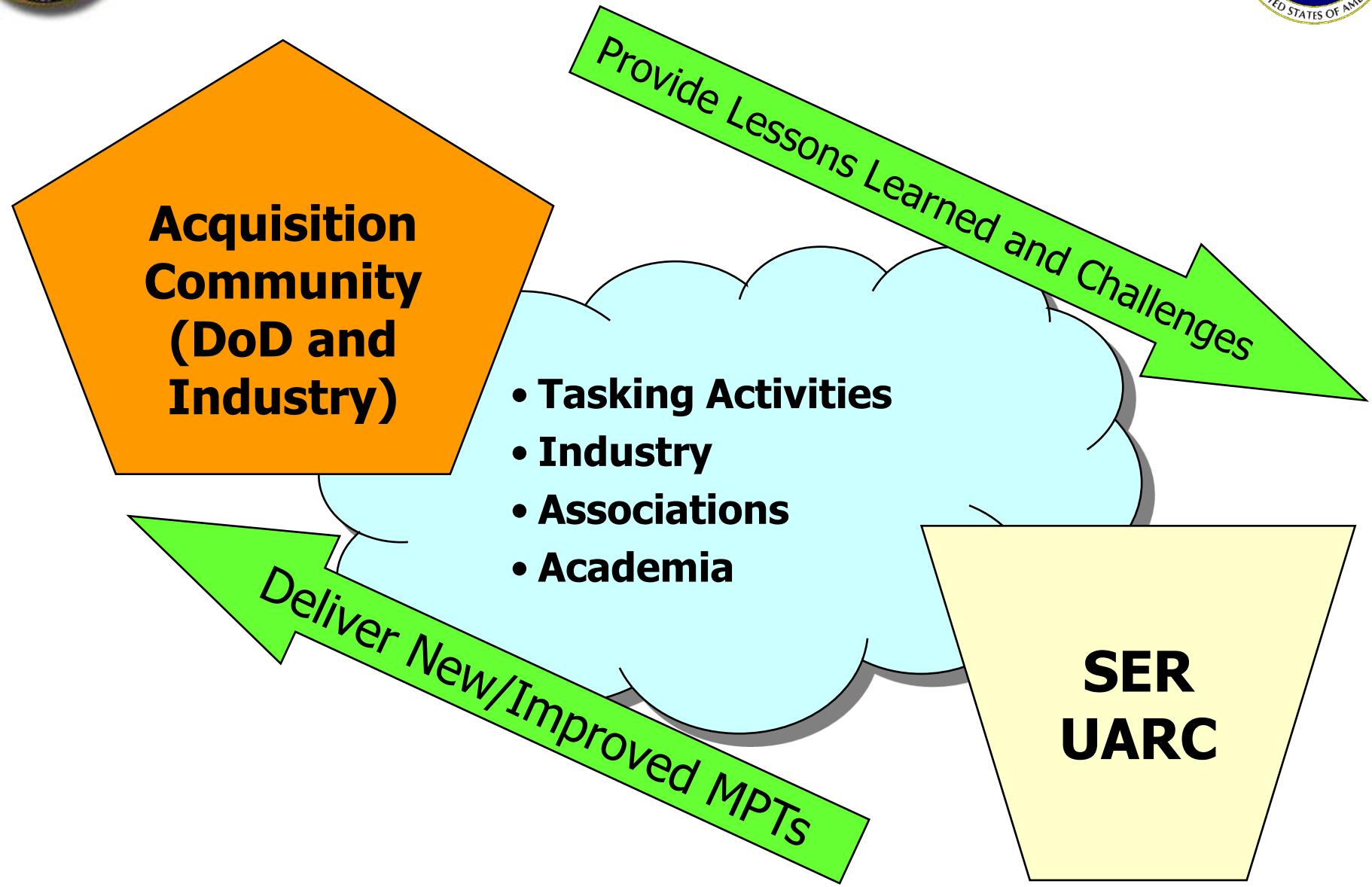
The Solution

- Provide funding for a center to lead, coordinate, and harmonize research focused on delivering improved SE MPTs that support DoD challenges
  - Establishes and maintains essential systems engineering research and analysis capabilities
  - Nurtures and grows graduate-level systems engineering academic and research programs that support DoD acquisition program needs

Why Establish a DoD SER UARC?

- Long-term strategic relationship
- Non-competitive with SE providers/practitioners
- Provide an objective viewpoint
- Access to information across government and industry
- Greater flexibility to respond to evolving requirements
- Grow graduate-level systems engineering academic and research programs that support DoD needs

Advancing SE Practice



SER UARC Mission

To research and analyze advanced and emerging systems engineering practices and relevant technologies to address the full spectrum of DoD and Intelligence systems across the Department

Goal: Ensuring consistency and systems engineering excellence throughout the acquisition cycle

Summary of Core Competencies

- Conduct long-term, comprehensive systems engineering research focused on DoD acquisition
- Leverage developments in systems architecting, complex systems theory, systems thinking, systems science, knowledge management, and software engineering to perform research to advance the design and development of complex systems across all DoD domains
- Leverage developments in open systems standards, organizational theory, program management, systems engineering management, and information technology to provide needed integration of program / technical management MPTs

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  –SE MPTs to enable integrated development and management of requirements, design, interfaces, verification and validation, technical baselines, and risk
  –Exploration of new ways of linking requirements to design
  –SE MPTs to fully leverage modeling and simulation advances including the use of formal languages (e.g., XML, SAML) and modeling techniques (e.g., UML, SysML) to capture and document requirements along with other program artifacts and to support design trade studies
  –Linkage of technical baselines to architectures
  –Application of SE to acquisition of services

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- Leverage developments in systems architecting, complex systems theory, systems thinking
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  - –Enterprise systems engineering
  - –Software-unique extensions and modern software development techniques and how they relate to SE
  - –Flexible SE environments to support complex software systems and commercial-off-the-shelf (COTS) hardware and software integration
  - –Knowledge management SE repositories
  - –Undergraduate/graduate SE education needs
- Leverage standards, manage and integrate MPTs

Summary of Core Competencies

- Conduct long-term, comprehensive systems eng
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–Integrating technical performance measures (TPM) with earned value management (EVM)

–Role of maturity reviews in SE planning – technology, manufacturing, and software, and their integration

–Systems engineering team structures, communication mechanisms, internal and external collaboration, and other mechanisms for continuous process improvement

–Improved SE information sharing across the enterprise, program, and engineering team using technologies such as wikis, blogs, portals, search engines, etc.

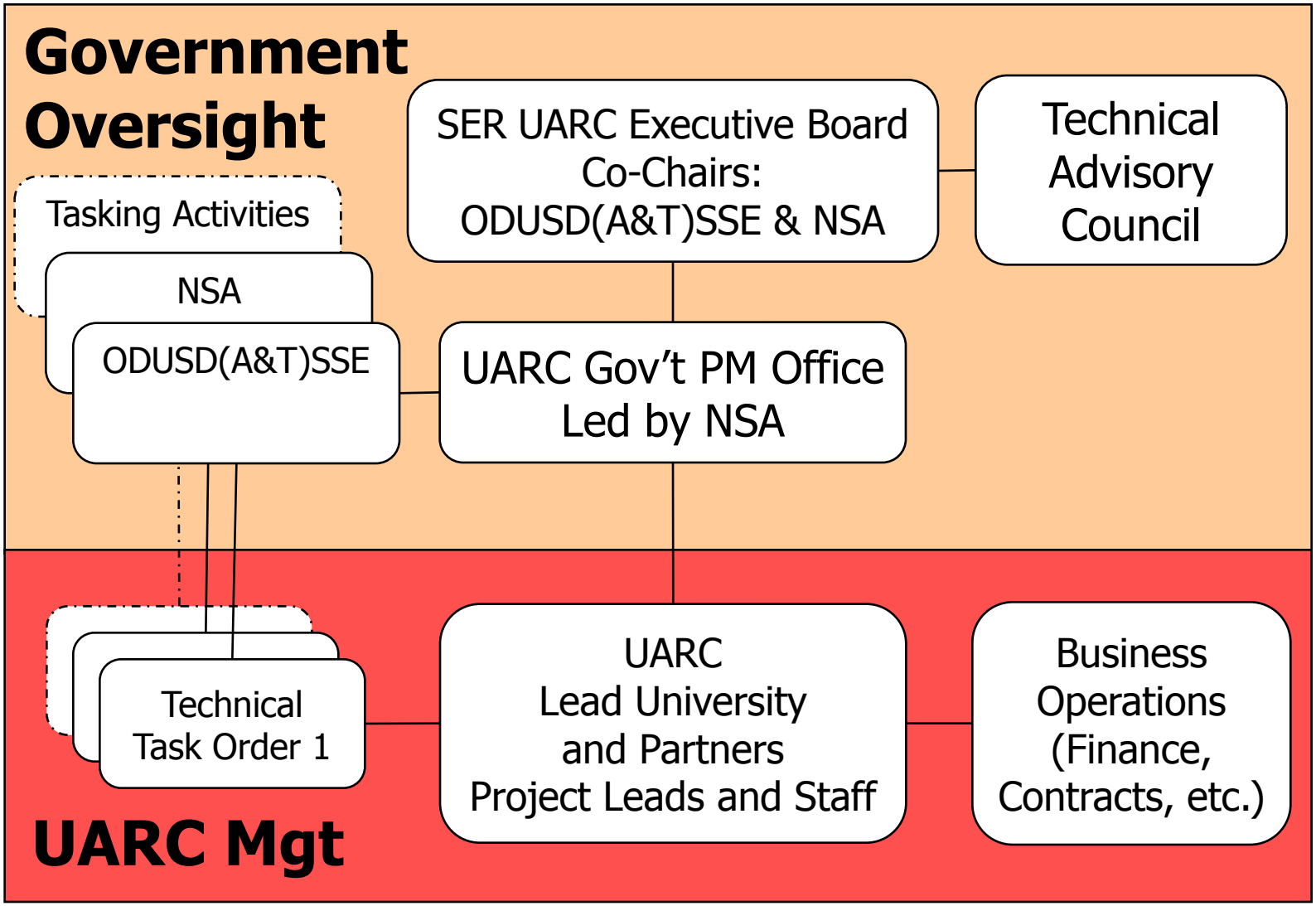
–Rationale and way ahead for standards harmonization

–Consideration of toolsets throughout the system life cycle

–Analyzing SE costs, cost accounts, and return on investment (ROI)

–SE metrics and use of leading indicators to track/forecast program success

Integrated UARC Oversight and Management Structure



SER UARC Team

Lead organizations

STEVENS Institute of Technology

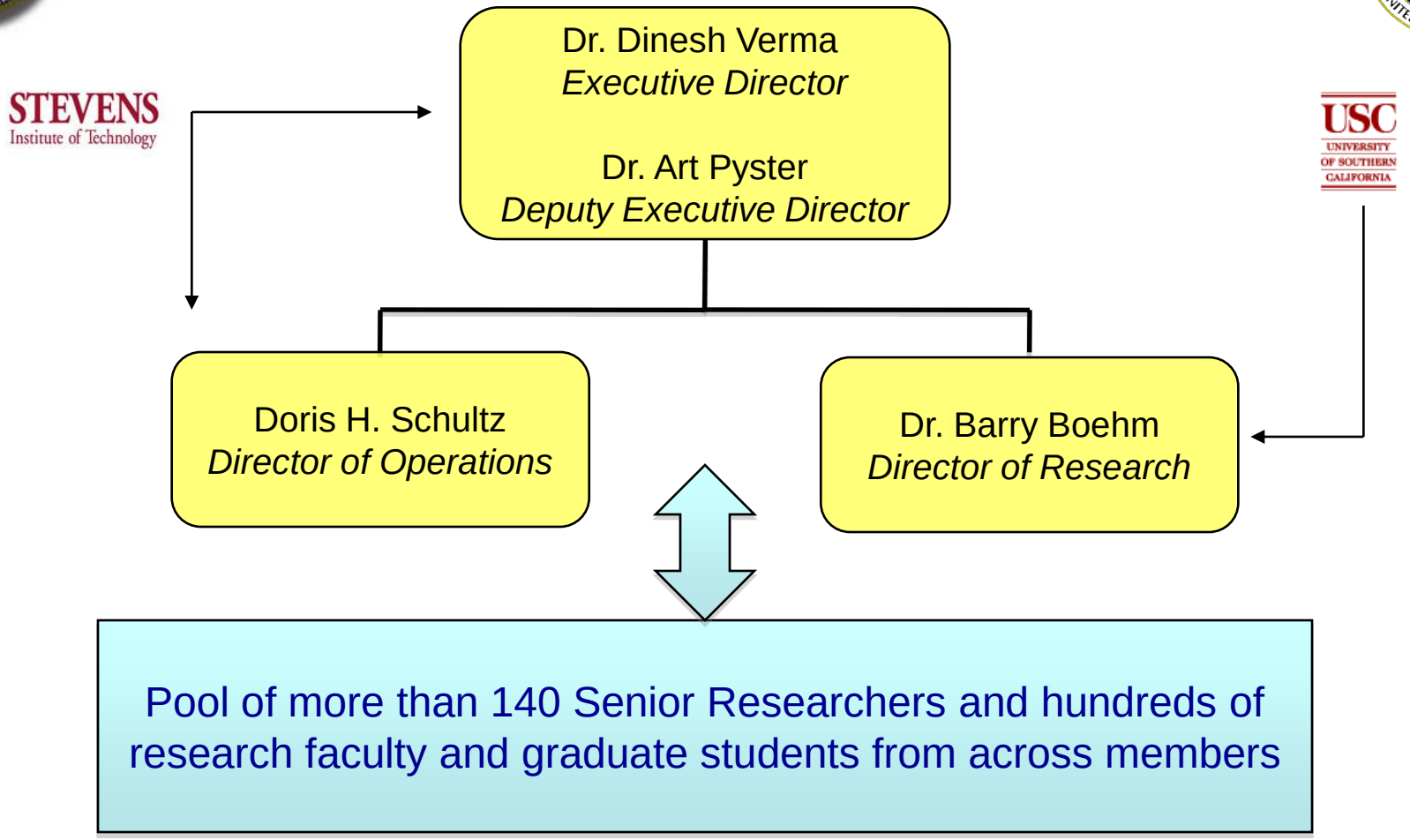
USC University of Southern California

Members

- Auburn University
- Air Force Institute of Technology
- Carnegie Mellon University
- Fraunhofer Center at UMD
- Massachusetts Institute of Technology
- Missouri University of Science and Technology (S&T)
- Pennsylvania State University
- Southern Methodist University
- Texas A&M University
- Texas Tech University
- University of Alabama in Huntsville
- University of California at San Diego
- University of Maryland
- University of Massachusetts
- University of Virginia
- Wayne State University

The DoD *Systems Engineering Research-University Affiliated Research Center* will be responsible for systems engineering research that supports the development, integration, testing and sustainability of complex defense systems, enterprises and services. Stevens has MOUs to develop enhanced SE courseware for competency development within DoD with AFIT, NPS and DAU. Further, SER-UARC members are located in 11 states, near many DoD facilities and all DAU campuses.

SER UARC Leadership



Stevens' School of Systems and Enterprises will host the SER-UARC at Stevens' Hoboken, NJ, campus. Stevens' faculty engagement will be complemented by a critical mass of systems engineering faculty at USC. A fundamental tenet of SER-UARC is its virtual nature – each of its 18 members will be a nexus of research activities. All research projects will be staffed by the best available researchers and graduate students from across the members.

Initial SE Research Tasks

- "Assessing Systems Engineering Effectiveness in Major Defense Acquisition Programs (MDAPs)"
  - Barry Boehm (USC) task lead, with support from Stevens, Fraunhofer Center, MIT, University of Alabama at Huntsville
- "Evaluation of Systems Engineering Methods, Processes, and Tools (MPT) on Department of Defense and Intelligence Community Programs"
  - Mike Pennotti (Stevens) task lead, with support from USC, University of Alabama at Huntsville, and Fraunhofer

Summary

- DoD Systems Engineering Research UARC established; initial tasks underway
- UARC may address SE research challenges across DoD and the Federal Government
- Research results (new/improved MPTs) will be shared across Government and industry to improve SE practice.

The Vision

Help **government and industry program managers** meet stakeholder needs by delivering new and improved **systems engineering methods, processes, and tools (MPTs)** that support **successful program execution**

For More Information

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Backup Slides

Initial SE Research Tasks

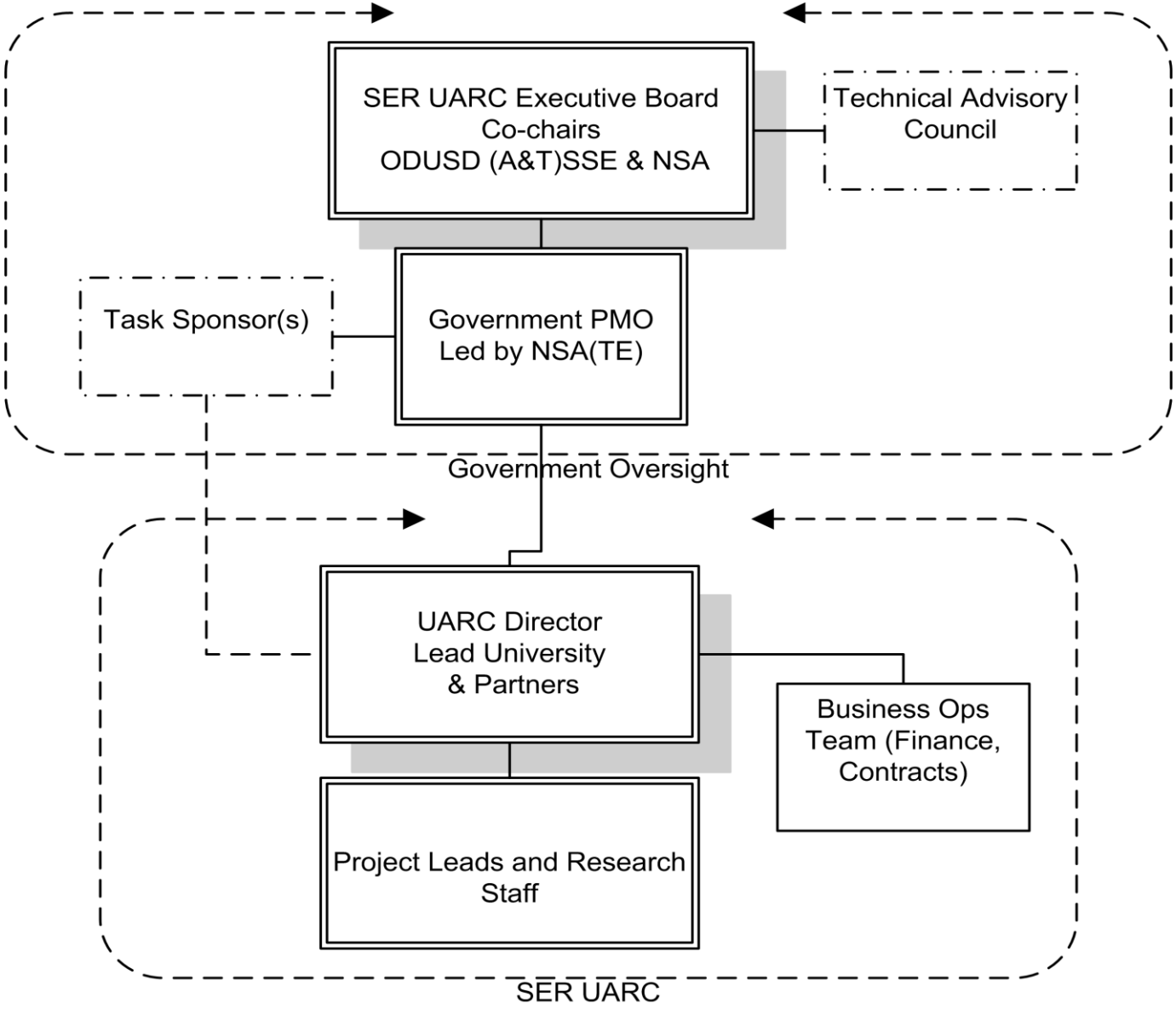
- Examine and recommend areas for advancing current SE methods, processes, and tools (MPTs) as they are applied across the DoD acquisition life cycle focusing on three different development environments: individual weapons systems, SoS, and network-centric systems (NSA)

- Characterize SE effectiveness within the context of DoD acquisition and identify methods of measurement suitable for application to project execution organizations (e.g., defense contractors), program management organizations (e.g., project managers and program executive offices) and oversight organizations (e.g., OUSD(AT&L)) (OSD)

Submitted Abstract
This slide for reference only

- The National Security Agency (NSA) and the Deputy Under Secretary of Defense (Acquisition and Technology) (DUSD (A&T)) have established a Systems Engineering Research (SER) University Affiliated Research Center (UARC) to lead, coordinate, and harmonize SE research efforts DoD-wide. The UARC serves as focal point for interaction among a range of universities that possess unique SE thinking and capabilities. The mission of the SER UARC is to perform research that addresses the full spectrum of DoD and Intelligence Community (IC) systems, from capability areas, enterprise systems, systems of systems, net-centric set of services, and interoperability down to subsystems and configuration items with applicability across a diverse range of acquisition program types such as business systems; command, control, intelligence, surveillance, and reconnaissance systems; communication systems; ships and subs; fixed wing aircraft and space; rotary wing aircraft/unmanned airborne systems; missiles; and land vehicular systems. The UARC will perform SE research to identify and inform the current state of practice, provide a means to explore and exploit concepts to enable efficient/effective design and development of complex systems, and underpin effective integration of program/business processes with technical management. The SER UARC is expected to actively share its research results and new methods, processes, and tools with SE practitioners, including the defense industrial base, thereby advancing sound systems engineering and related technical disciplines. This presentation will discuss the unique nature of a UARC, the SER UARC's core competencies, the unique experience offered by the lead and partner universities, its long-term research strategy, and the near-term objectives.

UARC Structure



Facts about UARCs

- Affiliated with, or part of university/college
- Provides or maintains DoD essential engineering, research and/or development capabilities defined as core
- Receives sole source (non-competitive) contract funding from DoD under 10 USC 2304(c)(3)(B) (See note 1)
- Receives in excess of $2M sole source funds annually from DoD
- Maintains a strategic relationship with DoD

[1] "..to establish or maintain an essential engineering, research, or development capability to be provided by an education or other nonprofit institution or a federally funded research and development center…" http://www.law.cornell.edu/uscode/

SER UARC at a Glance

- Concept: Lead university and partner universities together have SER expertise to meet core competencies
- Funding: A&T and NSA have together budgeted $10M for five years; others can provide additional funding for specific tasks as need arises
- Contract Vehicle: Five year, sole source IDIQ Task Order contract awarded under authority of 10 USC 2304(c)(3)(B)

Need for SE Research

- State-of-the-practice must keep up with application needs of DoD acquisition
  - Methods, processes, and tools to enable effective acquisition and sustainment of systems
  - Leveraging Modeling & Simulation for SE
- Size and complexity of modern systems drive need for commensurate extensions of SE,
  - To System of Systems (SoS), to complex systems, to "architecting," to net-centric sets of services
  - Validation & Verification challenges
- SE "theory and practice" should be inclusive of, and establish linkages to, challenged sub-specialty areas
  - Software engineering, reliability engineering, system safety, costing, etc

Core Competencies

- Conduct long-term, comprehensive systems engineering research focused on DoD acquisition including:
  - SE MPTs to enable integrated development and management of requirements, design, interfaces, verification and validation, technical baselines, and risk
  - Exploration of new ways of linking requirements to design
  - SE MPTs to fully leverage modeling and simulation advances including the use of formal languages (e.g., XML, SAML) and modeling techniques (e.g., UML, SysML) to capture and document requirements along with other program artifacts and to support design trade studies
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  - Software-unique extensions and modern software development techniques and how they relate to SE
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  - Knowledge management SE repositories
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- Leverage developments in open systems standards, organizational theory, program management, systems engineering management, and information technology to provide needed integration of program / technical management MPTs including:
  - Integrating technical performance measures (TPM) with earned value management (EVM)
  - Role of maturity reviews in SE planning – technology, manufacturing, and software, and their integration
  - Systems engineering team structures, communication mechanisms, internal and external collaboration, and other mechanisms for continuous process improvement
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