



DoD Systems and Software Engineering

Taking it to the Next Level

Boeing SE Leadership Conference

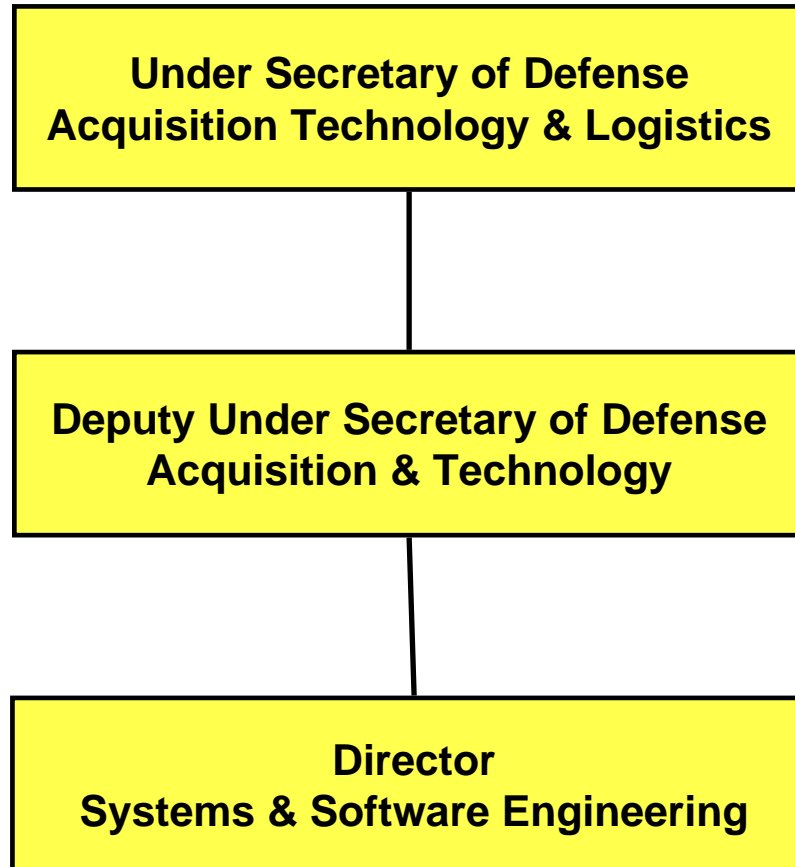
28 November 2006

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Office of the Deputy Under Secretary of Defense (A&T)



Recent Acquisition & Technology Reorganization



as of June 1, 2006

Systems Engineering is well positioned in DoD



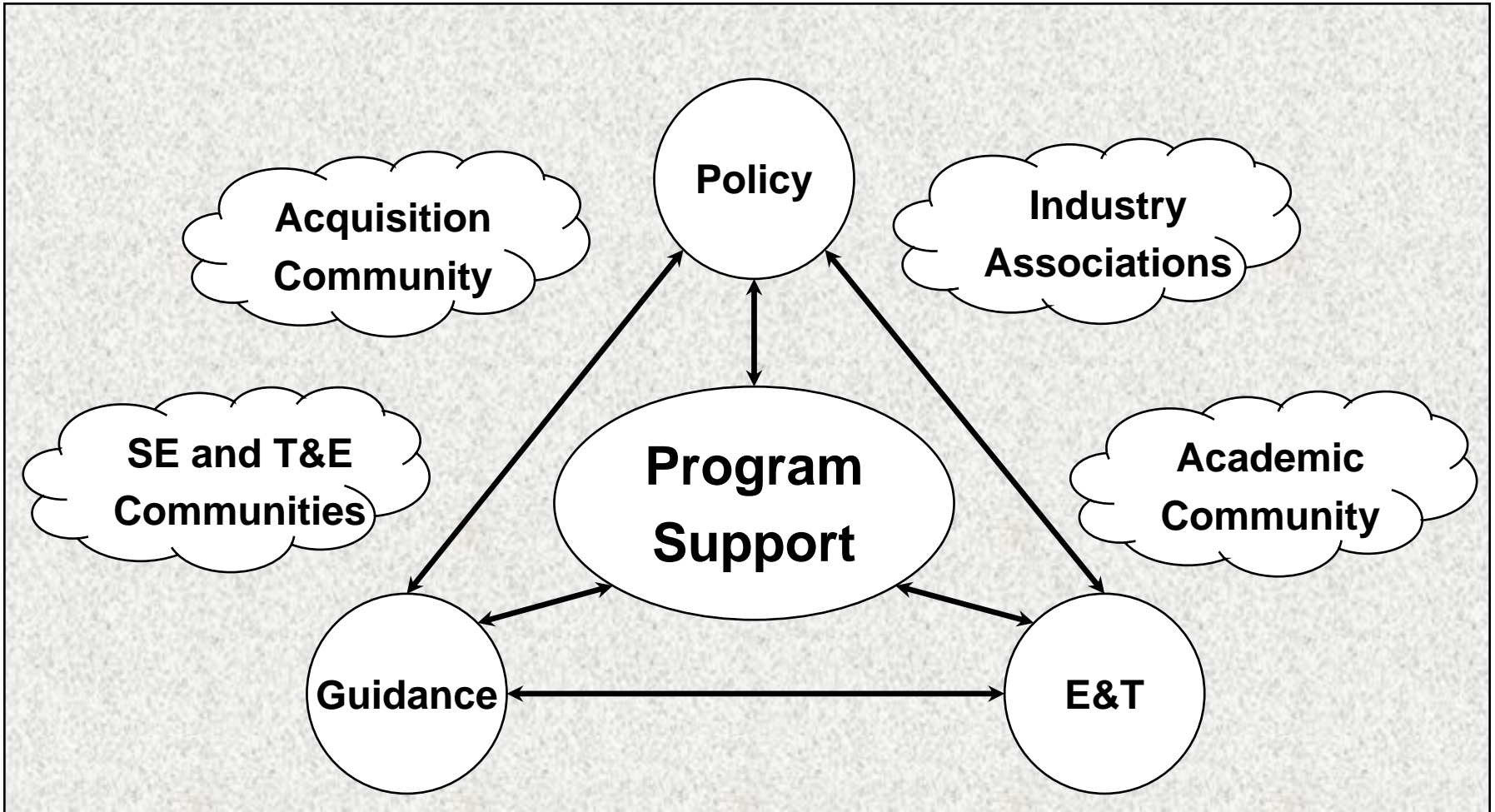
Systems and Software Engineering Mission Statement

- Shape acquisition solutions and promote early technical planning
- Promote the application of sound systems and software engineering, developmental test and evaluation, and related technical disciplines across the Department's acquisition community and programs
- Raise awareness of the importance of effective systems engineering and drive the state-of-the-practice into program planning and execution
- Establish policy, guidance, best practices, education, and training in collaboration with academia, industry, and government communities
- Provide technical insight to program managers and leadership to support decision making

Evolving System Engineering Challenges



Systems Engineering Revitalization Framework



Driving Technical Excellence into Programs!



Systems Engineering Revitalization Effort

- Issued Department-wide Systems Engineering (SE) policy
- Issued guidance on SE, T&E, and SE Plans (SEPs)
- Instituted system-level assessments in support of DAB, OIPT, DAES, and in support of programs
- Established SE Forum to ensure senior-level focus within DoD
- Integrating DT&E with SE policy and assessment functions--focused on effective, early engagement of both
- Instituting a renewed emphasis on modeling and simulation in acquisition
- Working with Defense Acquisition University to revise curricula (SPRDE, T&E, PQM, LOG, PM, ACQ, FM, CONT)
- Leveraging close working relationships with industry and academia

Necessary but not sufficient!



Driving Technical Rigor Back into Programs “Portfolio Challenge”

- Systems and Software Engineering have been tasked to:
 - Review program’s SE Plan (SEP) and T&E Master Plan (TEMP)
 - Conduct program support reviews
- Portfolio of major acquisition (ACAT ID and IAM) programs, supporting 10 Domain Areas:
 - Business Systems
 - Communication Systems
 - C2ISR Systems
 - Fixed Wing Aircraft
 - Unmanned Systems
 - Rotary Wing Aircraft
 - Land Systems
 - Ships
 - Munitions
 - Missiles

Software

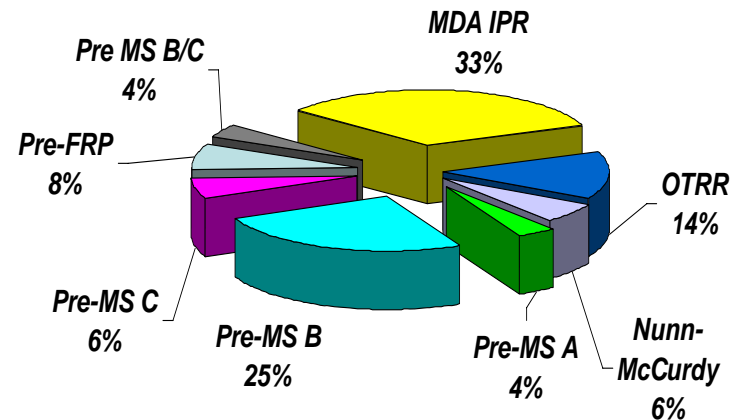
***Systems Engineering and T&E Support to Over
150 Major Programs in 10 Domain Areas***



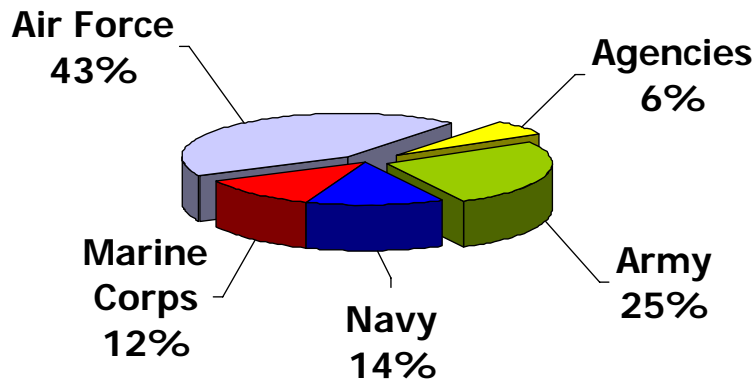
Program Support Review (PSR) Activity (since March 2004)

- PSRs/NARs completed: 34
- AOTRs completed: 7
- Nunn-McCurdy Certification: 3
- Participation on Service-led IRTs: 4
- Technical Reviews: 3
- Reviews planned for rest of FY06
 - PSRs/NARs: 10
 - AOTRs: 4
 - NARs: 2

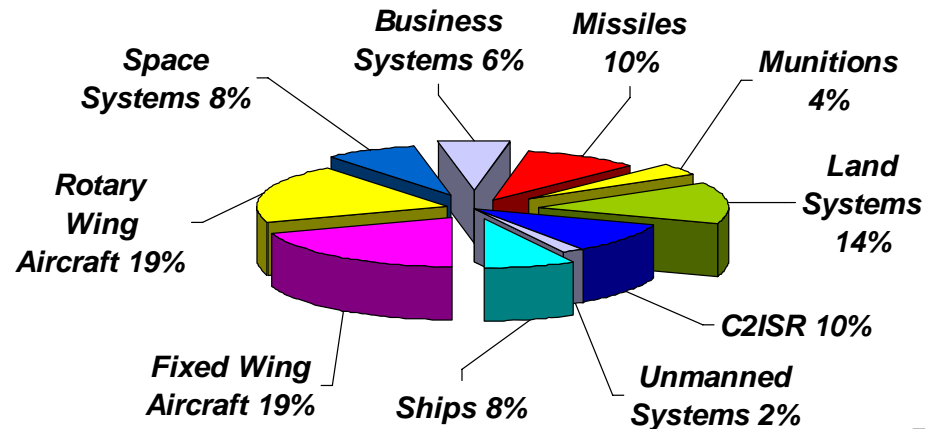
Decision Support Reviews



Service-Managed Acquisitions



Programs by Domain Area





Top 10 Emerging Systemic Issues

1. Management
 - IPT roles, responsibilities, authority, poor communication
 - Inexperienced staff, lack of technical expertise
2. Requirements
 - Creep/stability
 - Tangible, measurable, testable
3. Systems Engineering
 - Lack of a rigorous approach, technical expertise
 - Process compliance
4. Staffing
 - Inadequate Government program office staff
5. Reliability
 - Ambitious growth curves, unrealistic requirements
 - Inadequate “test time” for statistical calculations
6. Acquisition Strategy
 - Competing budget priorities, schedule-driven
 - Contracting issues, poor technical assumptions
7. Schedule
 - Realism, compression
8. Test Planning
 - Breadth, depth, resources
9. Software
 - Architecture, design/development discipline
 - Staffing/skill levels, organizational competency (process)
10. Maintainability/Logistics
 - Sustainment costs not fully considered (short-sighted)
 - Supportability considerations traded

Major contributors to poor program performance

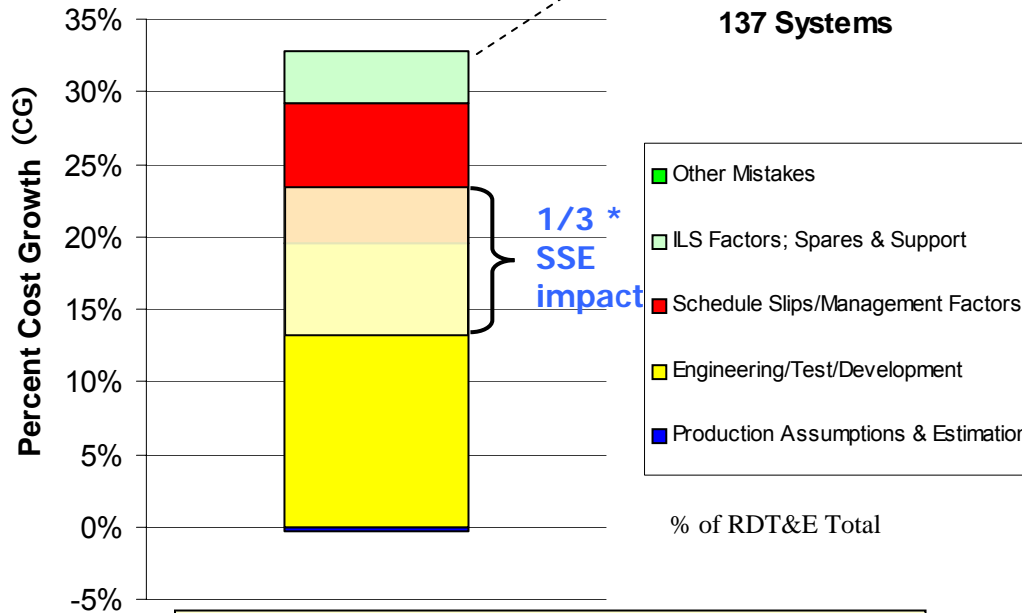


Systems and Software Engineering in Programs Reduces Costly Mistakes

RDT&E Mistakes

Under estimating engineering effort is Major source of error

137 Systems



Source: DoD Cost Avoidance Study (CAIG) 10 year ongoing

33% historical RDT&E Cost Growth

Applied to

\$222.8B RDT&E FYDP**

Yields a Potential

\$73.52B RDT&E Cost Growth FYDP

* SSE positive impact on just 1/3 of RDT&E mistakes (11%)

Yields a Potential

\$24.51B RDT&E Cost Avoidance FYDP

** SAR data for MAIS and MDAP programs under OSD Systems Engineering Oversight



Necessary but not sufficient

now

“Take SE to the Next Level”



Initiatives For Strategic and Tactical Acquisition Excellence

STRATEGIC
“Big A”



“Little A”
TACTICAL

OBJECTIVES	INITIATIVES
<p>Making Decisions that Balance the Trade-Space</p> <ul style="list-style-type: none"> Affordable, Feasible Investments 	<ul style="list-style-type: none"> Portfolio Management Tri-Chair Concept Decision / Time-Defined Acquisition Evaluation of Alternatives Synchronize Existing Processes Tri-Chair Investment Balance Reviews
<p>Starting Programs Right</p> <ul style="list-style-type: none"> Improved, Up-Front Planning Awareness of Risk / Improved Source Selection More Responsive Acquisition Solutions 	<ul style="list-style-type: none"> Risk-Based Source Selection Small Business Innovative Research Acquisition of Services Policy Systems Engineering Excellence Award Fee and Incentives
<p>Process efficiency</p> <ul style="list-style-type: none"> Tailored, agile, transparent 	<ul style="list-style-type: none"> DAB / OIPT Process Optimization Common Data / DAMIR Restructured DAES
<p>Program Stability</p> <ul style="list-style-type: none"> No Downstream Surprises Issue Awareness 	<ul style="list-style-type: none"> Program Baseline Assurance Capital Accounts

Improving the Full Range of Acquisition Execution



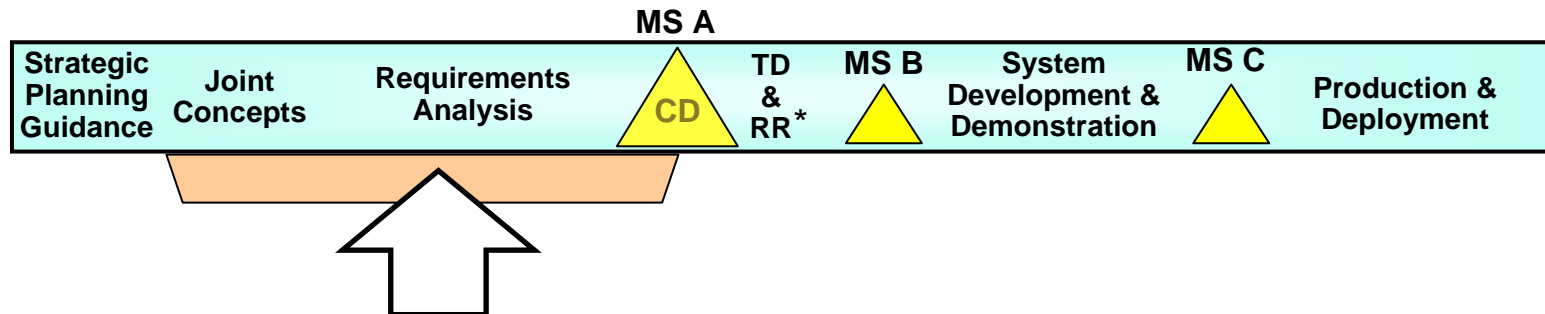
Make Decisions that Balance the Trade Space

Early Lifecycle Planning

➤ Early lifecycle involvement of Systems Engineering:

- Inform evaluation of alternatives with technical insights
- Ensure solutions balance requirements with technical feasibility
- Ensure solutions can be validated and verified

➤ Appropriate resourcing (personnel/funding) required



*Technology Development and Risk Reduction



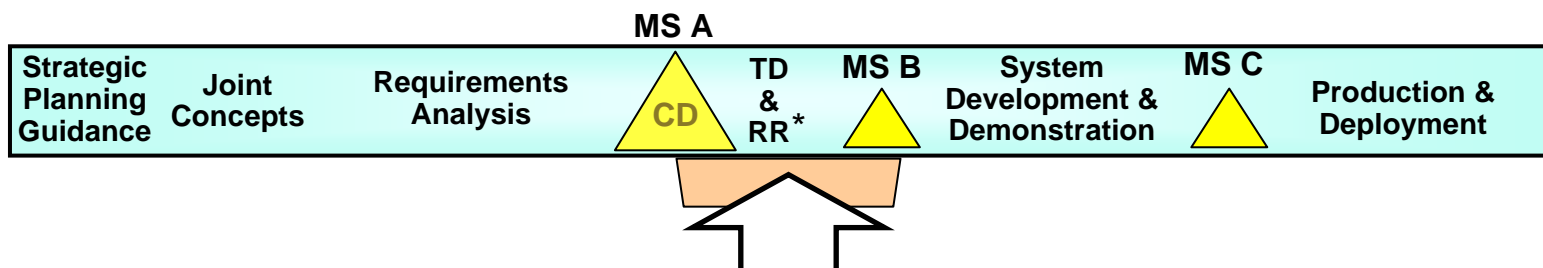
Starting Programs Right

Shaping Systems Acquisition Solutions

➤ System Level

- Application of System Engineering principles contributes to successful program execution
- Leverage System Engineering relationship to cost, schedule, and performance
- Ensure enabling disciplines are in concert with technical planning

➤ Ensuring program and milestone reviews are informed by technical planning, verification and validation, and complementary business rules



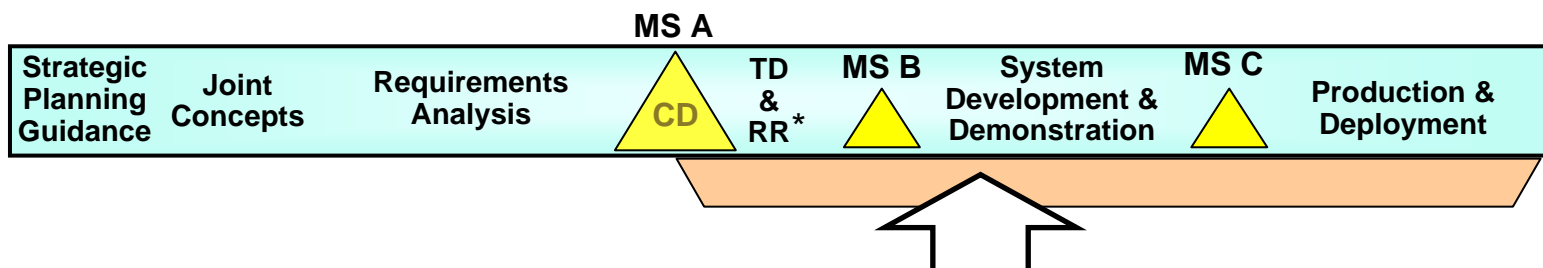


Starting Programs Right

Shaping System-of-Systems Acquisition Solutions

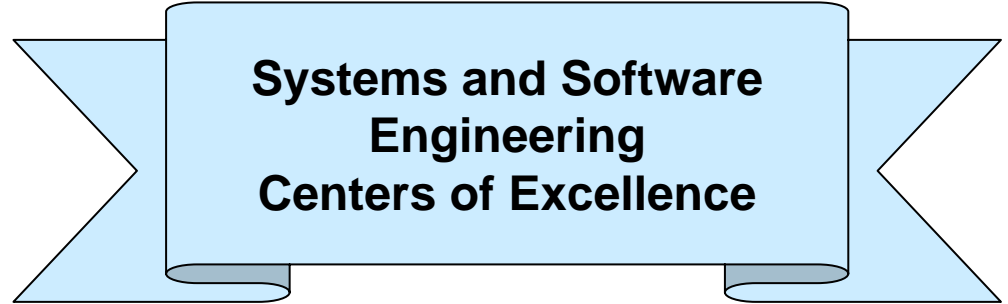
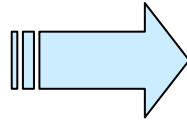
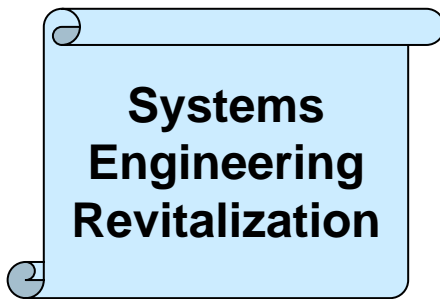
➤ System-of-Systems Level

- Needs will be satisfied by groupings of legacy systems, new programs, and technologies
- Presents additional integration and management issues
- Success depends heavily upon software interfaces
- Broad context and knowledge of system interrelationships and CONOPS are critical to decision-making
- Sound SE practices enable the integration of these SoS solutions





Vision for Systems Engineering and Software



- **Competencies Improved**
- **Delivered Product Suite**
 - Courseware
 - Policy/Guidance
 - Program Support methods
- **Elevated Stature**
- **Raised Awareness**
- **Positive Influence**

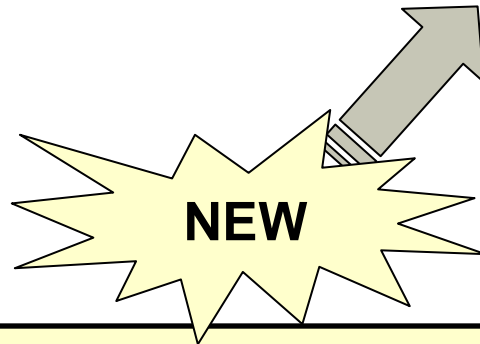
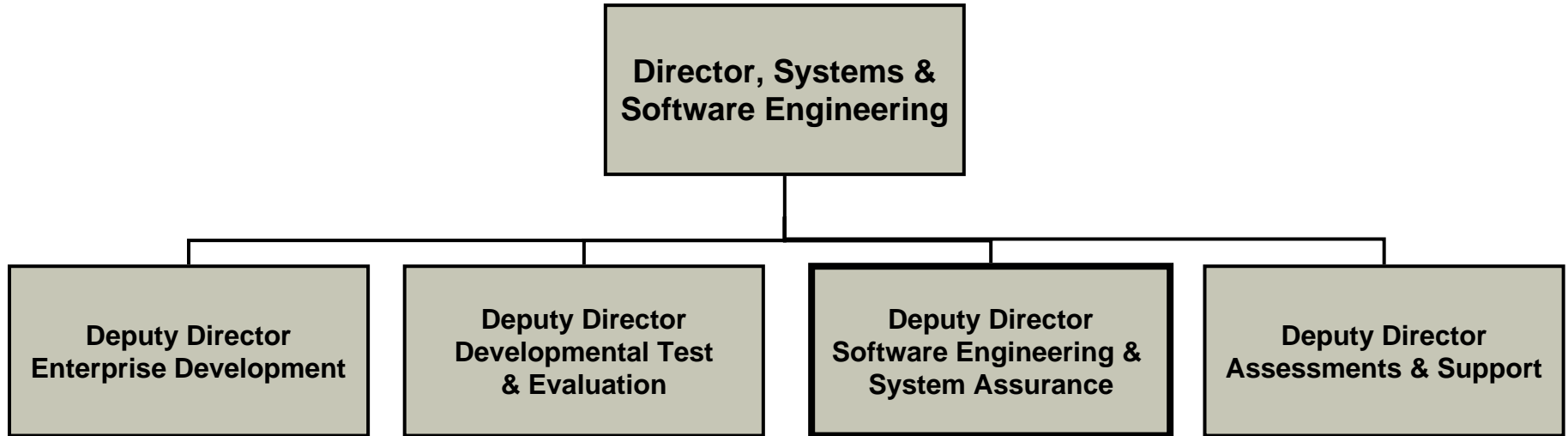
- **World class leadership**
- **Broaden to Software Engineering, System Assurance, Complex Systems-of- Systems, Test & Evaluation**
- **Responsive and agile, technical discipline to shape acquisition solutions**
- **Ensure appropriate human capital needs are met**

***... the Technical Foundation
that Enables Acquisition Excellence***



Systems and Software Engineering

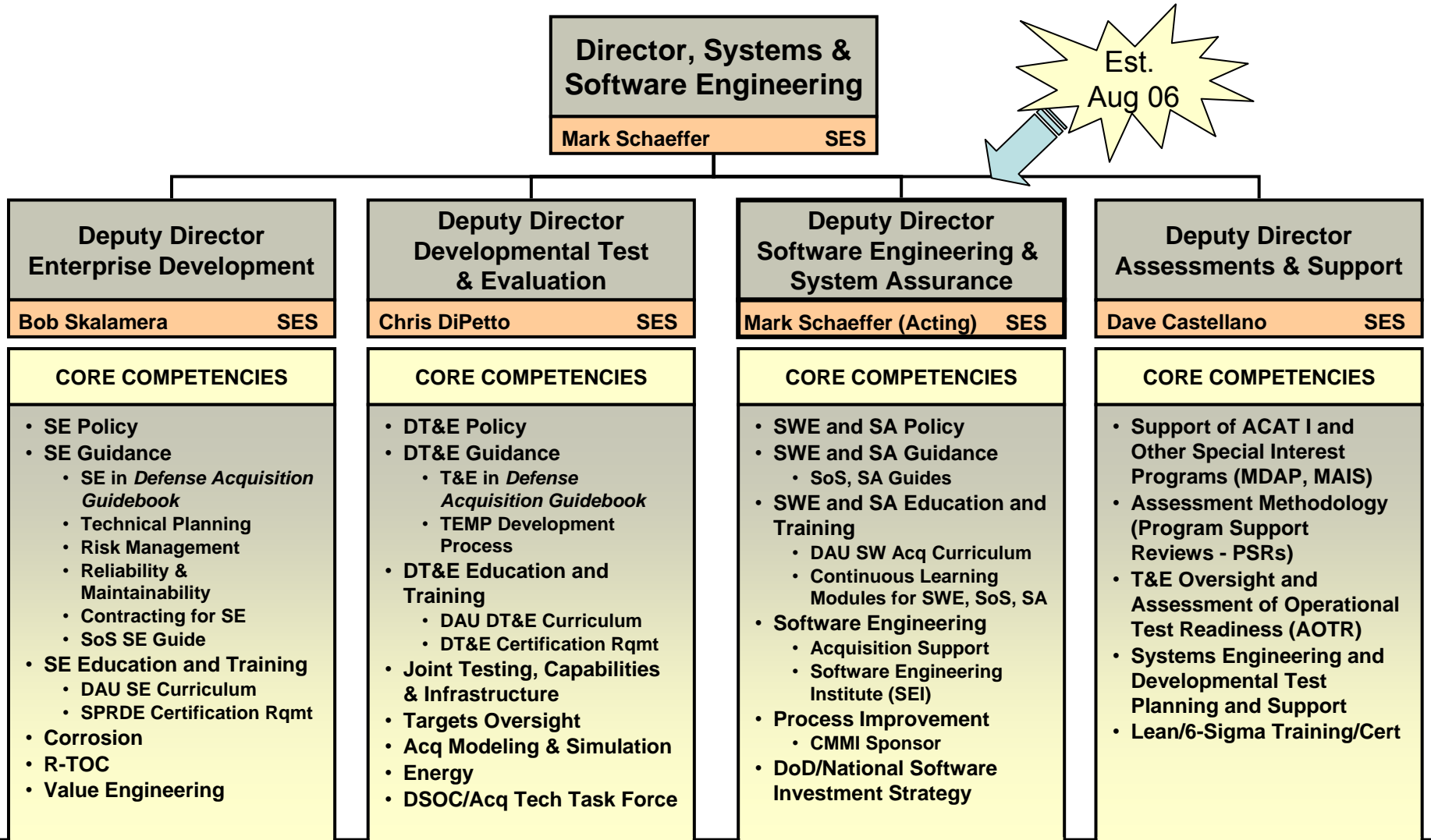
An Organizational Construct



Management Visibility – Best Practices – Acquisition Excellence



State of Systems Engineering Director, Systems & Software Engineering



Acquisition program excellence through sound systems and software engineering



Other Challenges

- Implementing a DoD vision and strategy for software and systems assurance
- Component and Industry adoption and effective implementation of sound SE practices as early as possible in the system life cycle
- SE support to Acquisition Initiatives stemming from the QDR
- Retention and development of technical acumen in an aging and shrinking acquisition workforce
- Meeting all requests for technical support to programs
- Continue to evolve “high visibility” initiatives:
 - Energy
 - CMMI
 - System-of-Systems
 - Modeling & Simulation
 - Defense Safety Oversight Council



System Engineering Challenges

CMMI



Have We Lost Sight of the Goal?*

- The end goal of CMMI is to provide a model for continuous process improvement to achieve:
 - Reduced cycle times
 - Meet cost and schedule targets
 - Improved quality
 - Common Systems Engineering and Software model

When achieving a level replaces the focus on continuous improvement, we've lost sight of the goal



Summary of CMMI Problems DoD Sponsor Report 2006

- Programs execute at lower maturity levels than their organizations have achieved and advertised
- High-maturity practices are not consistently applied at the project level after contract award
- How to ensure new projects will incorporate CMMI processes
- Appraisal sampling procedures – how to ensure adequate coverage of the organizational unit
- Appraiser quality – training, consistency
- Lack of agreement on what constitutes Levels 4 and 5
- Need to converge to a single representation
- Content of appraisal disclosure statements is lacking
- Inadequate training and education for acquirers
- Should CMMI be used for source selection

What is the resolution of these issues?



CMMI Government Assessment: Spring 2006

8 Major Issues for Resolution

1. High Maturity

- Lack of consistency and agreement on what constitutes levels 4 and 5

2. Integrity

- If certified, how can programs be performing at a lower level?

3. Organizational Commitment

- Commitment and ability to implement processes on new projects

4. Acquirer Education

- Misunderstanding and misuse of CMMI by Acquirers



CMMI Government Assessment: Spring 2006

8 Major Issues for Resolution

5. Two representations

- Staged and Continuous representations

6. Model Complexity and Size

- Balancing content (700 pages) with ease of use

7. New Constellation Strategy

- Impacts of the new architecture on original goal

8. Intended usage of CMMI

- Current application of CMMI against original and future goals



Improvements Implemented in CMMI v1.2

- “Level for Life” - **ELIMINATED**
- Organizational Commitment
 - Added new goal and 2 practices to CMMI v1.2 to address commitment to processes at project start-up
- Appraisal Sampling
 - Developed new sampling rules
 - Precise definition of sample size and organizational coverage
- Appraisal Disclosure Statement (ADS)
 - Added specific sampling information to enhance transparency
 - DoD Contractor ADSs will be posted for Government acquirer access



Improvements Implemented in CMMI v1.2

➤ High maturity appraisers

- Established certification requirements for appraisers
- Oral exams being given to all high maturity appraisers
- High maturity training course under development – Oct 07 release

➤ Guidebook for Acquirers

- Provide concise information to acquirers on supplier use of CMMI
- Expected release January 2007

➤ Appraisal Integrity

- Lead Appraiser cannot be from the appraised business unit
- Lead Appraiser certification of sample, and appropriateness of Level 4/5 practices
- SEI is conducting appraisal audits



Reinforce the Basics

- Continue focus on refining what CMMI was intended to achieve
 - Does the current product suite allow us to achieve those objectives?
- Make sure that v1.2 changes bring value added to the user
 - Assess the value of each change
- Ensure changes facilitate achievement of the CMMI objectives

The Department is committed to ensuring CMMI has integrity, and is responsive to next generation process improvement needs



Moving Forward

- Evaluate changes to the CMMI v1.2 product suite to ensure improvement goals are really being met
- Monitor constellation evolution
 - Pilot CMMI-ACQ model
 - Assess implementation
- Continue to capture the right knowledge in the CMMI Guidebook for Acquirers
- Leverage DCMA for actual performance monitoring



Remaining Opportunities ...and some Questions

- Revisit Levels 4 and 5
 - Do we need something else to define high maturity?
- Lean the Model and the Appraisal Method
 - Eliminate cumbersome material included for legacy reasons
 - Eliminate staged representation?
- Evaluate Constellation strategy
 - Will Constellations result in stovepipes? Do they make sense?
- Assess next generation process improvement
 - Should CMMI be used for source selection?
 - Given worldwide adoption, is the CMMI Governance Structure appropriate?

Need your ideas and participation



System Engineering Challenges

Defense Safety Oversight Council



Defense Safety Oversight Council

Joint Weapons Safety

➤ Issue:

- For USSOCOM to field joint systems involving weapons, ammunition, and/or explosives, safety certifications and/or releases must be obtained from multiple system safety boards with differing processes, procedures, and certification criteria

➤ Solution

- Working with the Service Safety Boards, SOCOM and OSD developed a “Joint Weapons Safety Review” process to address SOCOM issue
- “Joint Weapons Safety Review Guide for USSOCOM” developed and is in use; SOCOM regulation expected Jan 07
- OSD looking to expand process across DoD

The process changed without forfeiting the integrity of safety!



Defense Safety Oversight Council

Unmanned System Safety

➤ Issue

- FCS Board of Directors raised issue of whether or not proper procedures & processes in place to ensure weaponized unmanned systems safety in the joint battle space

➤ Solution

- Working across OSD, Services, and other agencies: war fighters, technical experts, acquisition staffs
- Developed Unmanned System Safety Guide for DoD Acquisition; available and in use
- Formalizing options for implementation: DAG, training courses, encouraging inclusion in commercial standards

Safety is no accident!



Unmanned Systems Challenges

Airspace

Weapons

Spectrum

Safety

Reliability

**Architect
ure**

Payloads

C2

**Interoper-
ability**

Training

**Inter-
Agency**

Treaty

**Data
Sharing**

Legal

**Industrial
Base**



System Engineering Challenges

Energy Leadership

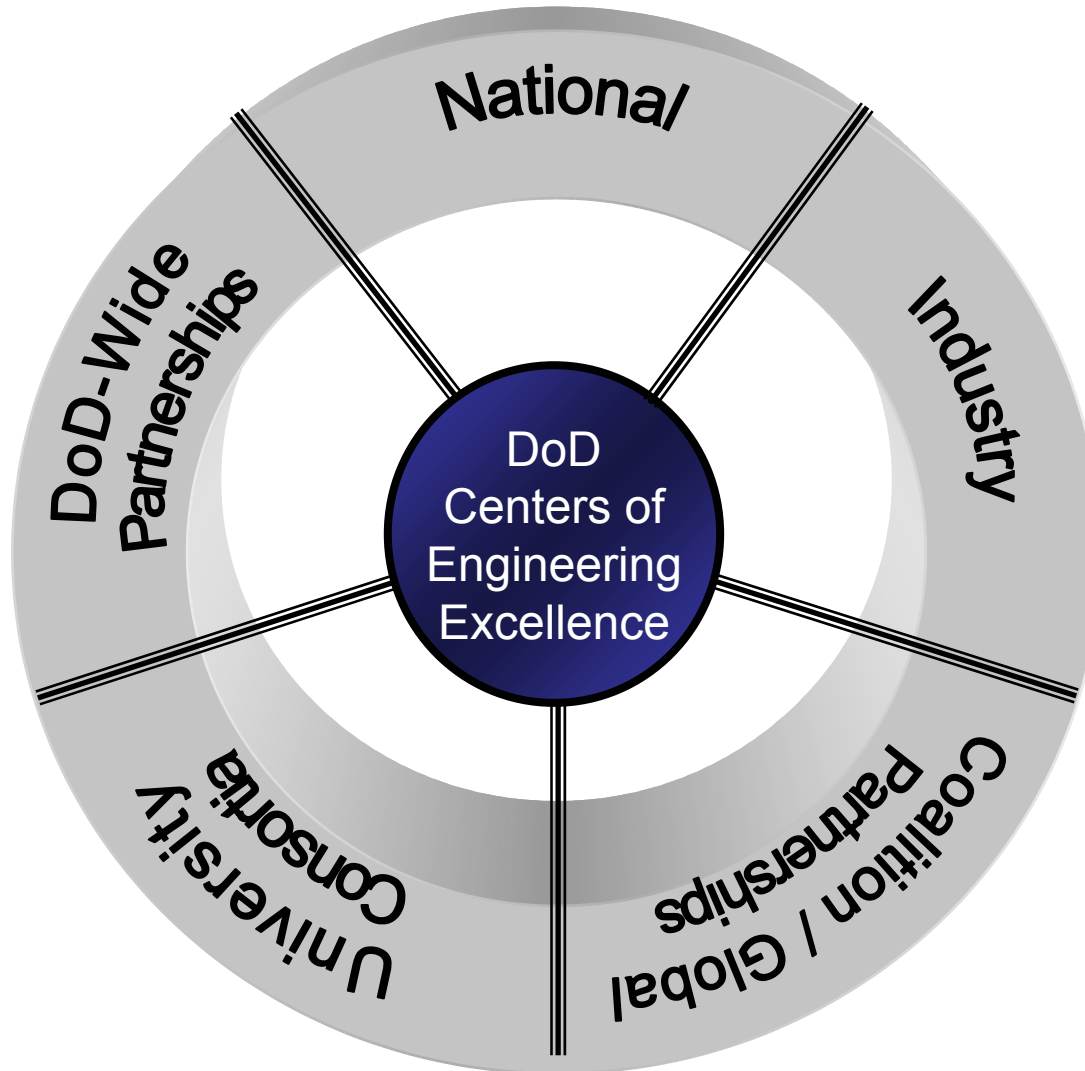


Energy Leadership

- Commodity fuel costs are significant, but only the tip of the iceberg
 - It costs the Army about 16 times as much to deliver fuel as to purchase it....”
- Investments in end-use efficiency at spear tip cascade down supply pyramid
- Energy Security IPT recommendations approved by DAWG
 - Platform Fuel Efficiency – revise policy to incorporate delivered cost of fuel in acquisition decisions
 - 3 pilot programs being considered
 - Assured Fuels (testing, certification, industry incentives)
 - Accelerate Facilities Initiatives



How do we get there?





CMMI: New Release and Next Steps

Issues:

- Integrity of CMMI appraisals
- Misperception and misuse of the CMMI by acquirers

Actions:

- Implemented changes to the CMMI v1.2 product suite to ensure:
 - Integrity of appraisals
 - Quality of the product suite
 - Education of acquirers
 - Opportunities for streamlining where appropriate
- Developing a CMMI model for Acquirer process improvement
 - Partnership with General Motors
 - Stakeholders cross DoD, Govt Agencies and Industry
- Writing a CMMI guidebook
 - Help acquirers understand what CMMI is and is not
- Conducting study of actual process implementation post-Level 5



DoD Software Performance: What We're Seeing*

- Software systemic issues are significant contributors to poor program execution
 - Software requirements not well defined, traceable, testable
 - Immature architectures, COTS integration, interoperability, obsolescence (electronics/hardware refresh)
 - Software development processes not institutionalized, planning documents missing or incomplete, reuse strategies inconsistent
 - Software test/evaluation lacking rigor and breadth
 - Schedule realism (compressed, overlapping)
 - Lessons learned not incorporated into successive builds
 - Software risks/metrics not well defined, managed



DoD Software Center of Excellence Organizational Tenets

- **Support Acquisition Success**
 - Ensure effective and efficient software solutions across the acquisition spectrum of systems, SoS and capability portfolios
- **Improve the State-of-the-Practice of Software Engineering**
 - Advocate and lead software initiatives to improve the state-of-the-practices through transition of tools, techniques, etc.
- **Provide Leadership, Outreach and Advocacy**
 - Implement at Department and National levels, a strategic plan for meeting Defense software requirements
- **Foster Software Resources to meet DoD needs**
 - Enable the US and global capability to meet Department software needs, in an assured and responsive manner

***Promote World-Class Leadership for Defense
Software Engineering***



Balancing Key Programmatic Elements

Element	Systems Engineering	Test & Evaluation	Risk Management	Exit Criteria	Acquisition Strategy
Focus Areas	Requirements	V&V Traceability	Risk ID	Mission Systems	Mission Capability
	Organization & Staffing	Test Resources	Risk Analysis	Support	Resources & Management
	Technical Reviews	Test Articles	Risk Mitigation Planning	Manufacturing	Technical Process
	Technical Baseline	Evaluation	Risk Tracking	R & M	Technical Product
	Linkage w/ Other Program Mgmt & Controls	Linkage w/ Other Program Mgmt & Controls	Evidence of Effectiveness	Net Centric	Enterprise Environment
Product	SEP	TEMP	RM Plan	Phase Exit Criteria	ASR/APB



Systems Engineering Policy

- Policy Memorandum (February 2004) and Policy Addendum (October 2004)
 - Programs shall apply robust SE approach and develop a SE plan
 - Each PEO shall have a lead or chief systems engineer
 - Event-driven technical reviews with entry criteria and independent SMEs unless waived by MDA
 - OSD shall review program SEPs for ACAT ID and IAM programs
 - Defense Systems shall establish a SE Forum



Systems Engineering Guidance

- Establish Defense Acquisition Guidebook System Engineering Baseline
- Developed the following guides:
 - Reliability, Availability, and Maintainability
 - Integrated Master Plan and Integrated Master Schedule Preparation and Use
 - Systems Engineering Plans
 - Risk Management for DoD Acquisition
 - CMMI version 1.2
- In development:
 - Update Defense Acquisition Guidebook
 - Contracting for SE Guide
 - CMMI Guide for Acquirers
 - System Assurance Guide
 - Systems-of-Systems System Engineering Guide



Systems Engineering Education, Training, & Outreach

- Updated /Developed Systems Engineering curriculum
- Reviewed and modified enabling disciplines curriculum
 - Acquisition Program Management, Contract Management, Finance, Logistics
- Continuous learning, on-line courses:
 - Developed: Reliability and Maintainability, Technical Reviews, System Safety, Modeling and Simulation, Technical Planning
 - In development: Corrosion Prevention and Control, Modular Open Systems Approach, Trade Studies
- Established new, strengthened certification requirements for DoD systems engineers
 - New Systems Engineering career path provides for broader experience and training for selected positions
- Engaging universities:
Stevens Institute of Technology, University of Southern California, Stanford, Southern Methodist, George Mason, Service Academies and Naval Postgraduate School, Air Force Institute of Technology Center for Systems Engineering



Why the Focus on Software...

- Research investment has been static or declining
 - DARPA computer science R&D funding 50% ↓ ('01 - '04, universities)
- Requirements growth 10X (% functionality) '60s -'00s
- Need vs. skilled/clearable workforce - gaps increasing
- President's Information Technology Advisory Committee Report, February 2005
 - Identifies SW as "major vulnerability"
 - Recommends priority attention: "Secure Software Engineering and Software Assurance" and "Metrics, Benchmarks, and Best Practices"
- Cost, schedule and performance issues

Software is an increasingly, important factor