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# **NRO Systems Engineering Conference**

**June 4, 2007**

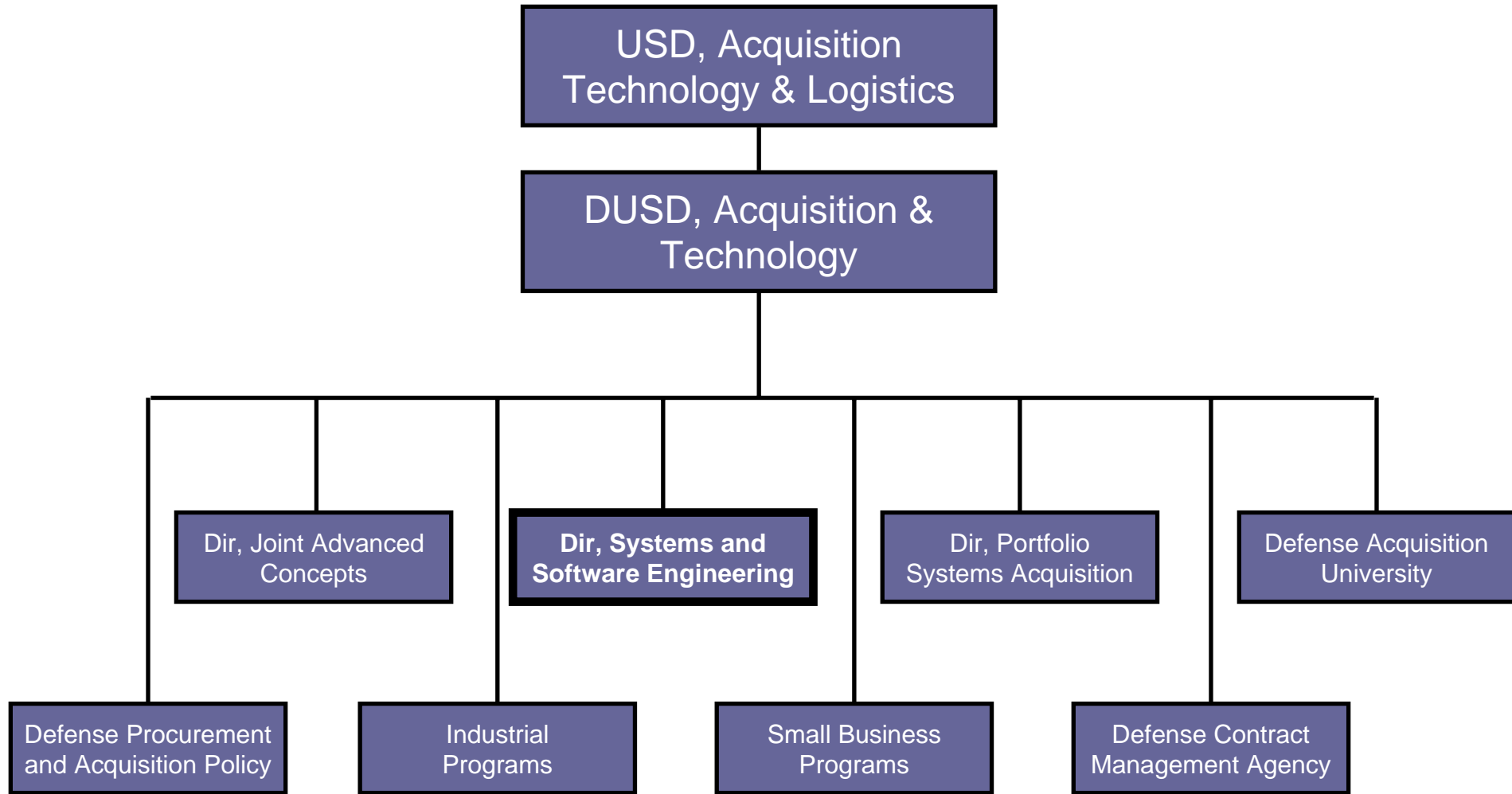
***Best Practices in Systems Engineering***

**Mark D. Schaeffer**

Director, Systems and Software Engineering  
Office of the Deputy Under Secretary of Defense (A&T)



# OUSD (AT&L) Organization

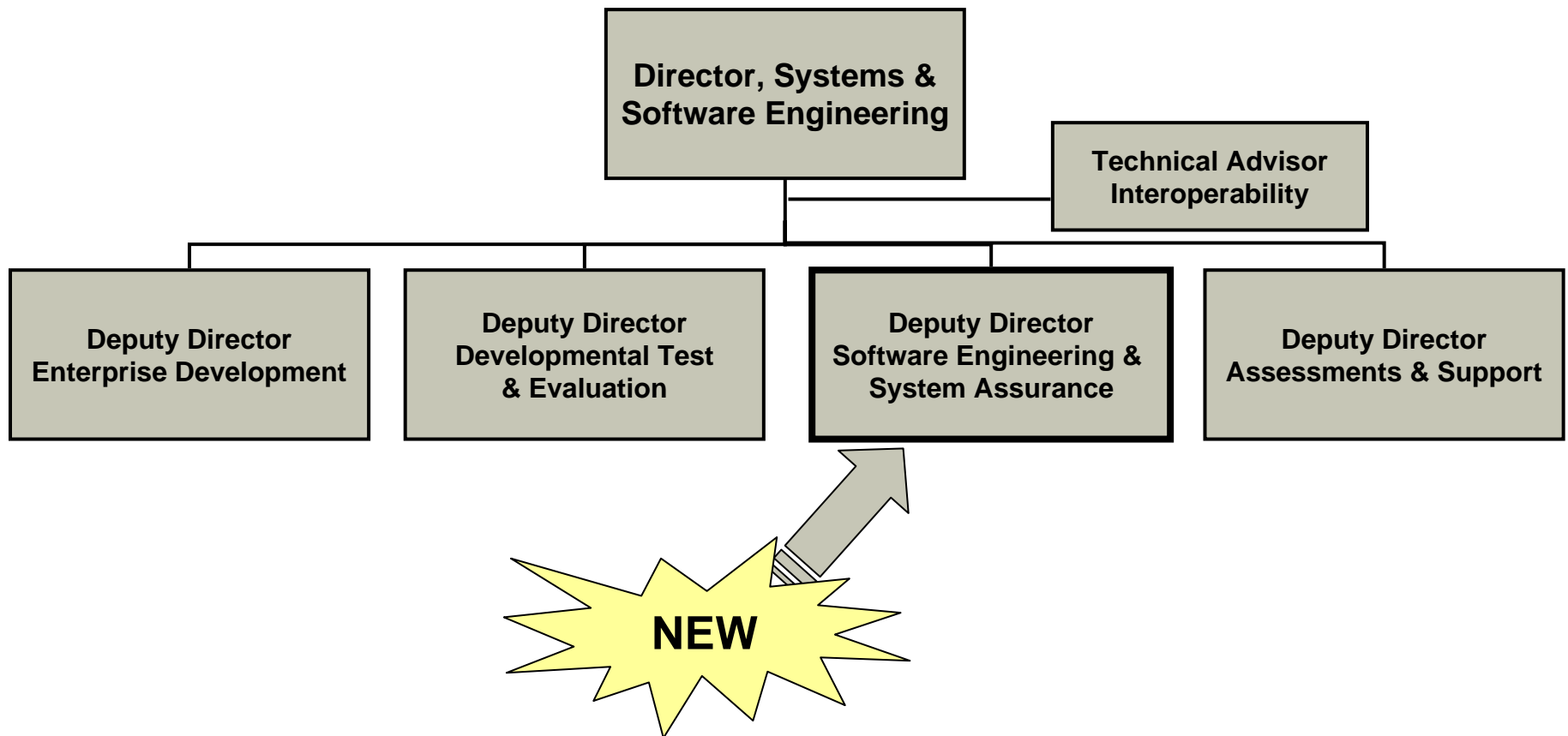


***Flatter, Leaner, Empowered!***



# Systems and Software Engineering

## *An Organizational Construct*



***Management Visibility – Best Practices – Acquisition Excellence***



# Systems and Software Engineering Mission Statement

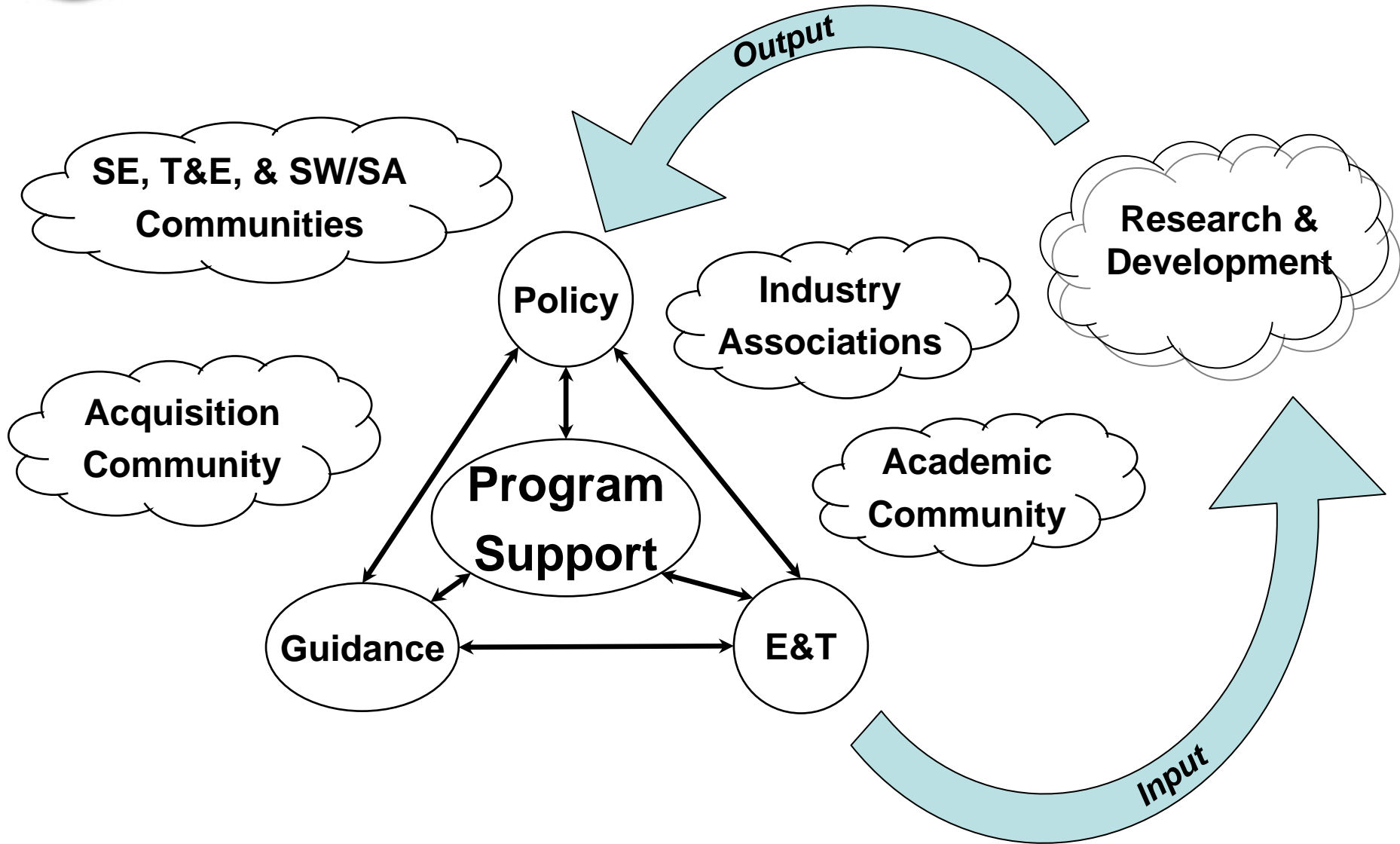
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- Shape acquisition solutions and promote early technical planning
- Promote the application of sound systems and software engineering, developmental test and evaluation, and related technical disciplines across the Department's acquisition community 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 Cycle





# What We Have Done To Revitalize Systems Engineering

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- Issued DoD-wide SE policy – focused effort on up front, sound technical planning
- Issued guidance on SE, test and evaluation (T&E) and software
- Worked with Defense Acquisition University to revise SE curricula -- currently revising T&E and enabling career fields curricula (Acq, FM, etc.)
- Established SE Forum—senior-level focus within DoD
- Instituted system-level assessments in support of OSD major acquisition program oversight role
- Integrating developmental T&E, software/system assurance and system of systems into revitalization efforts
- Instituting a renewed emphasis on modeling and simulation
- Leveraging closer working relationships with industry and academia

***Much Accomplished – Much to Do!***



# Driving Technical Rigor Back Into Programs “Program Support Reviews”

➤ Program Support Reviews (PSR) provide insight into a program’s technical execution focusing on:

In RFP and Contract

Adequate Staff and Tools

- SE as envisioned in program’s technical planning
- T&E as captured in verification and validation strategy
- Risk management - integrated, effective and resourced
- Quantifiable milestone exit criteria as captured in Acquisition Decision Memo
- Acquisition strategy as captured in Acquisition Strategy Report

➤ Independent, cross-functional view aimed at providing risk-reduction recommendations

***The PSR reduces risk in the technical and programmatic execution on a program***



# Driving Technical Rigor Back into Programs “Portfolio Challenge”

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- Systems and Software Engineering have been tasked to:
  - Review program’s SE Plan (SEP) and T&E Master Plan (TEMP)
  - Conduct PSRs
  
- Portfolio of major acquisition programs, supporting 10 Domain Areas:
  - Business Systems (3%)
  - Space Systems (7%)
  - C2ISR Systems (10%)
  - Fixed Wing Aircraft (22%)
  - Unmanned Systems (2%)
  - Rotary Wing Aircraft (22%)
  - Land Systems (17%)
  - Ships (7%)
  - Munitions (3%)
  - Missiles (7%)

*and Software*

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





# Driving Technical Rigor Back into Programs

## “Importance and Criticality of the SEP”

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- Program’s SEP provides insight into every aspect of a program’s technical plan, focusing on:
  - What are the program requirements?
  - Who has responsibility and authority for managing technical issues—what is the technical staffing and organization?
  - How will the technical baseline be managed and controlled?
  - What is the technical review process?
  - How is the technical effort linked to overall management of the program?
- Living document with use, application, and updates clearly evident

***The SEP is fundamental to technical and programmatic execution on a program***



# Driving Technical Rigor Back into Programs

## "Importance of TEMP"

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- TEMP provides insight into adequacy of T&E planning:
  - Are the scope and content of planned tests adequate?
  - Is the T&E program structured to support decisions at major milestones? Measure technical progress and maturity?
  - Are the schedule and resource requirements adequate?
  - Is DT&E program structured to achieve successful OT&E?
- Living document that must reflect all major changes to a program

***The TEMP is fundamental to validating program maturity***



# Top 10 Emerging Systemic Issues

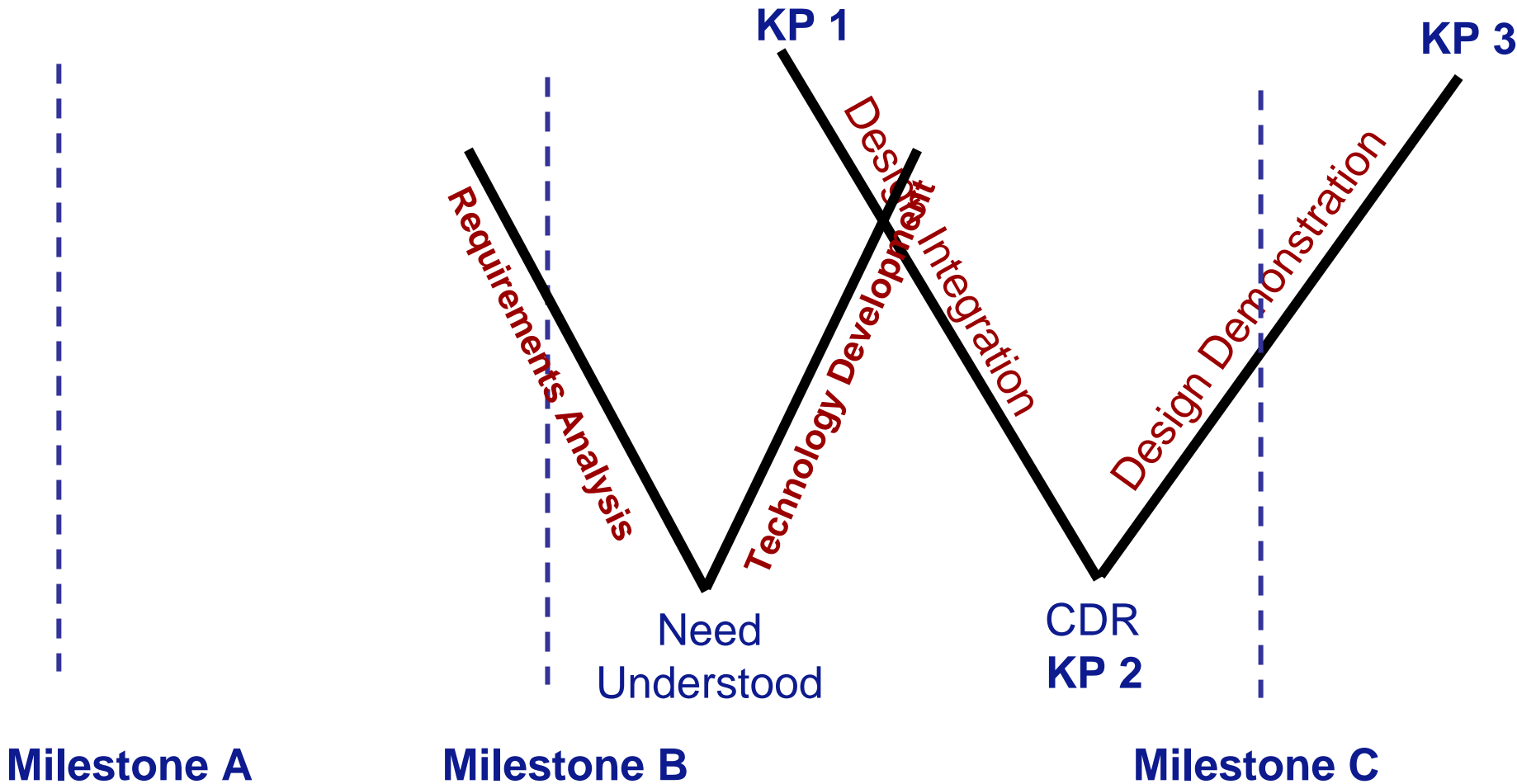
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1. Management
  - IPT roles, responsibilities, authority, poor communication
  - Inexperienced staff, lack of technical expertise
2. Requirements
  - Creep/stability
  - Tangible, measurable, testable
3. Systems Engineering
  - Lack of a rigorous approach, 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***



# Actual Acquisition Strategies Do Not Align with Systems Engineering





# Initiatives for Strategic and Tactical Acquisition Excellence

**STRATEGIC**  
“Big A”



“Little A”  
**TACTICAL**

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

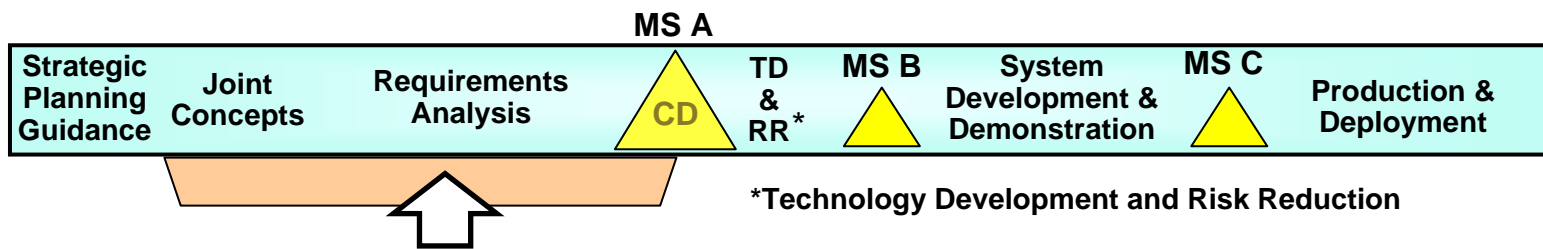
***Improving the Full Range of Acquisition Execution***



# Make Decisions that Balance the Trade Space

## Early Lifecycle Planning

- Early lifecycle involvement of Systems Engineering to:
  - Inform evaluation of alternatives with technical insights
  - Ensure solutions balance requirements with technical feasibility
  - Ensure solutions can be validated and verified
  - Use Modeling & Simulation to help refine warfighter concept of operations/system requirements, evaluate design alternatives, and identify potential technology/human interface constraints
- Appropriate resourcing (personnel/funding) required
- Include in requirements, specifications, and contracts



\*Technology Development and Risk Reduction

***Sustainment must be included up front and early***



# Structuring Programs Right Early Lifecycle Planning

Topic	Systems Engineering	Test & Evaluation	Risk Management	Exit Criteria	Acquisition Strategy
Focus Areas	Operational Requirements	V&V Traceability	Risk Drivers	Draft KPPs/KSAs	CONOPS
	Budget/Schedule Realism	Test Resources	Risk Analysis	ROM Cost & Schedule	Bounded Solution
	Technical Planning & Trades	Parametric Models	Technology Maturity	TRL	Technology Base
	Technical Constraints	M&S	Risk Planning	EOA	Risk Reduction
	System of Systems Integration	Joint/Interop Test Planning	Program/System Dependency	SoS Architecture	Incremental Strategy
Product	Concept SEP	TES	Risk Mitigation Strategy	Phase Exit Criteria	Draft RFP, ASR

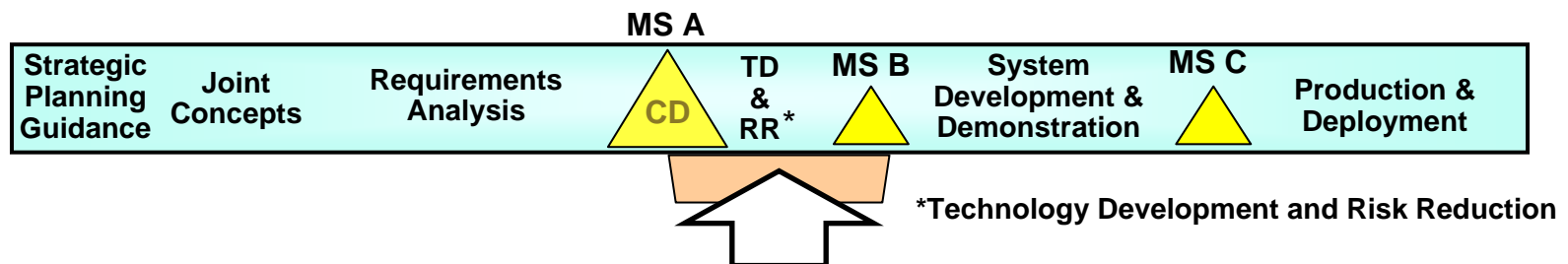


# Starting Programs Right – System Level

## ➤ 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







# Structuring Programs Right – System Level

Topic	Systems Engineering	Test & Evaluation	Risk Management	Exit Criteria	Acquisition Strategy
Focus Areas	System Requirements	V&V Traceability	Risk ID	Thresholds & Objectives	KPPs/KSAs
	Organization & Staffing	Test Resources	Risk Analysis	Life Cycle Cost	Defined Budget & Schedule
	Technical Reviews	Test Articles	Risk Mitigation Planning	Technical Maturity Level	Industrial Base
	Technical Baseline	Evaluation	Risk Tracking	Material Readiness	Development & Demonstration
	Linkage w/ Other Program Mgmt & Controls	Linkage w/ Other Program Mgmt & Controls	Program/ System Dependency	Net Centric	Risk-based Source Selection
Product	SEP	TEMP	RM Plan	Phase Exit Criteria	Contract Scope, ASR



# New SE Policy in Draft DoDI 5000.2

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- § 3.5.5. SE “shall be considered” during CR and TD.
- § 3.7.7. “System Design [phase of SDD] shall include the establishment of the functional, allocated, and product baselines for all configuration items.”
- § 3.7.8. Proceeding beyond the CDR. “The system-level CDR provides an opportunity for mid-phase assessment of design maturity as evidenced by measures such as successful completion of subsystem CDR; the percentage of hardware and software product build-to specifications and drawings completed and under configuration control.”



# New SE Policy in Draft DoDI 5000.2 (cont)

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- § 3.7.9. System Demonstration. “The program shall enter System Demonstration when the program has successfully completed the system-level CDR and established a product baseline.”
- § 3.10.5. Program Support Reviews. PSRs mandated for all MDAPs and “. . . shall be conducted prior to each milestone event, before approval of the SDD acquisition strategy, and at other times as directed by the USD(AT&L).”
- Enclosure 3. Table E3.T2: SEP is mandated at milestones A, B, and C.
- Enclosure 12. Systems Engineering. Includes new policy on CM, DM, and ESOH and previously approved SE and related policies.



# What's Next?

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- We have revitalized Systems Engineering Policy, Guidance, Education and Training...
- We have driven good systems engineering practices back into the way the acquisition community does business, and have had a positive impact on programs...
- We have expanded the boundaries to include increasingly important enablers for sound SE application...
- We have a rigorous process to capture what went wrong...
- ...**but failed to change**, root cause behavior that leads to programs that do not meet cost, schedule, and performance expectations...adequate maturity at program initiation

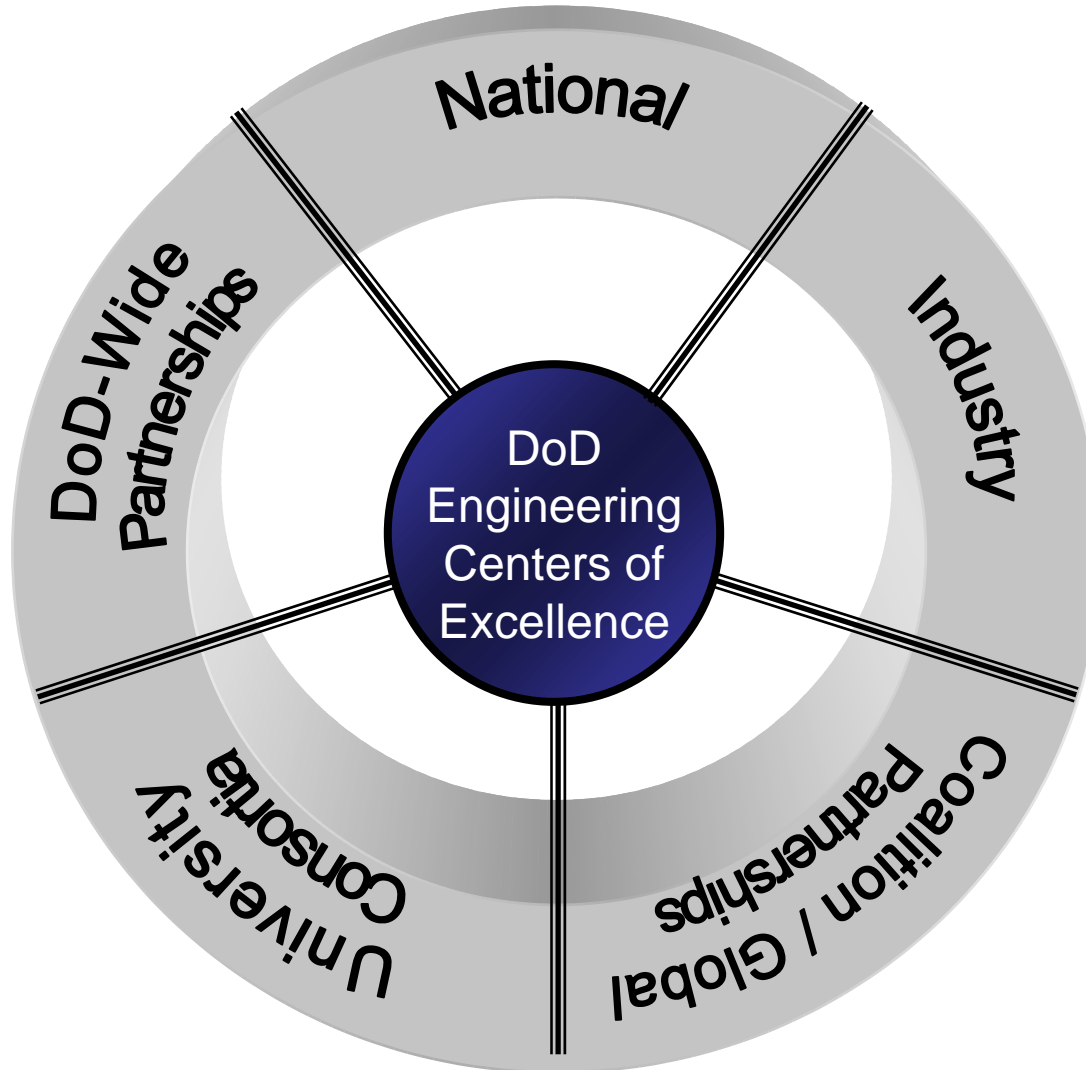
***Much Accomplished – Much to Do!***





# Many Challenges...

## How do we get there?





# Software Engineering Issues for Consideration

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- Requirements growth 10X (% functionality and program content) 1960s – Present\*
- Impact of requirements upon software is not consistently quantified and managed in development or sustainment\*\*
- Software life-cycle planning and management by acquirers and suppliers is ineffective\*\*
- Quantity and quality of software engineering expertise is insufficient to meet the demands of government and the defense industry\*\*
- Traditional software verification techniques are costly and ineffective for dealing with the scale and complexity of modern systems\*\*
- Failure to assure correct, predictable, safe, secure execution of complex software in distributed environments\*\*
- Inadequate attention given to total lifecycle issues for COTS/NDI impacts on lifecycle cost and risk\*\*

***Effectively Addressing Software Issues Overdue***



# DoD Software -- What We're Seeing\*

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- 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 ~65 program reviews to date





# SW Issue/GAP Workshop Findings

*\*based on NDIA Top SW Issues, OSD Program Support Reviews, and DoD Software Summit findings*

## Primary Software Focus Groups\*

### Software Acquisition Management

Standards – O, N  
 DAG Ch 4/7 – O, AF  
 Prog Spt – O, All  
 Contract Language – A, M, N  
 SW Estimation – GAP  
 Lifecycle Policy – AF  
 Risk Identification - GAP

### Software Development Techniques

Agile – O, SEI  
 Architecture – A, SEI  
 COTS – SEI  
 Open Source – AF  
 Sustainment – GAP  
 SW Interoperability – GAP  
 SW Test - GAP

### SW & SE Integration

Requirements – GAP  
 SE/SW Process Int – O  
 SW Council – N  
 SW Dev Plan – N  
 SW in SEP – N  
 SW in Tech Reviews – N  
 SW Quality Attributes - GAP

### Knowledge Sharing

Standards – O, N  
 DAG Ch 4/7 – O, AF  
 Prog Spt – O, All  
 Contract Language – A, M, N  
 Estimation – GAP  
 Lifecycle Policy – AF  
 Risk Identification - GAP

### Data and Metrics

SW Metrics – A, O  
 SW Cost – O  
 SW EVM – DCMA  
 SW Estimation - GAP

### Human Capital

Education Sources – N, A  
 Leadership Training – A, SEI  
 SETA Quals – GAP  
 SW Human Cap Strategy – GAP  
 Industrial Base – O  
 University Curriculum – O  
 Workforce Survey - AF

#### Ongoing Initiative Owners

O – OSD/SSA  
 A – Army  
 N – Navy  
 AF – Air Force  
 M – MDA  
 SEI  
 DCMA  
 GAP – No activity

**Ongoing SW Initiatives (w/owners) and Gaps binned to Focus Groups**



# Elements of a DoD Strategy for Software

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- Established Directorate focused on software/system assurance
- 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.
- 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***



# System Assurance

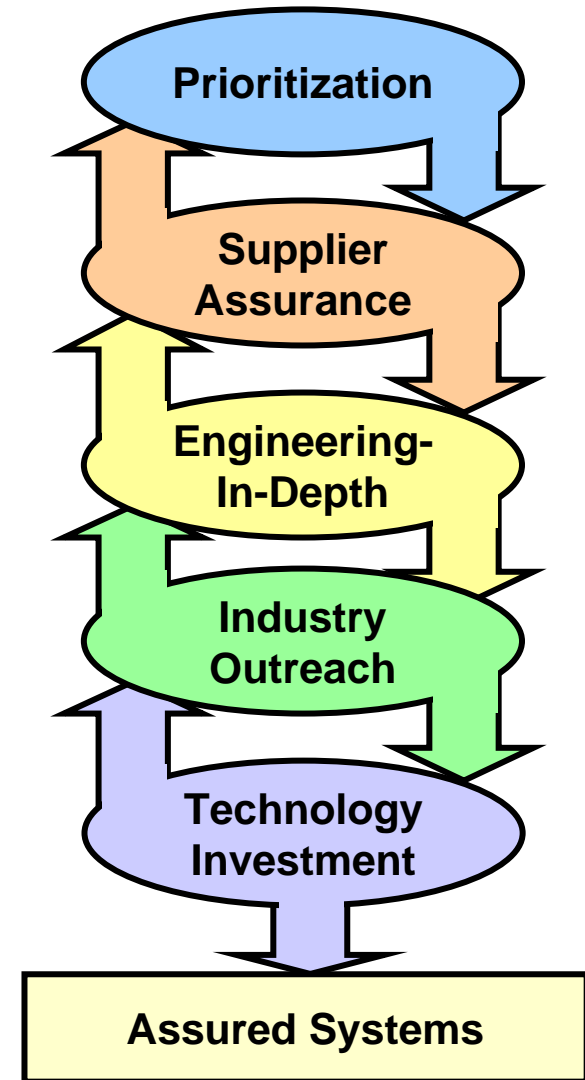
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- Definition: *Level of confidence* that a system functions as intended, is free of exploitable vulnerabilities, and protects critical program information
  
- The Problem:
  - Growing system complexity makes vulnerabilities (through malicious intent or unintentional) much more difficult to discover and mitigate
  - Commercial components desirable but compounded by inherent risks of globalization and difficulty in verifying COTS products
  - Numerous assurance, protection and safety initiatives that are not well aligned, including anti-tamper, software & hardware assurance, information assurance...



# What Does Success Look Like?

- The requirement for assurance is allocated among the right systems and their critical components
- DoD understands its supply chain risks
- DoD systems are designed and sustained at a known level of assurance
- Commercial sector shares ownership and builds assured products
- Technology investment transforms the ability to detect and mitigate system vulnerabilities





# System of Systems

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## ➤ Why SoS

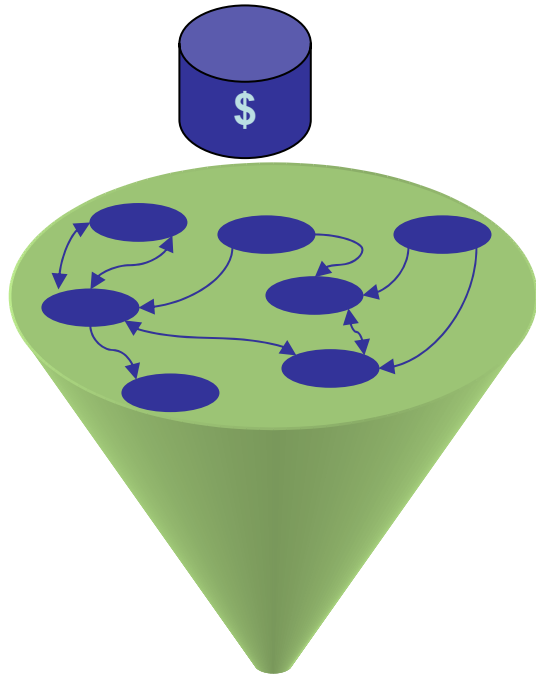
- Changing operations - changing threats and concepts mean that new (ad hoc) SoS configurations will be needed to address changing, unpredictable operational demands
- Legacy - given defense budget projections, current systems will be part of the defense inventory for the long-term and need to be factored into any approach to SoS

## ➤ Observations/challenges

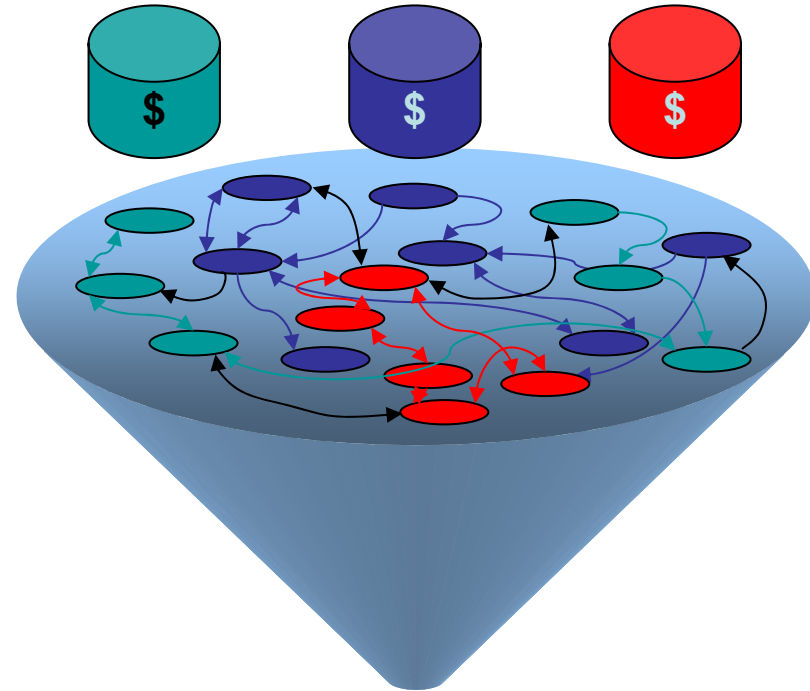
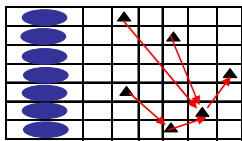
- Scale - size of defense enterprise makes a single integrated architecture infeasible
- Ownership/Management - individual systems are owned by the military component or agencies, introducing constraints on management and SE
- Criticality of software - SoS typically focus on integration across systems through cooperative or distributed software
- Role of network - conceptually DoD SoS will be network-based; budgetary and legacy challenges could lead to uneven implementation



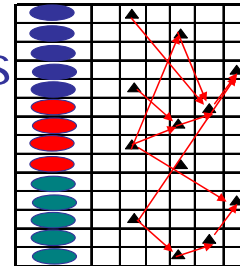
# System of Systems The Management Challenge



SoS:  
Within  
Single  
Organization



Joint SoS:  
Interdependencies  
Across  
Multiple  
Organizations



***Political and Cost Considerations impact on  
Technical Issues***



# DoD System of Systems SE Guide

SoS Guide Version .9

- Effort led by the Office of the Secretary of Defense
- Collaborative Approach with DoD, Industry, Academia
- Purpose
  - 6 month effort addressing areas of agreement across the community
  - Focus on technical aspects of SE applicable across SoS management constructs
  - Vehicle to capture and debate current SoS experience
- Audience
  - Program Managers and Lead/Chief Engineers

Pilot

- Pilot effort – “Beta test” the SoS guide
  - Structured walkthroughs with practitioners
  - Refine guide content, identify areas for future study
  - Update findings and release Version 1.0 (Fall 2007)



# CMMI Vision\*

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**The initial vision for CMMI was to integrate the competing maturity models and provide a framework for more consistent process improvement**

- Cause integration of the functional disciplines within organizations and across programs
- Increase systems engineering and software process maturity as organizations migrate from the sun-setting CMMs to CMMI

***Build on and improve the significant work done on CMM-like models***





# Have We Lost Sight of the Goal?\*

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- 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

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- 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?***



# Issues and Resolutions Included in CMMI v1.2

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- “Level for Life” – **ELIMINATED\***
- Organizational Commitment
  - Added new goal and 2 practices 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



# Issues and Resolutions Included in CMMI v1.2

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## ➤ 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
- Released March 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



# Remaining Opportunities ...and some Questions

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- 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***



# CMMI Way Ahead

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- Conduct “CMMI Beyond 1.2” Workshops
  - Facilitate discussion of remaining issues and opportunities
  - 4 sites around the globe – next one is May 23-25 in Washington, DC
- Review findings and implement
  - Adjudicate findings and strategy options
  - Propose Recommendations to the Steering Group
  - Socialize at CMMI Technical Conference, November 2007
  - Implement Strategy for 2.0



# OSD-Sponsored Activities to Promote Acquisition Process Improvement

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- **CMMI Acquisition Module (CMMI-AM)**
  - Developed for government acquisition projects acquiring systems or services
  - v1.1 published in May 2005
  
- **CMMI Acquisition Guidebook**
  - *Understanding and Leveraging a Supplier's CMMI® Efforts: A Guidebook for Acquirers* published in March 2007
  - Help acquirers benefit from, and avoid the pitfalls associated with, supplier process improvement activity
  
- **CMMI for Acquisition (CMMI-ACQ)**
  - Leveraged General Motors/SEI project to create an initial model
  - CMMI-ACQ updated through pilots and coordination with major acquisition stakeholders
  - Covers the acquisition of products and services, from IT outsourcing to DoD weapon systems
  - Expect final product Summer 2007



# Reinforce the Basics

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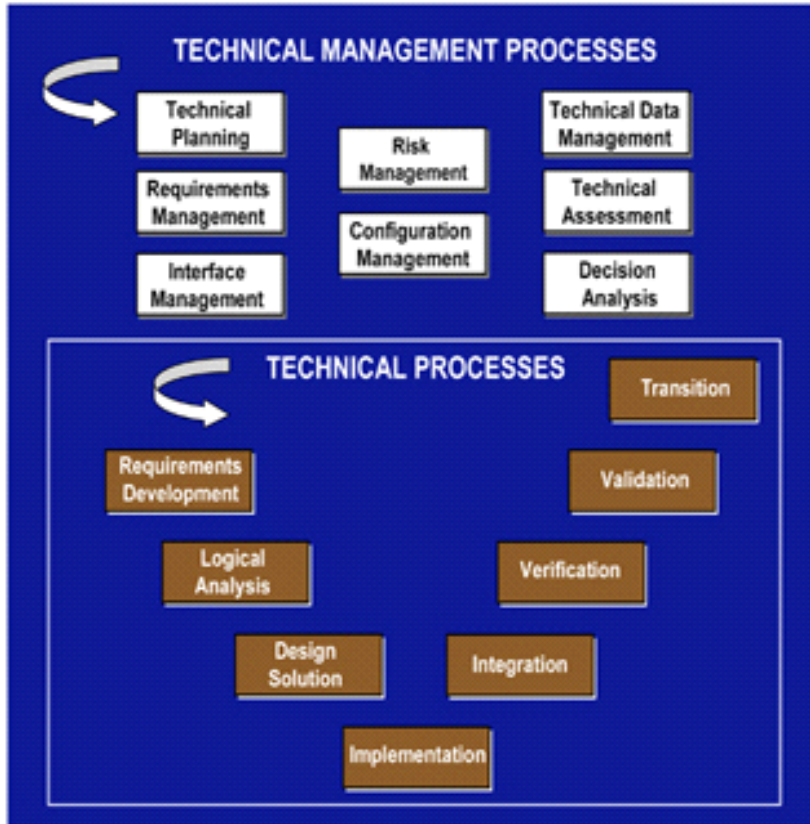
- Continue focus on refining the CMMI vision
- Ensure changes facilitate achievement of the CMMI goals
- Make sure v1.2 changes bring value added to the acquirer and developer
- Keep watch on the cost of doing business

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





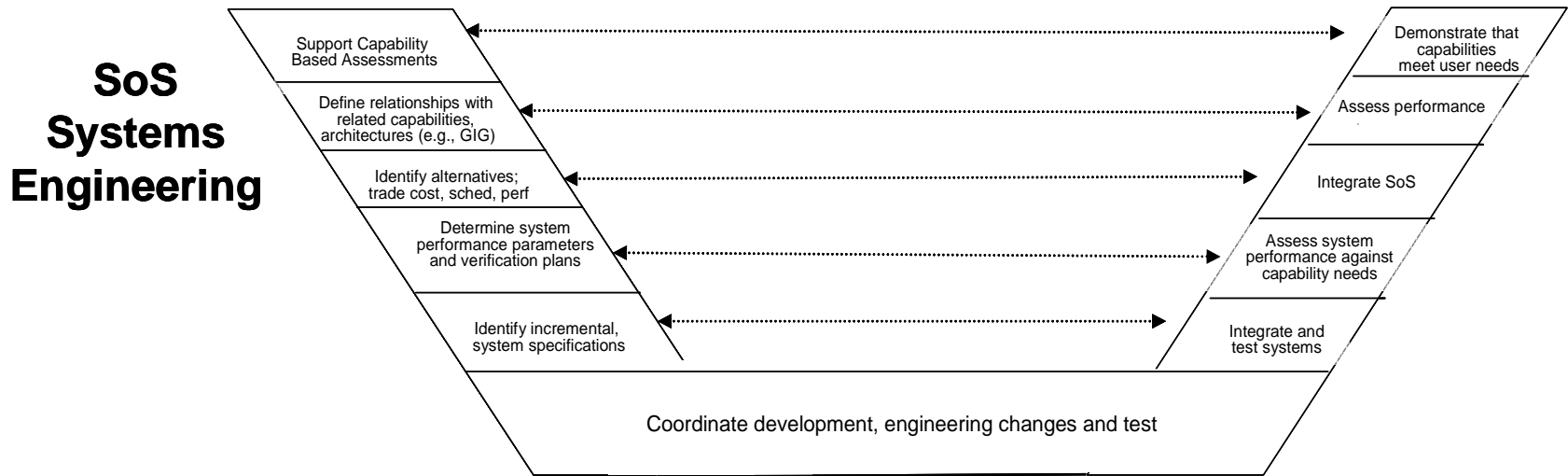
# Challenges of SoS for SE Processes



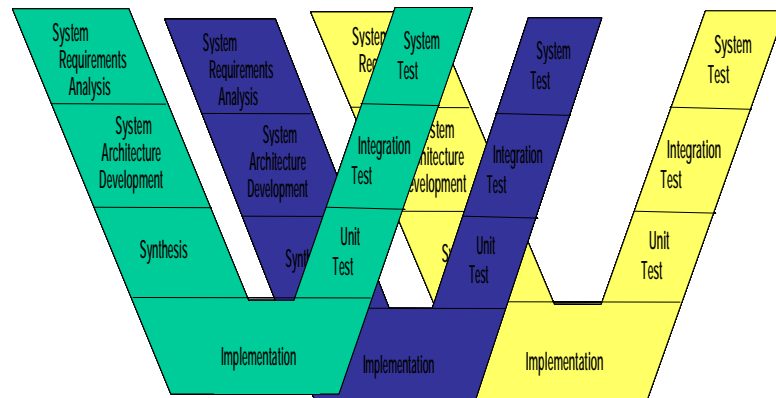
- Technical and Technical Management Processes for SE from Chapter 4 of the Defense Acquisition Guide
  - Identify implications of SoS for each process
  - Challenges these pose
  - Approaches to address the challenges
- Processes apply, but the SoS environment affects approaches, methods and tools needed by SE
  - More collaboration, less top down
  - More complexity to accommodate requirements, approaches and tools used by constituent systems
  - Balance between roles of SoS SE and SE of individual systems
  - More need for experimentation to determine ways to employ existing systems and to discover effects of combined systems



# An "Integrated Vee" for SoS SE\*



**Service/  
PEO/PM  
Program  
Systems  
Engineering**



**System 1  
(Requiring  
Modification)**

**System 2  
(New or  
Early in  
Development)**

**System 3  
(In production)**

\* From DoD SoS SE Guide v 0.9



# How We Got Where We Are\*

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- CMMI Sponsors opted to pursue staged and continuous models to preserve legacy
  - SW-CMM, staged
  - SECM, continuous
- Acquiring organizations do not have full understanding of how CMMI is intended to be used
  - What a specific level at the enterprise level actually means to an acquisition program
  - That the process and people evaluated to obtain a level are not necessarily applied to their program
  - Achievement of a specific level may or may not have meaning to any given acquisition program



# CMMI Government Assessment Spring 2006: 8 Major Issues for Resolution

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## 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

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## 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



# Data & Configuration Management

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## ➤ What's coming:

- Additional text proposed for DoDI 5000.2 update will require PMs to
  - document approach that controls a product's technical baseline across the total system life-cycle to ensure traceability to requirements
  - establish strategy that provides real-time access to sufficient data to design, manufacture, certify, and sustain the system
  - assess the long-term technical data needs of their system or subsystem
- Refinements to existing guidance in DAG and new guidebook that provides some details and relationships to industry standards on data & configuration Management (4QTR 07)
- Continuous learning module CLM on Data Management (AUG 07)
  - Complements other SSE CLM on DAU web site
  - Consistent with policy & guidance updates



# Data Management Guidebook

## Purpose, Scope, Content

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- Flow down of policy/guidance to the DoD community
- Extend DM information introduced by the DAG
  - What data is required to meet various use purposes
  - Estimating the cost of data
  - Form and format of data
- Clarify data rights, present use cases as examples
- Take forward relevant, updated 5010.12-M information
- Complete gaps left by GEIA-859 that are DoD-specific, for other topics
- Complement other SSE guide book like those for risk management and contracting for SE
- Just starting this now, est publishing OCT 07 after coordination through SE Forum and similar venues



# CM & DM Policy Updates

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- Proposed additions to 5000.2, Enclosure 12, Systems Engineering
- E12.9. Configuration Management. All programs responding to a capabilities or requirements document, regardless of acquisition category, shall apply a documented approach that establishes and controls a product's attributes and its technical baseline across the total system life-cycle to ensure traceability of its functional and physical characteristics to requirements. This approach shall be integrated with the Systems Engineering Plan and other technical planning"
- E12.8. Data Management and Technical Data Rights
- E12.8.1. The PM shall establish a data management strategy that provides for development of and real-time access to sufficient data to design, manufacture, certify, and sustain the system. The strategy shall be included in the acquisition strategy and integrated with other technical planning, and shall also provide data to support re-competition for production, sustainment, or upgrade
- E12.8.1. PMs for all major weapon systems or subsystems, regardless of planned sustainment approach, shall assess the long-term technical data needs of their system or subsystem. This assessment shall inform preparation of the data management strategy. The data management strategy shall be completed prior to issuing a contract solicitation for the system or subsystem; shall address the merits of including a priced contract option for the future delivery of technical data not acquired upon initial contract award; and shall address potential changes in the LCSP (reference (cg))





# Characterizing the System of Systems Environment

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- **Community Involvement: Stakeholders, Governance**
  - System: stakeholders generally committed only to the one system
  - SoS: stakeholders more diverse; stakeholders from each system involved will have some interest in the other systems comprising the SoS
- **Employment Environment: Mission environment, Operational focus**
  - System: mission environment is relatively stable, pre-defined, and generally well-known; operational focus is clear
  - SoS: emphasis on multiple missions, integration across missions, need to ad hoc operational capabilities to support rapidly evolving mission objectives
- **Implementation: Acquisition/Test and Validation, Engineering**
  - System: proceeds through acquisition process as an entity; specified requirements, single DoD program manager, SE with a Systems Engineering Plan, test and validating the system is possible
  - SoS: may be made up of constituent systems in various phases of the acquisition lifecycle, from initial design to sustainment; multiple DoD program managers and operational and support communities; testing is more difficult and test and validation can be distributed and federated



# Way Ahead for Systems Engineering

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## ➤ Continue Systems Engineering Revitalization

- Policy Guidance, Education, Training, Program and Decision Support, Outreach
- Continue to positively impact to major programs development
- Leverage software efforts to support acquisition success and improve State-of-the-Practice of software engineering
- Focused initiatives on System Assurance, process improvement and System-of-Systems systems engineering

## ➤ Taking Systems Engineering to the Next Level

- Foster early life-cycle involvement key to program success



# Emerging System of Systems (SoS) Need

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- Traditionally, DoD developed single system solutions to satisfy operational needs
  - SE processes applied at system level
- DoD has identified emerging need to develop SoS solutions
  - Example: MDA for ballistic missile threat
  - Department identified potential gap in guidance for programs trying to develop SoS and apply SE processes for SoS solutions



# Consequences of Fragmented Systems Assurance Initiatives

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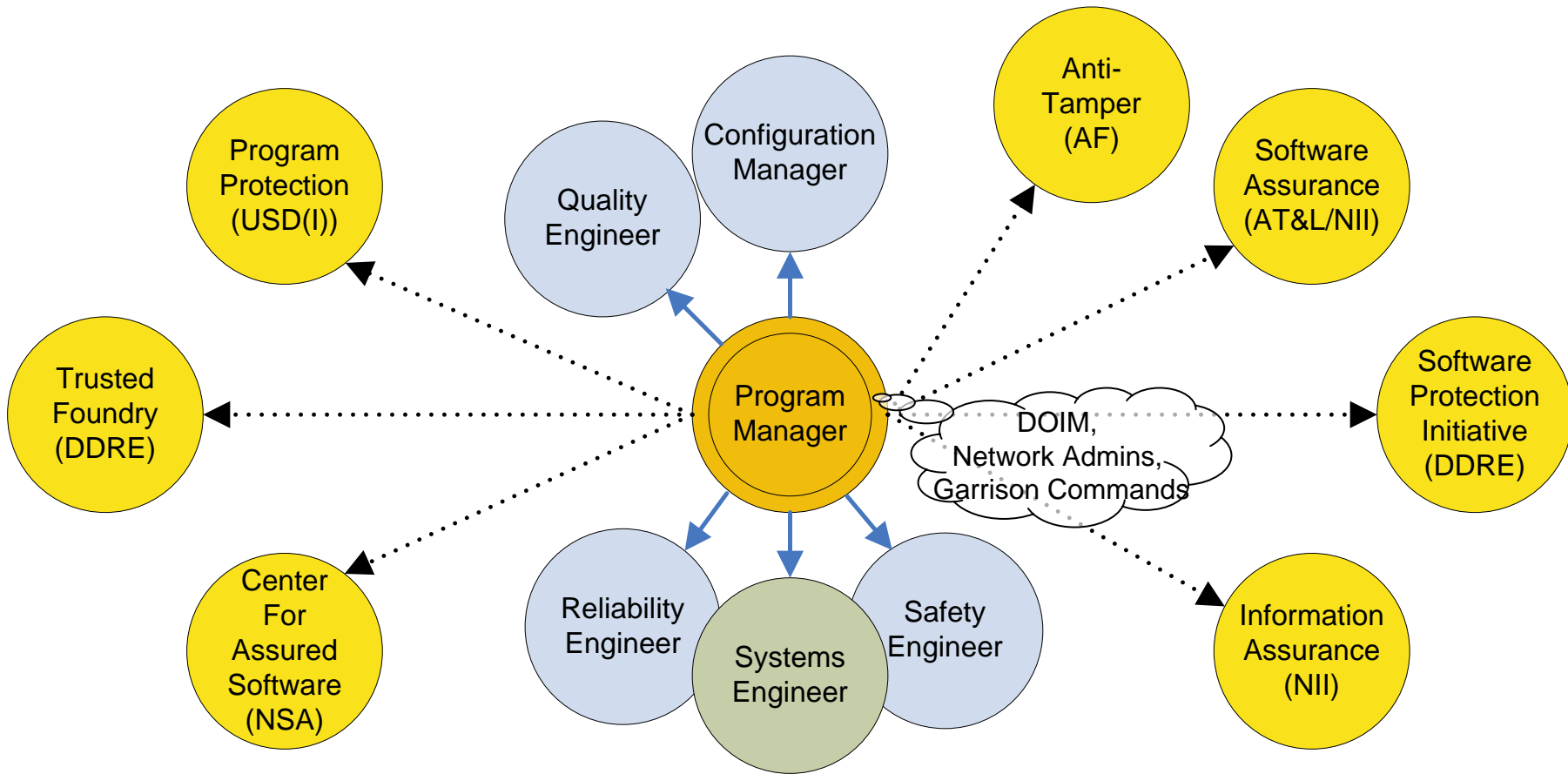
- Systems assurance policies are fragmented and confusing for programs to implement
  - Resulting in loss of time and money and lack of focus on applying the most appropriate engineering for systems assurance for each system
  - Resulting in ineffective and inefficient systems assurance for materiel
- Lack of Coherent Direction for PMs, and others acquiring systems
  - Numerous, uncoordinated initiatives
  - Multiple constraints for PMs, sometimes conflicting
- Synergy of Policy – Multiple ownership
  - Failure to capitalize on common methods, instruction among initiatives
- DoD Risk Exposure
  - Lack of total life cycle view
  - Lack of a focal point to endorse system assurance, resolve issues, advocate PM attention
  - Lack of system-of-systems, architecture perspective on system assurance
  - Fragmented policies leave gaps in systems assurance protection
  - Policies not net-ready

**There is a need to assimilate the multiple security disciplines into a cohesive, overarching Systems Assurance framework**



# Systems Assurance

Systems Assurance involves integrating multiple initiatives with multiple owners





# Technical Planning Systems Engineering Plan Trends

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## ➤ What is working:

- Programs beginning to establish SE Working IPTs early in the life cycle to develop and document their technical planning
- Increased Program Executive Office level Lead/Chief Systems Engineers involvement in SEP development
- Movement to event-driven versus schedule-driven programs
  - More focus on entry and exit criteria for technical reviews

## ➤ What needs work:

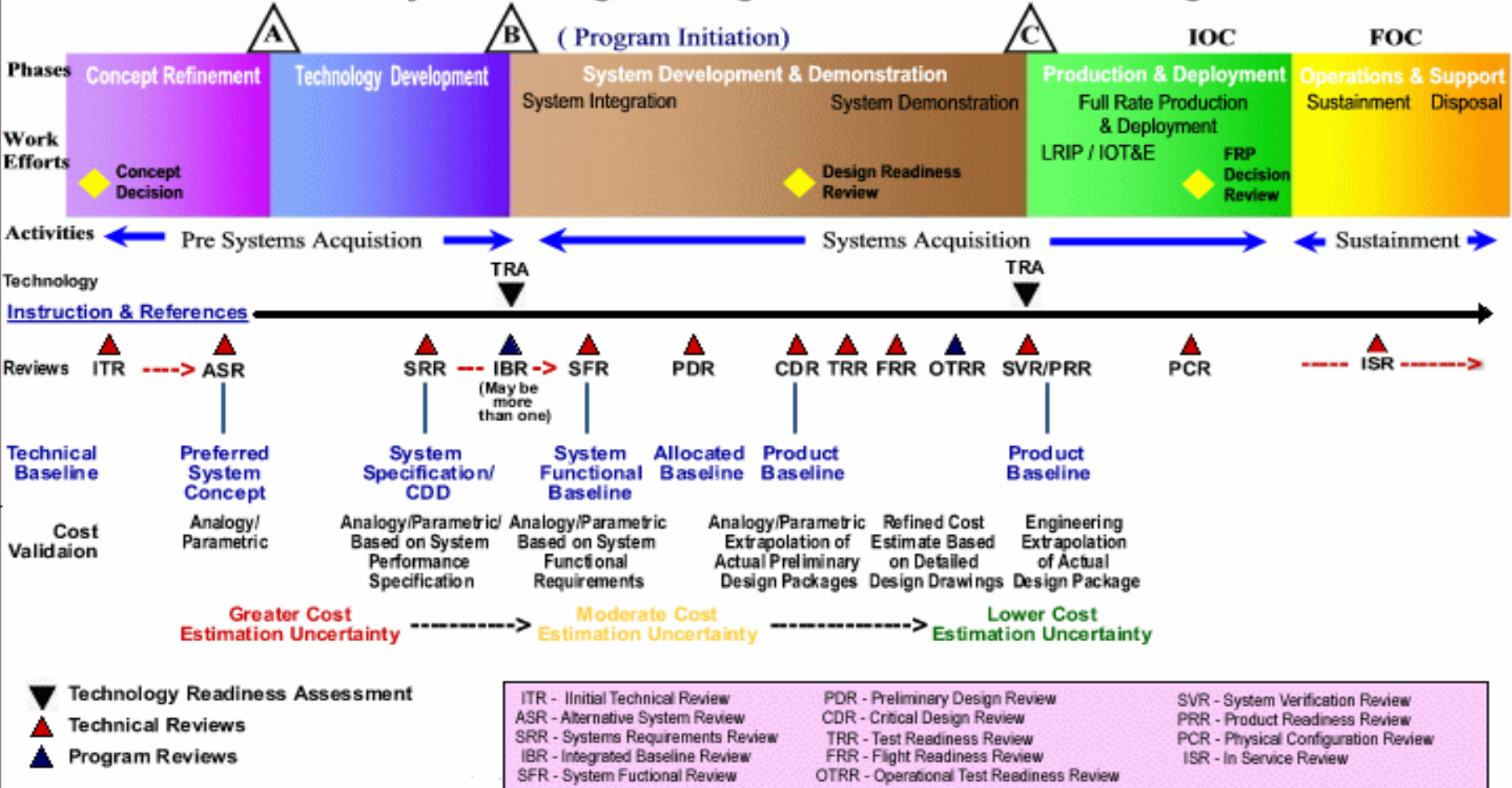
- Firming up technical planning prior to RFP release
- Proposed processes for a program not always tailored to fit program - often appear to be copied from a manual or guide
- SEP author is someone who is not familiar with the program technical strategy
- SEPs need to be better aligned with key program documents (RFP, contract, TEMP, etc)
- Align Program Office and Contractor plans



# Technical Reviews Across the Life Cycle

Version 1.2

## Systems Engineering Technical Review Timing





# Modeling & Simulation (M&S) in Systems Engineering

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- The Acquisition M&S Working Group – a working group of the SE Forum – is implementing the “Acquisition Modeling and Simulation Master Plan”
  - Plan contains 40 actions to improve effectiveness of M&S in programs
  - 25 of the actions now being worked by Acquisition M&S Working Group
  - Recently began effort to evaluate distributed simulation standards necessary to support integrated Live, Virtual, Constructive (LVC) Architecture
- Developing M&S best practices for use by SE personnel in program offices
  - Developed online continuous learning module “M&S for Systems Engineering”
  - Developing online continuous learning module “M&S for T&E”
  - Updated the M&S section of the Defense Acquisition Program Support (DAPS) to more accurately gauge a program’s application of M&S in support of their SEP
  - Offering assist visits for programs needing help with proper planning and use of M&S





# Developmental Test & Evaluation

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## ➤ Strategic View

- Relevance to T&E community – 5 Vectors
- Strategic Alliance – Developmental and Operational testing
- Outreach – industry, joint and coalition
- T&E Governance
- Defense Science Board on T&E

## ➤ Tactical View – 5 revitalization vectors

- Support Faster Fielding of Improved Capabilities
- Reduce Risk of Immature Technology in Systems Development
- Revitalize T&E Workforce Education
- Remove Barriers to Efficient Distributed Live-Virtual-Constructive Environments
- Provide Effective Acquisition Policy and Practices for DT&E



# CMMI: New Release and Next Steps

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## 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
- DCMA study of actual process implementation



# Our Challenge

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- Given the shortage of software resources and critical software reliance
  - We cannot afford to be stovepiped
  - We must integrate across cross-functional perspectives to improve our software capability
- We must focus on long standing software issues
  - Leverage ongoing activities to make a difference
  - Invest in collaborative efforts where there are gaps
- Now...
  - Work together to address software issues
  - Contribute to ongoing initiatives: SoS, Sys Assurance, CMMI Guides, more

***Become a DoD Software Center of Excellence***



## USD(AT&L) Response to June 06 SECDEF Memo on Improving Safety in DoD

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- USD(AT&L) memo of November 21, 2006 directs changes to influence systems' entire life cycle safety:
  - ATP TF will develop process for Safety community to provide early inputs to JCIDS
  - All Acquisition Program Reviews shall address status of (1) High and Serious risk and (2) compliance with applicable safety technology requirements
  - DoD Components will include in all Class A and B mishap investigation reports System Program Office analysis of materiel/design hazards that contributed to accident



# Joint Systems Software Safety Handbook

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- **A reference for use by all Services, the Coast Guard, appropriate government agencies (e.g. FAA and NASA) and industry.**
  - **All intended users are involved in developing the handbook**
  - **Incorporates lessons learned and latest advances in software engineering and software safety practices into a formal Military Handbook**
  - **Provides a single authoritative source of best practices to government and industry**



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# *Talking Points*



# Issue Area 1: High Maturity/Level 4 & 5

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## ➤ Issues:

- Lack of agreement on what constitutes Levels 4 and 5
- High-maturity practices are not consistently applied at the project level after contract award

## ➤ Resolution:

- Certification of high-maturity appraisers is now in place
  - July 06 workshop on high maturity training determined the requirements for which the lead appraisers have to provide evidence in order to do high maturity appraisals
  - Previous courses, oral questions, etc.
- Body of Knowledge on high maturity will be developed and available by October 2007
- Lead Appraisers must certify that level 4 and 5 appraised subprocesses map to organization's business objectives



## Issue Area 2:

# Integrity – Programs Execute at Lower Levels than Achieved and Advertised

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### ➤ Findings that lead to Integrity Issue:

- Issues with appraiser quality – training, consistency, independence
- Content of Appraisal Disclosure Statements (ADS) lacking
- Appraisal sampling inconsistent, and influenced by appraised organization

### ➤ Resolutions:

- CMMI v1.2 training upgrade: face-to-face training with focus on integrity
- Eliminated “level for life”— now 3 year limit
- DCMA developing a survey related to CMMI appraisal ratings and program performance to begin to measure the problem
- CMMI v1.2 updates to the ADS (separate chart)
- CMMI v1.2 updates to Sampling (separate chart)





# Issue Area 2: Integrity - continued

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## ➤ Issue

- Appraisal sampling inconsistent, and influenced by appraised organization
- Appraisal sampling representation of the organizational unit

## ➤ Resolutions:

- Precise definition of the sample
  - Organizational scope: name, type, location
  - Organizational Unit Coverage: size, application domain, geographical breadth, project type expressed in percentages of total organizational unit
  - Projects excluded and rationale
- Lead Appraiser certification that focus and non-focus projects are representative of organization
- Lead Appraisers must come from an organization other than the business unit being appraised



## Issue Area 2: Integrity - continued

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### ➤ Issue:

- Content of Appraisal Disclosure Statement (ADS) is not representative of CMMI appraisal data

### ➤ Resolution: v1.2 ADS requires improved level of detail

- Provides details on appraisal sample
  - Organizational unit, projects, domains
- Provides Lead Appraiser certifications
  - Project sampling is representative
  - Level 4/5 certifications are based upon practices that represent organizational business goals
- All appraisals performed after 28 Nov 2006 must use ADS v1.2 (includes CMMI v1.1 appraisals)
- DoD contractor ADS's will be posted (website tbd) for Government acquirer review



# Issue Area 3: Organizational Commitment

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## ➤ Issue:

- How to ensure new projects will incorporate CMMI processes

## ➤ Solution:

- Added new goal and two practices to Operational Process Focus (OPF) PA to stress deployment of processes to projects.
- Added text in Integrated Project Management (IPM) PA to emphasize having a defined process at project start-up
- CMMI Guidebook for Acquirers will discuss need to address project level implementation with developers



# Issue Area 4: CMMI Guidance for Acquirers

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## ➤ Issues

- Inadequate training and education for acquirers resulting in misrepresentation and misuse of CMMI

## ➤ Solution

- *CMMI Guidebook for Acquirers*
  - Due out after the first of the year
  - Will address how CMMI should be used by acquirers, how to interpret appraisal results, how to treat CMMI throughout the lifecycle
- Development of the CMMI-Acquisition Constellation



# Software Issue/Gap Identification Process

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1. Consolidated findings/recommendations from Top Software Issues Workshop, Program Support Reviews, and DoD Software Summit
  - Identified 6 major focus groups
  - Identified key recommendations for each group
2. Developed Survey to map ongoing software initiatives against the recommendations
  - Services, MDA DCMA, SEI, L&MR, DAU, DDRE completed survey
3. Held software working group session – 21 March 07
  - Reviewed Survey Results, Component Briefings
  - Determined high level focus areas for attention (next chart)
  - Binned activities against each area
  - Identified areas where no activity existed (gaps)



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Necessary but not sufficient

now

*“Take SE to the Next Level”*