# DoD Systems and Software Engineering

## *Taking it to the Next Level*

**CMMI Technology Conference Executive Panel**

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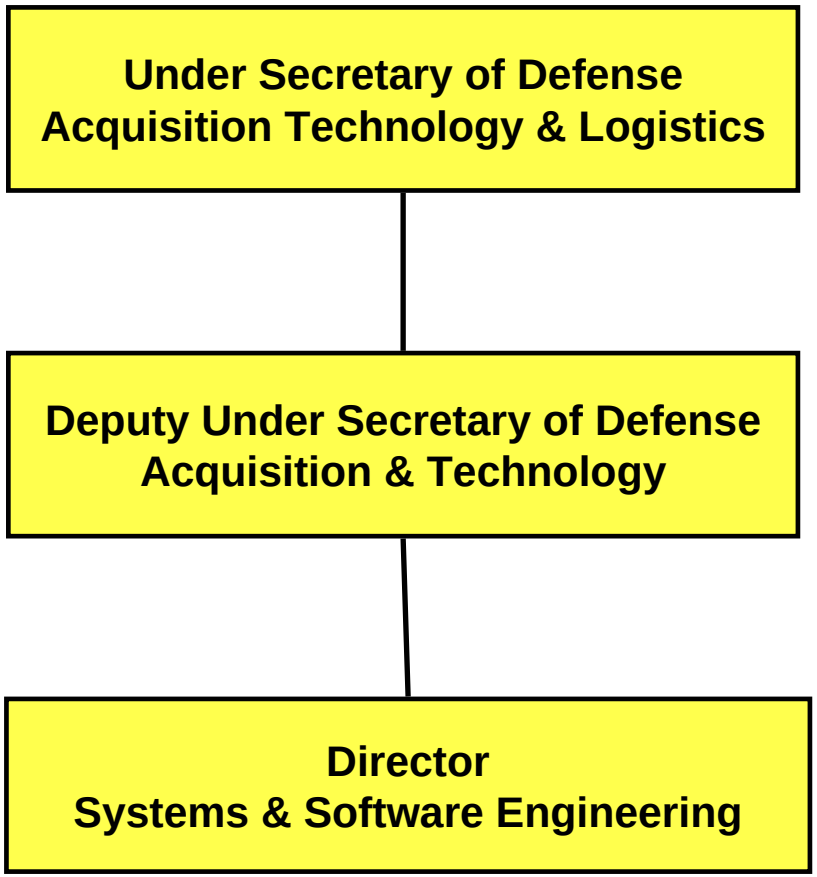
Office of the Deputy Under Secretary of Defense (A&T)

# 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 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 acquistion
- 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

# Top 10 Emerging Systemic Issues

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

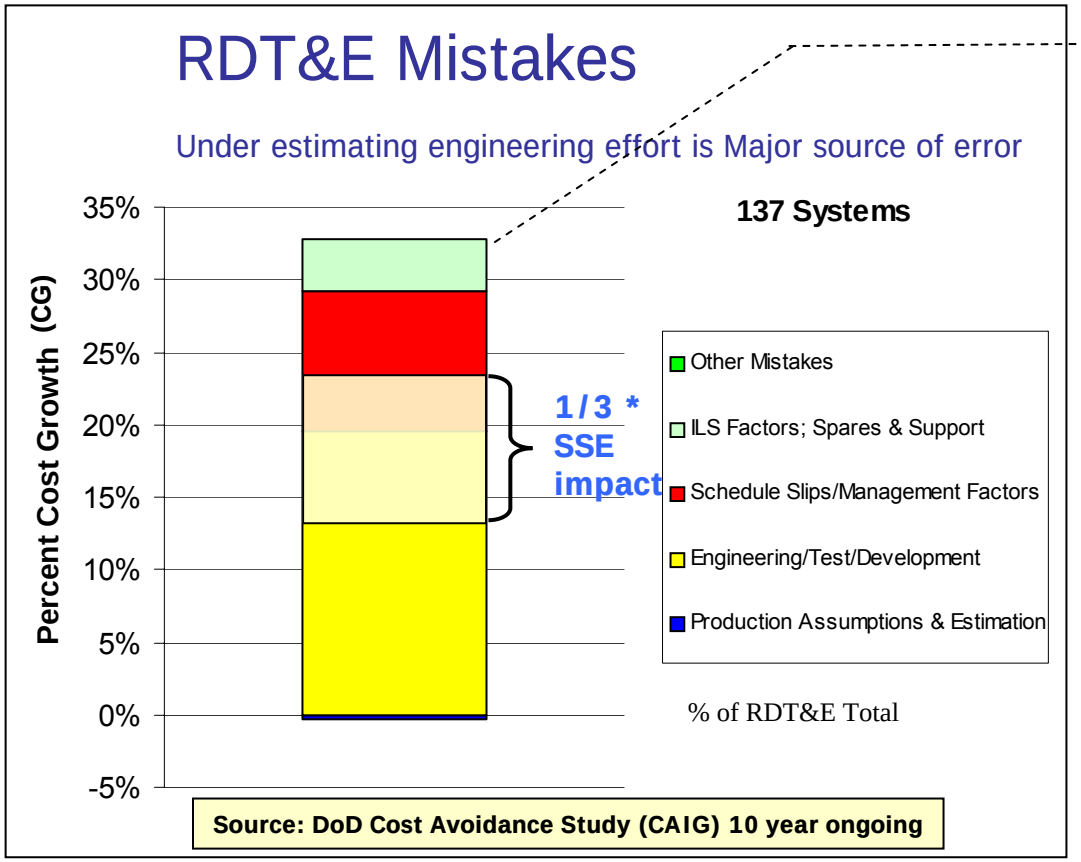
***Major contributors to poor program performance***

Necessary but not sufficient

now

*“Take SE to the Next Level”*

# Systems and Software Engineering in Programs Reduces Costly Mistakes




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**

# Initiatives For Strategic and Tactical Acquisition Excellence

**STRATEGIC**
**"Big A"**

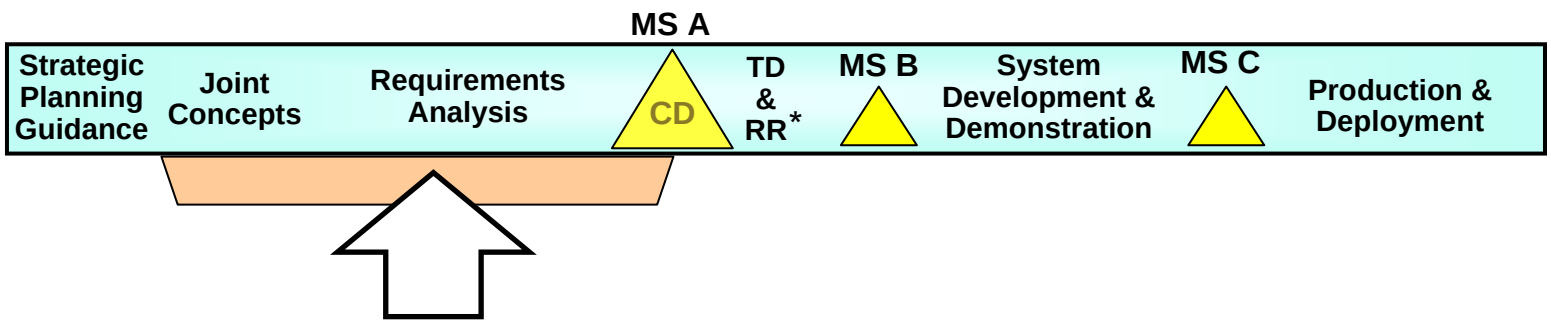
**"Little A"**
**TACTICAL**

| OBJECTIVES | INITIATIVES |
|---|---|
| **Making Decisions that Balance the Trade-Space**<br>• Affordable, Feasible Investments | • Portfolio Management<br>• Tri-Chair Concept Decision / Time-Defined Acquisition<br>• Evaluation of Alternatives<br>• Synchronize Existing Processes<br>• Tri-Chair Investment Balance Reviews |
| **Starting Programs Right**<br>• Improved, Up-Front Planning<br>• Awareness of Risk / Improved Source Selection<br>• More Responsive Acquisition Solutions | • Risk-Based Source Selection<br>• Small Business Innovative Research<br>• Acquisition of Services Policy<br>• Systems Engineering Excellence<br>• Award Fee and Incentives |
| **Process efficiency**<br>• Tailored, agile, transparent | • DAB / OIPT Process Optimization<br>• Common Data / DAMIR<br>• Restructured DAES |
| **Program Stability**<br>• No Downstream Surprises<br>• Issue Awareness | • Program Baseline Assurance<br>• Capital Accounts |

***Improving the Full Range of Acquisition Execution***

# Make Decisions that Balance the Trade Space Early Lifecycle Planning

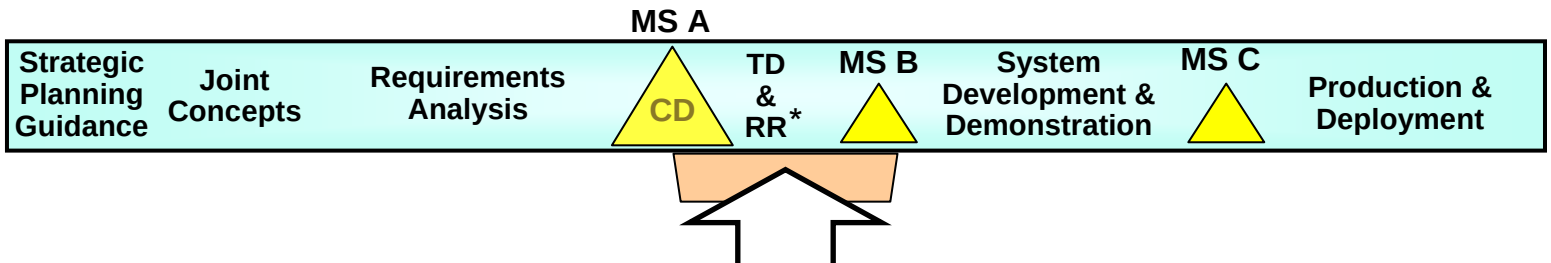
- Early lifecycle involvement of Systems Engineering:
  - Inform evaluation of alternatives with technical insights
  - Ensure solutions balance requirements with technical feasibility
  - Ensure solutions can be validated and verified
- Appropriate resourcing (personnel/funding) required




*Technology Development and Risk Reduction

# Starting Programs Right
# Shaping Systems Acquisition Solutions

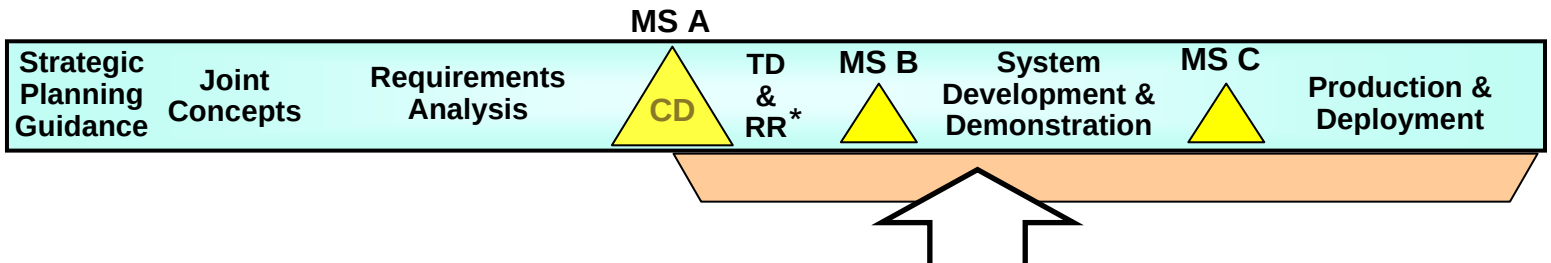
- System Level
  - Application of System Engineering principles contributes to successful program execution
  - Leverage System Engineering relationship to cost, schedule, and performance
  - Ensure enabling disciplines are in concert with technical planning
- Ensuring program and milestone reviews are informed by technical planning, verification and validation, and complementary business rules



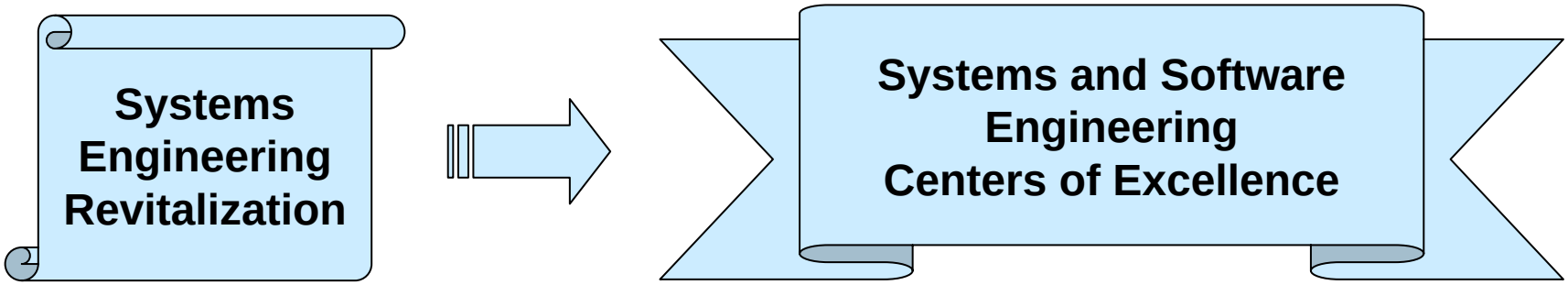
# Starting Programs Right
# Shaping System-of-Systems Acquisition Solutions

## ➢ 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***

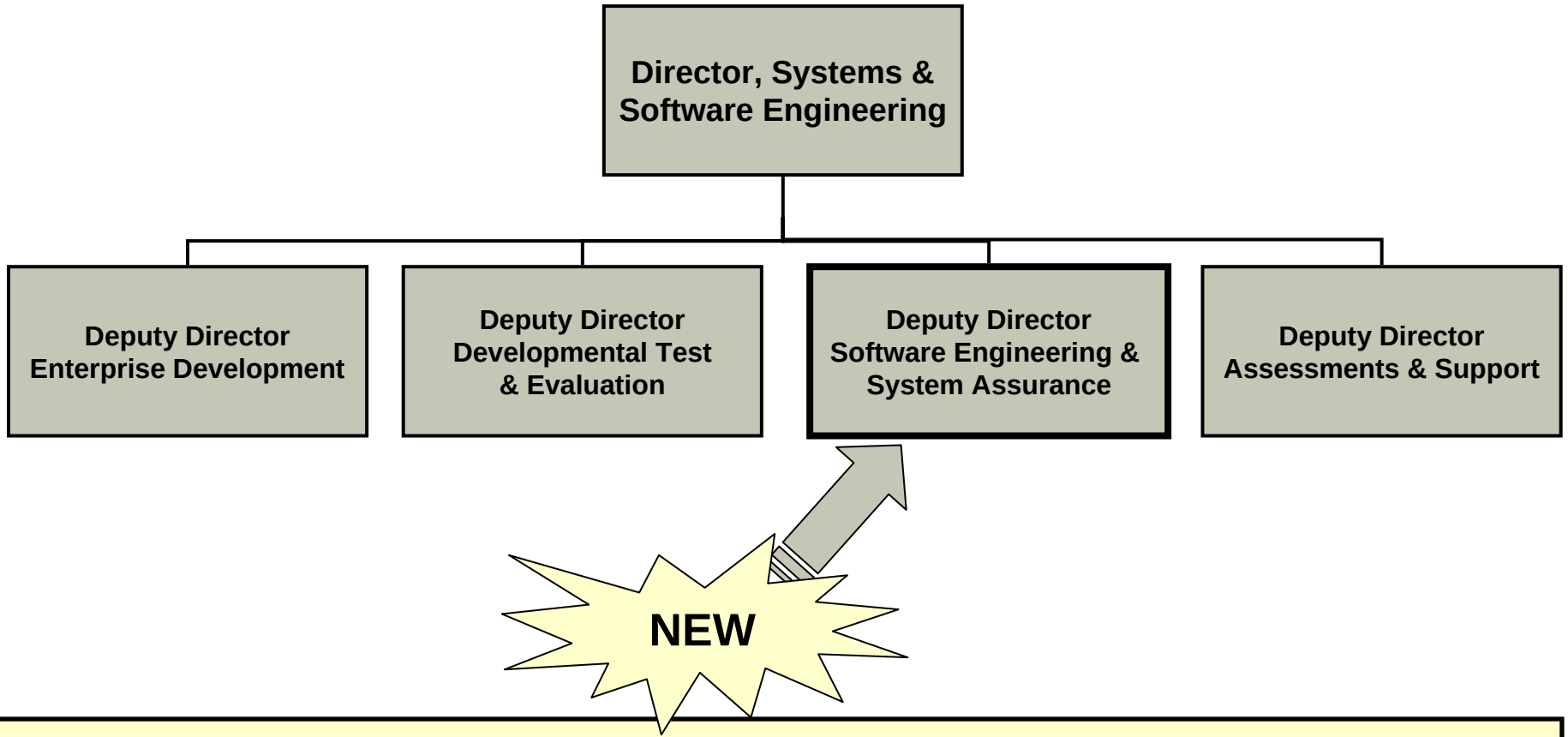
# Why the Focus on Software…

- 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***

# Systems and Software Engineering

## *An Organizational Construct*



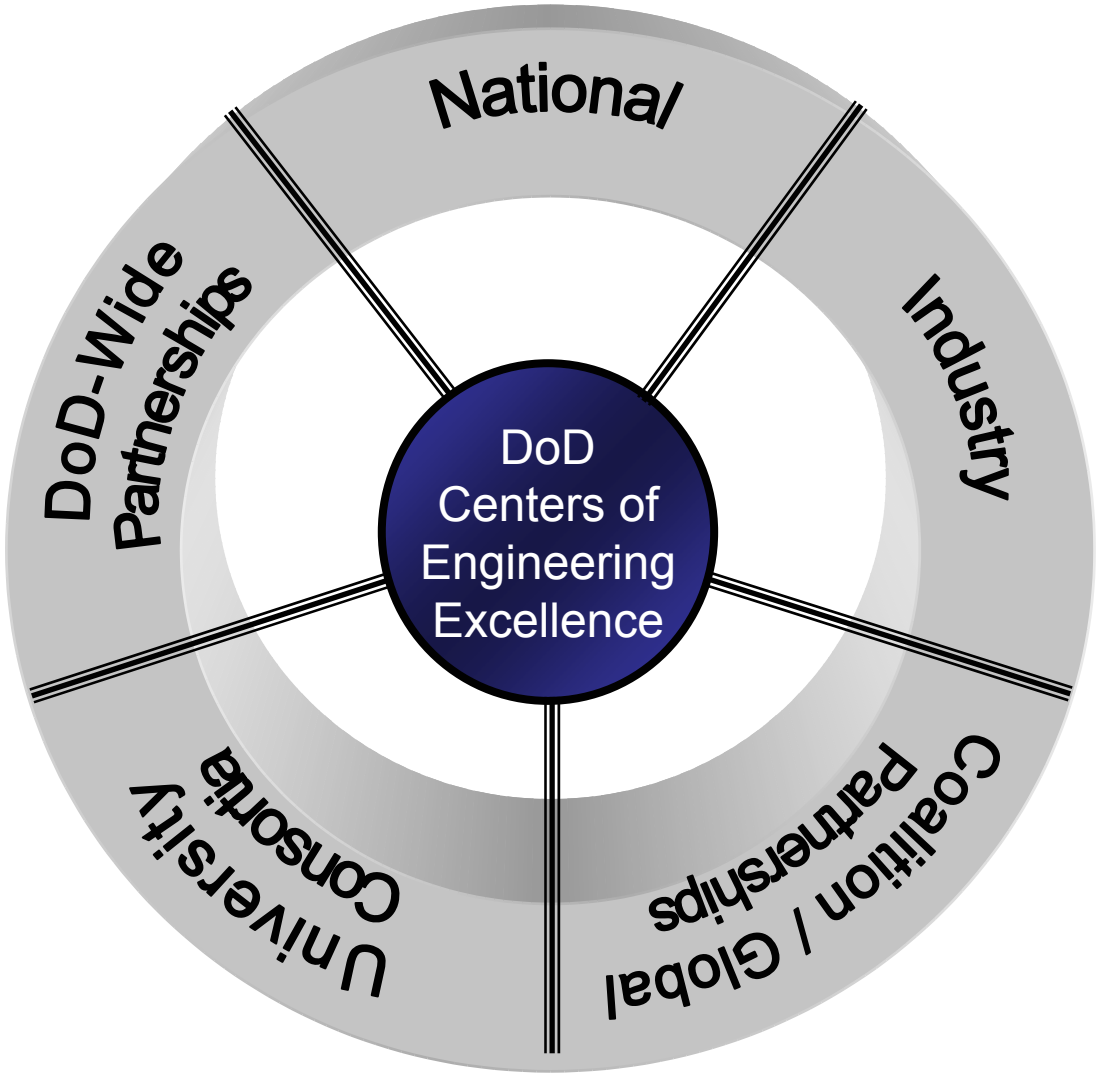

*Management Visibility – Best Practices – Acquisition Excellence*

# DoD Software Center of Excellence Organizational Tenets

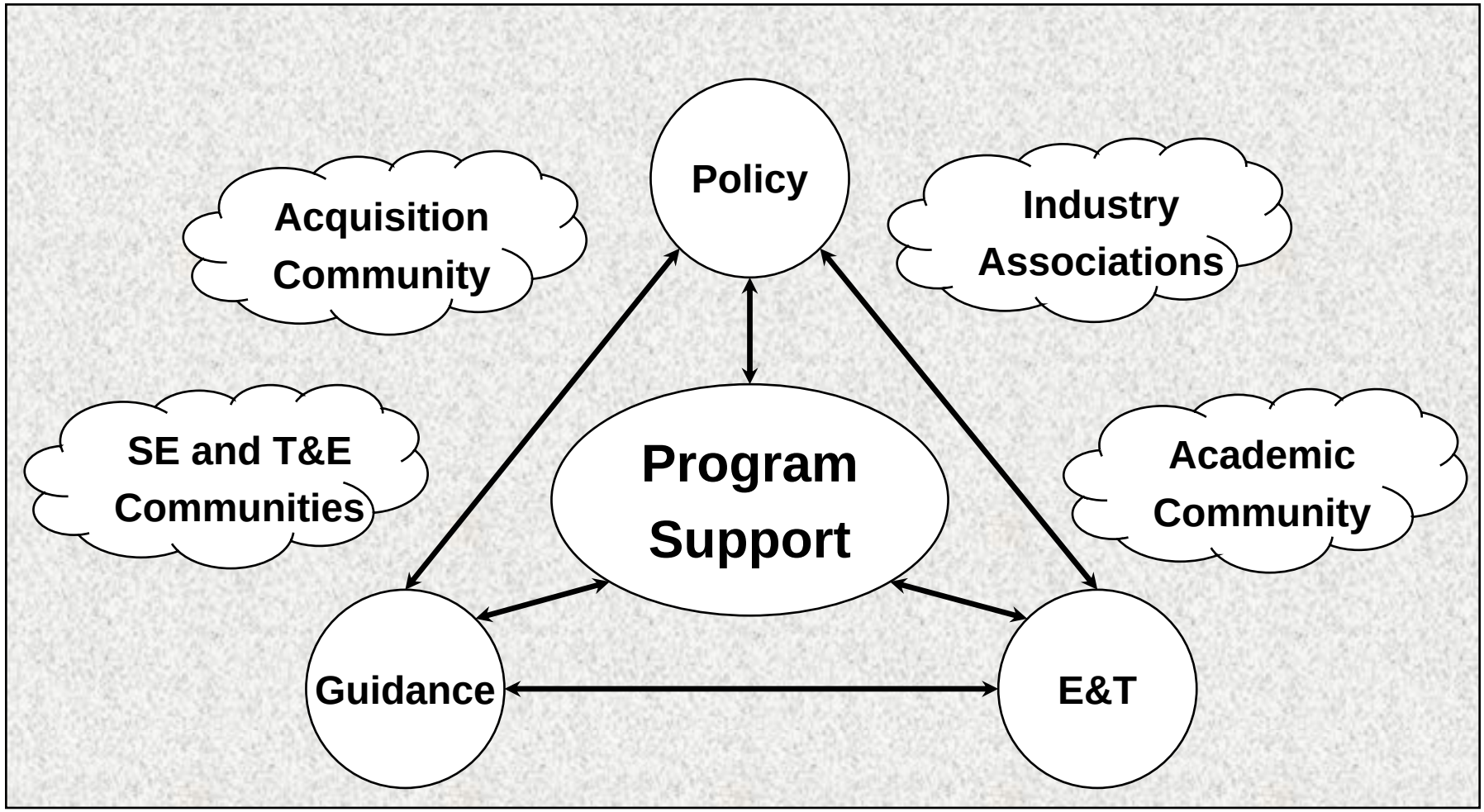
- Support Acquisition Success
  - Ensure effective and efficient software solutions across the acquisition spectrum of systems, SoS and capability portfolios
- Improve the State-of-the-Practice of Software Engineering
  - Advocate and lead software initiatives to improve the state-of-the-practices through 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***

# How do we get there?



# Systems Engineering Revitalization Framework




***Driving Technical Excellence into Programs!***

# 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

# 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***

# 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

*Based on ~40 program reviews to date

# Other Challenges

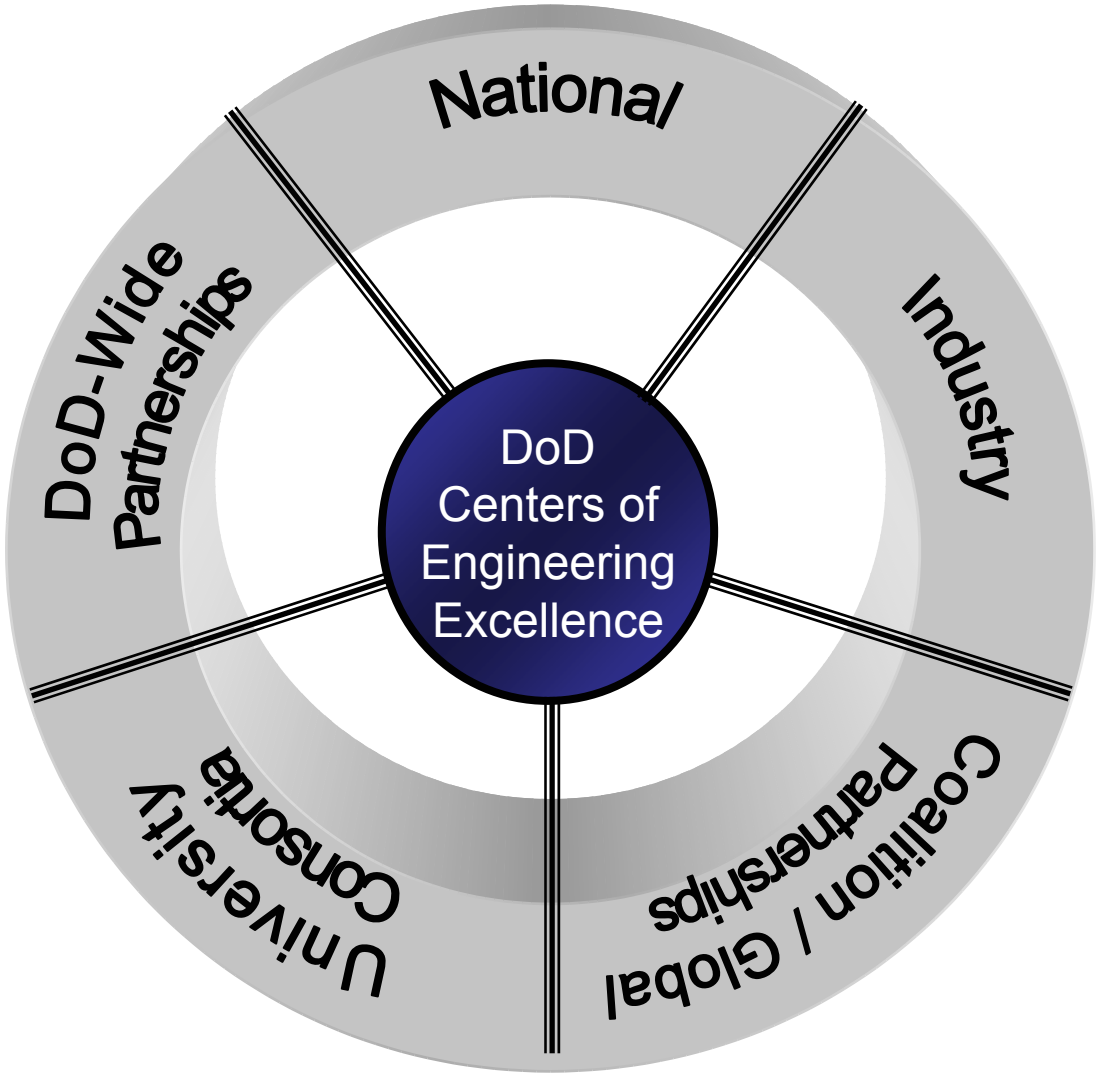
- Implementing a DoD vision and strategy for software and systems assurance
- Component and Industry adoption and effective implementation of sound SE practices as early as possible in the system life cycle
- SE support to Acquisition Initiatives stemming from the QDR
- Retention and development of technical 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

# Global Acquisition

- Benefits of leveraging reliable non-US sources
  - Price, performance, and schedule benefits
  - Increase interoperability with allies and coalition partners
  - International competition spurs US innovation and efficiencies
  - Mutually beneficial industrial linkages enhance access to global markets
- US is committed to effective systems engineering and best value
- Norway has demonstrated it is committed to being a Global Supplier by:
  - Formation of the National Center of Expertice in Systems Engineering
  - Securing significant Joint Strike Fighter work this past year with best value products

***Much is Left to do…Vector is Correct***

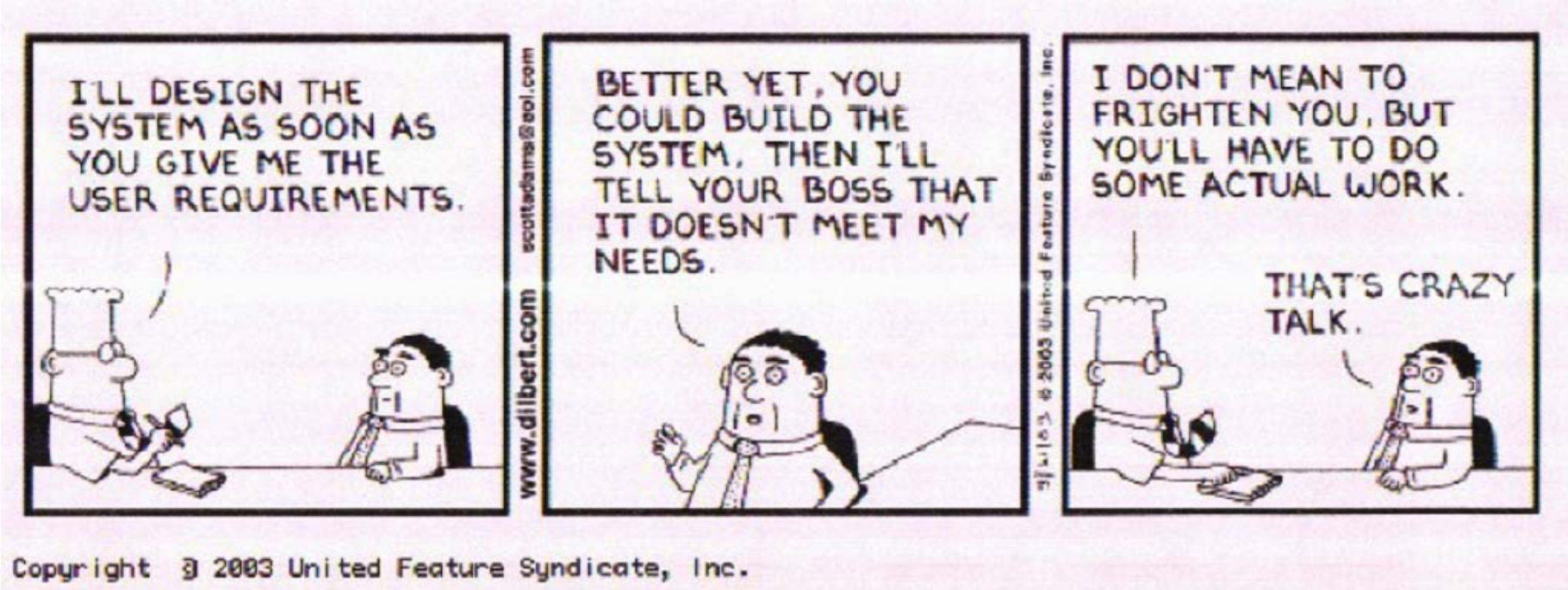
# How do we get there?



# Systems Engineering Revitalization

- Policy
  - No new policies in 2006
- Guidance
  - Continues to be refined
- Education and Training
  - E&T portfolio refreshed and growing
- Program Support
  - Gaining momentum; yielding systemic insights

# Defining User Requirements



# 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 |

Examples