IEEE AUTOTESTCON 2006

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

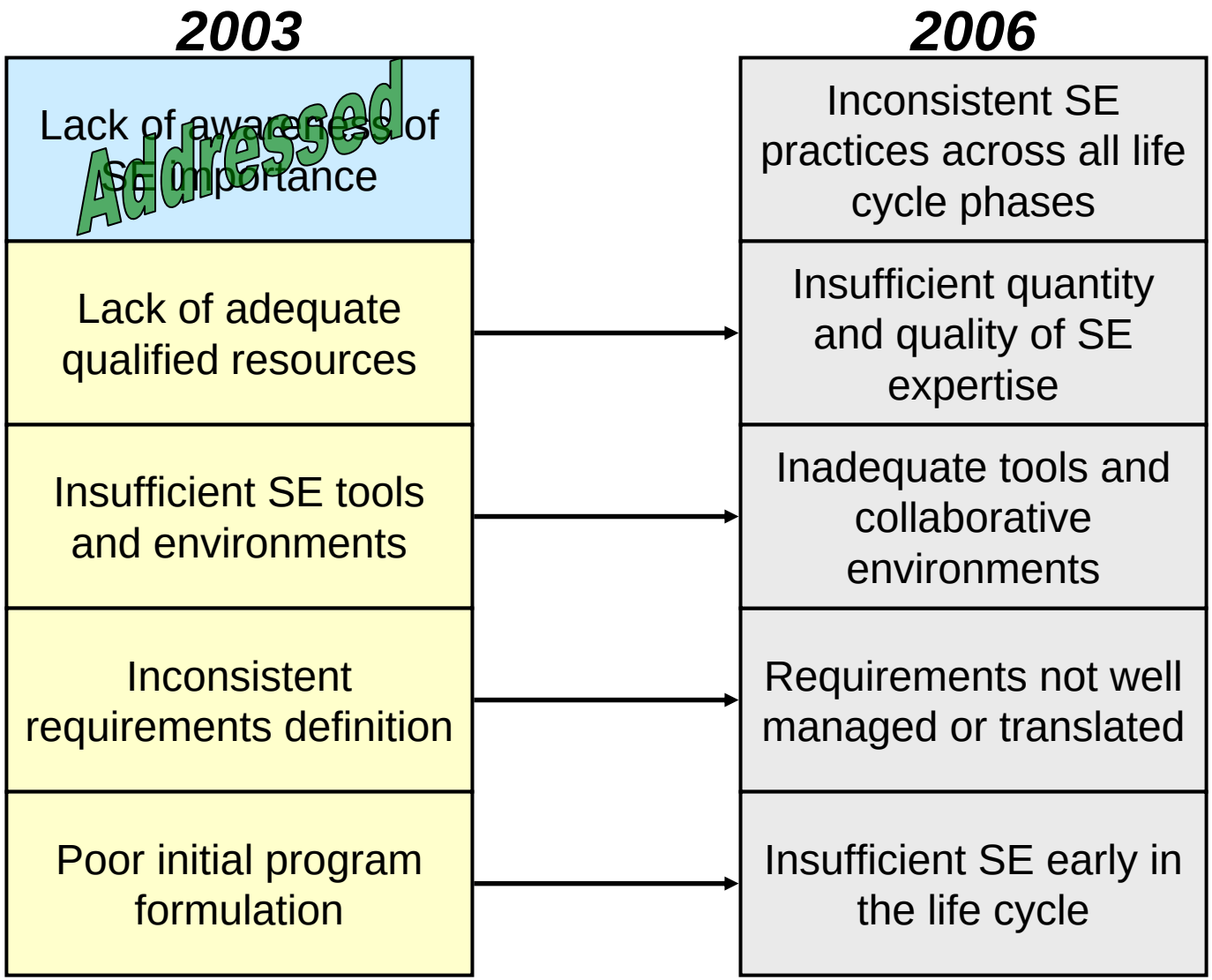
USD(AT&L) Imperatives

- "Provide a context within which I can make decisions about individual programs."
- "Achieve credibility and effectiveness in the acquisition and logistics support processes."
- "Help drive good systems engineering practice back into the way we do business."

Honorable Michael Wynne, Principal Deputy (USD AT&L), 2002

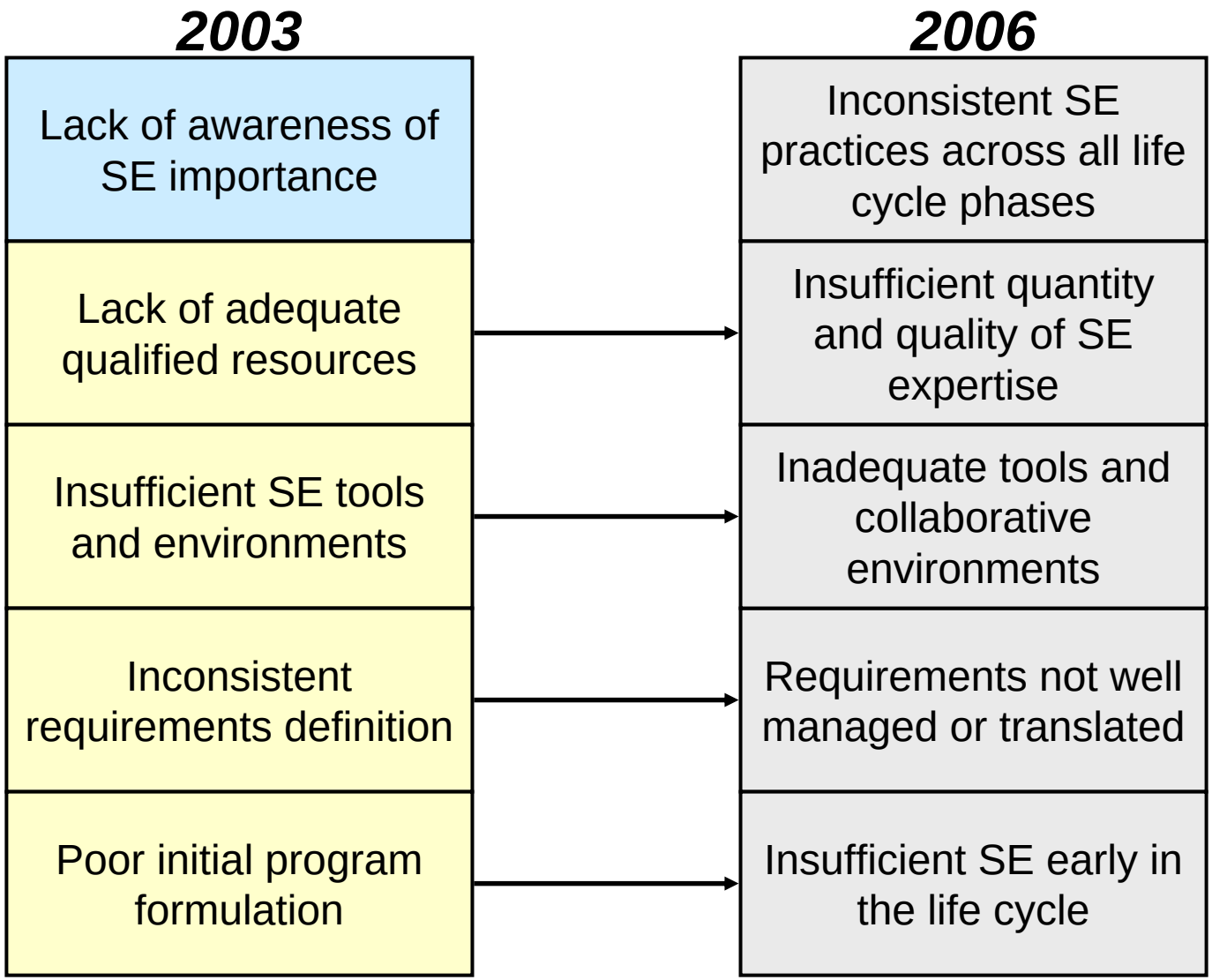
Still Operative after nearly 4 years

Evolution of Top 5 SE Issues



Source: NDIA Systems Engineering Division

Evolution of Top 5 SE Issues



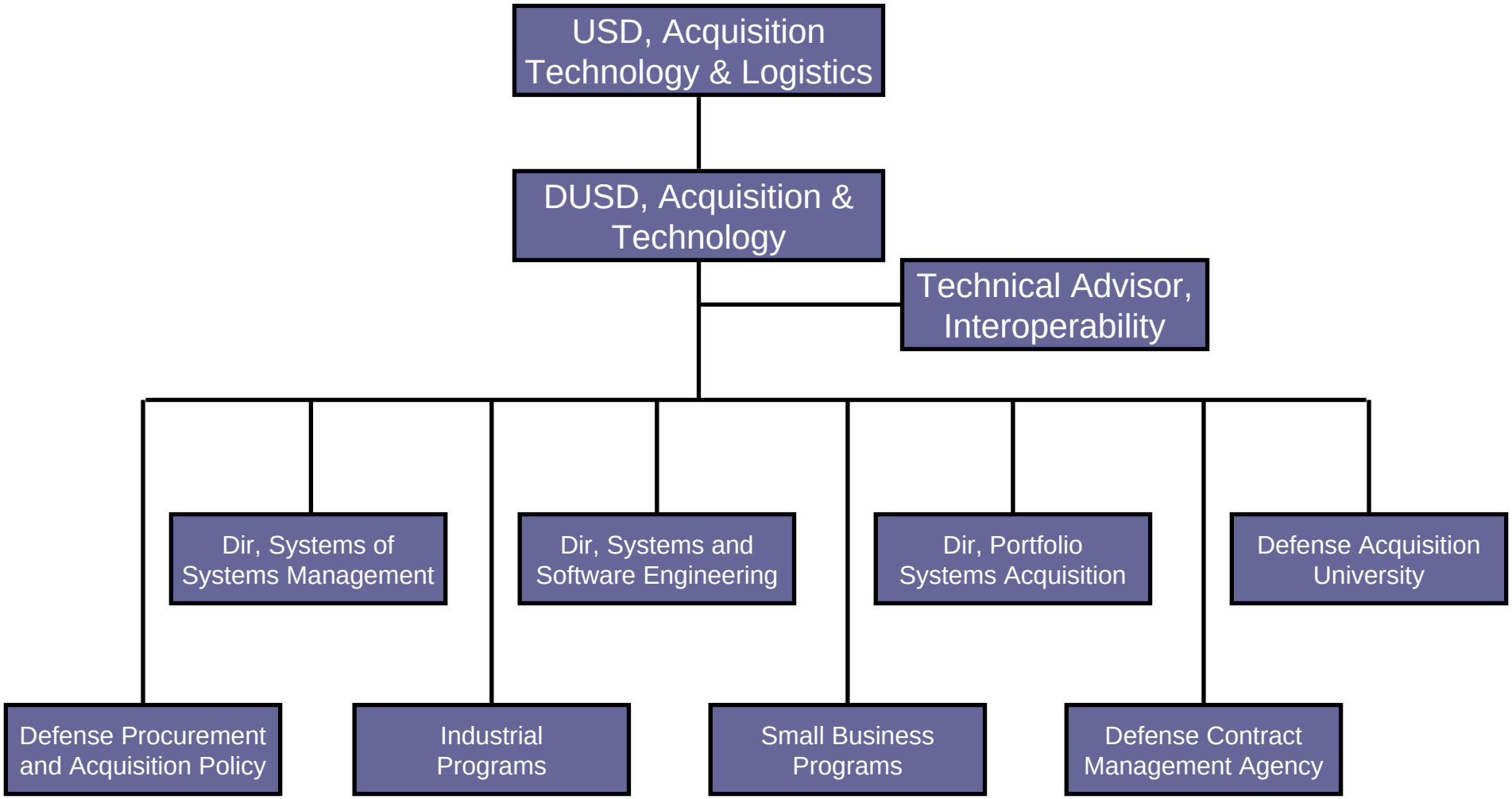
Source: NDIA Systems Engineering Division

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

Driving Technical Excellence into Programs!

ODUSD, Acquisition and Technology



Systems and Software Engineering
Organizational Core Competencies

Director, Systems & Software Engineering
Mark Schaeffer SES

Deputy Director Enterprise Development
Bob Skalamera SES

CORE COMPETENCIES

- SE Policy
- SE Guidance
  - SE in *Defense Acquisition Guidebook*
  - Technical Planning
  - Risk Management
  - Reliability & Maintainability
  - Contracting for SE
  - SoS SE Guide
- SE Education and Training
  - DAU SE Curriculum
  - SPRDE Certification Rqmt
- Corrosion
- R-TOC
- Value Engineering

Deputy Director Developmental Test & Evaluation
Chris DiPetto SES

CORE COMPETENCIES

- DT&E Policy
- DT&E Guidance
  - T&E in *Defense Acquisition Guidebook*
  - TEMP Development Process
- DT&E Education and Training
  - DAU DT&E Curriculum
  - DT&E Certification Rqmt
- Joint Testing, Capabilities & Infrastructure
- Targets Oversight
- Acq Modeling & Simulation
- Energy
- DSOC/Acq Tech Task Force

Deputy Director Software Engineering & System Assurance
Mark Schaeffer (Acting) SES

CORE COMPETENCIES

- SWE and SA Policy
- SWE and SA Guidance
  - SoS, SA Guides
- SWE and SA Education and Training
  - DAU SW Acq Curriculum
  - Continuous Learning Modules for SWE, SoS, SA
- Software Engineering
  - Acquisition Support
  - Software Engineering Institute (SEI)
- Process Improvement
  - CMMI Sponsor
- DoD/National Software Investment Strategy

Deputy Director Assessments & Support
Dave Castellano SES

CORE COMPETENCIES

- Support of ACAT I and Other Special Interest Programs (MDAP, MAIS)
- Assessment Methodology (Program Support Reviews - PSRs)
- T&E Oversight and Assessment of Operational Test Readiness (AOTR)
- Systems Engineering and Developmental Test Planning and Support
- Lean/6-Sigma Training/Cert

Acquisition program excellence through sound systems and software engineering

Software Engineering and System Assurance (SSA)

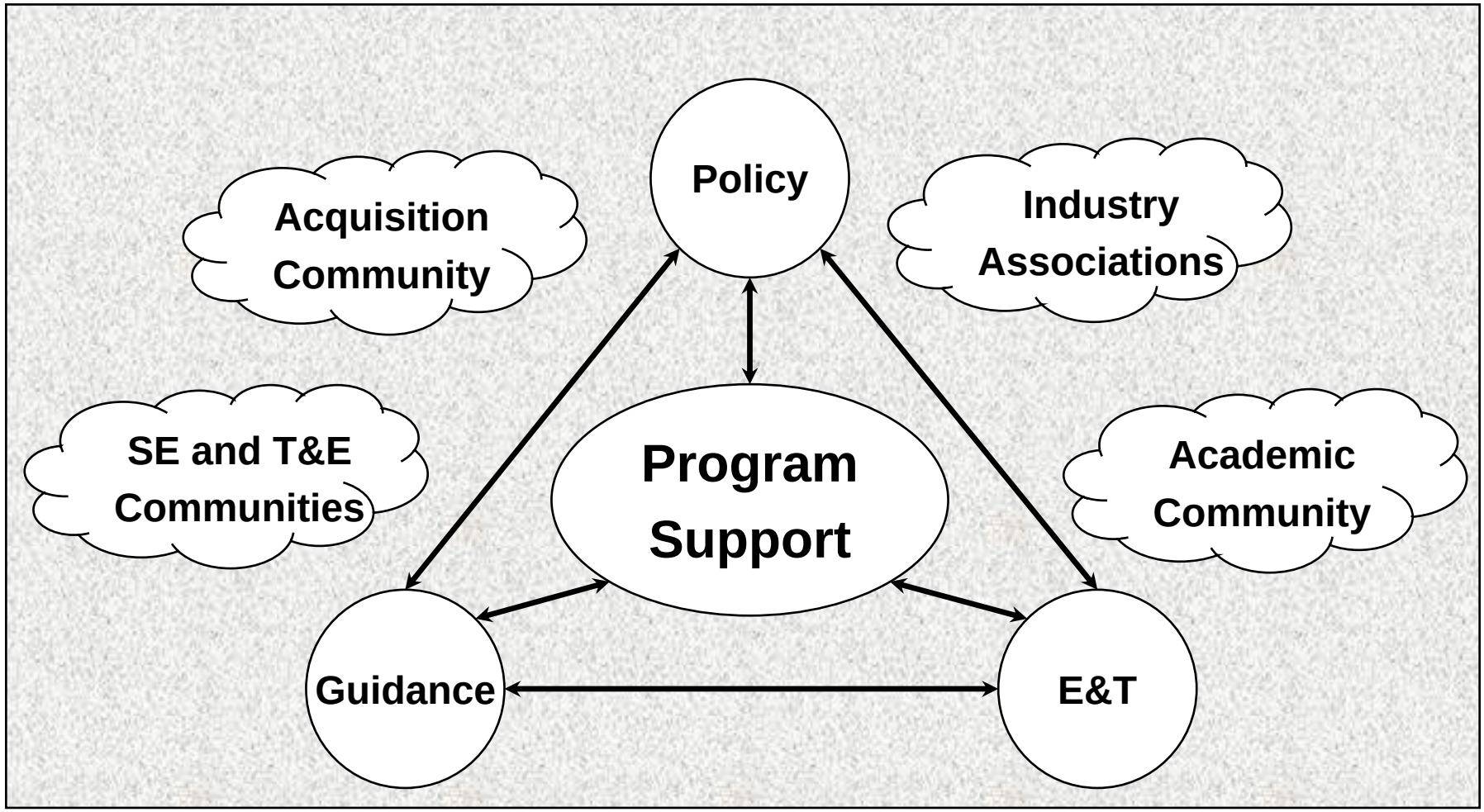
- Support Acquisition Success
  - Ensure effective and efficient software solutions across the acquisition spectrum of systems, SoS and capability portfolios
- Improve the State-of-the-Practice of Software Engineering
  - Advocate and lead software initiatives to improve the state-of-the-practices through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

Be a World-Class Leader in Software Engineering

Update:

DoD SE Revitalization

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
- DoDD 5000.2 Update
  - Reflect “fact-of-life” policy changes

Systems Engineering Guidance

- Published Defense Acquisition Guidebook
- Published DoD Guide for Achieving Reliability, Availability, and Maintainability
- Published Integrated Master Plan and Integrated Master Schedule Preparation and Use Guide
- Published Systems Engineering Plan Preparation Guide
- Published Risk Management Guide for DoD Acquisition
- Upcoming:
  - Update Defense Acquisition Guidebook
  - Publish Contracting for SE Guide

Systems Engineering
Education, Training, & Outreach

- Updating formal training across key career fields:
  SE, Acquisition Program Management, Contract Management, Finance, Logistics
  - New introductory course SYS101 now online
  - new intermediate course SYS202 online next week, classroom SYS203 available Oct 07
  - New advanced SYS302 course available Jan 07
- Developing continuous learning, on-line courses:
  - Available: 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 systems engineers
  - New SPRDE 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, AFIT/CSE

Driving Technical Rigor Back Into Programs
"Program Support Reviews"

- Program Support Reviews provide insight into a program's technical execution focusing on:
  - SE as envisioned in program's technical planning
  - T&E as captured in verification and validation strategy
  - Risk management—integrated, effective and resourced
  - 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"

- Systems and Software Engineering was 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

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

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

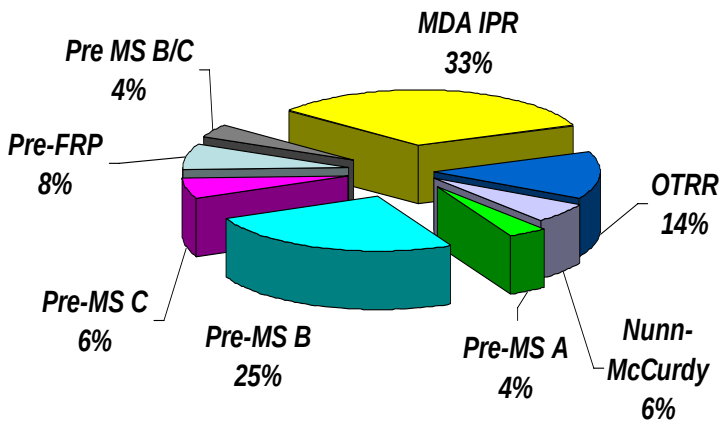
State of Systems Engineering:

What we are seeing in programs

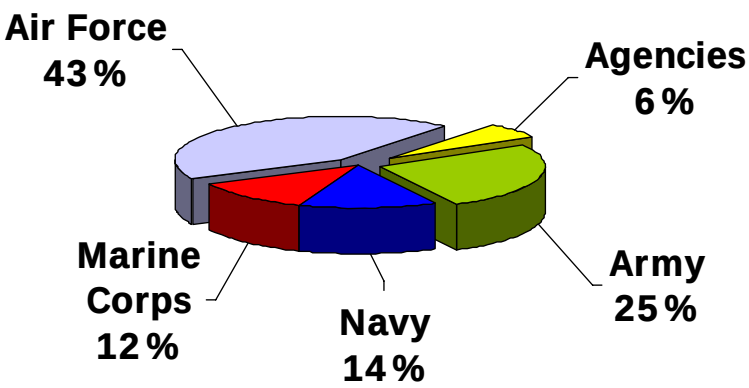
Program Support Review (PSR) Activity (since March 2004)

- 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

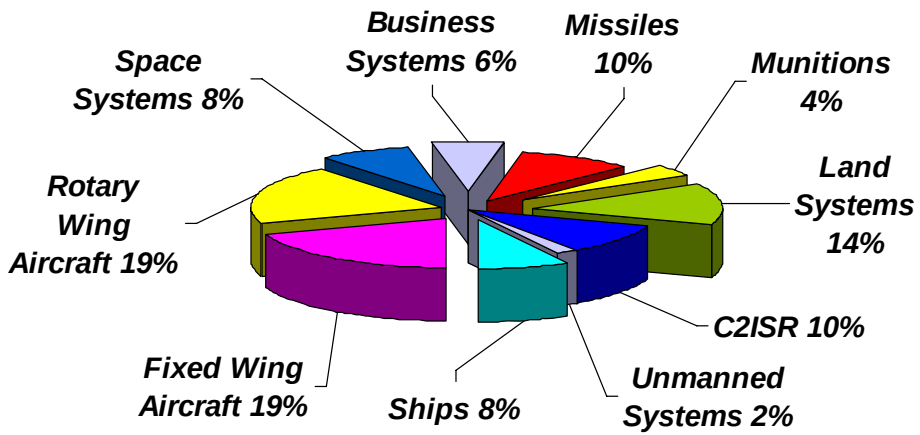
Decision Support Reviews



Service-Managed Acquisitions



Programs by Domain Area



Program Support Reviews
Representative Issues

- Mission Capabilities
  - Requirements—reasonable, measurable, complete
- Resources/Management
  - Schedule adequacy—success-oriented vice event-driven; schedule realism
  - Risk management—inadequate or not linked to technical effort
- Technical Process
  - Systems Engineering Planning—inadequate technical planning
  - Test & Evaluation—insufficient tests or test articles
- Technical Product
  - Reliability—insufficient reliability growth program
  - Supportability/Maintainability—timing of validation

Program Support Reviews
Representative Reliability Issues

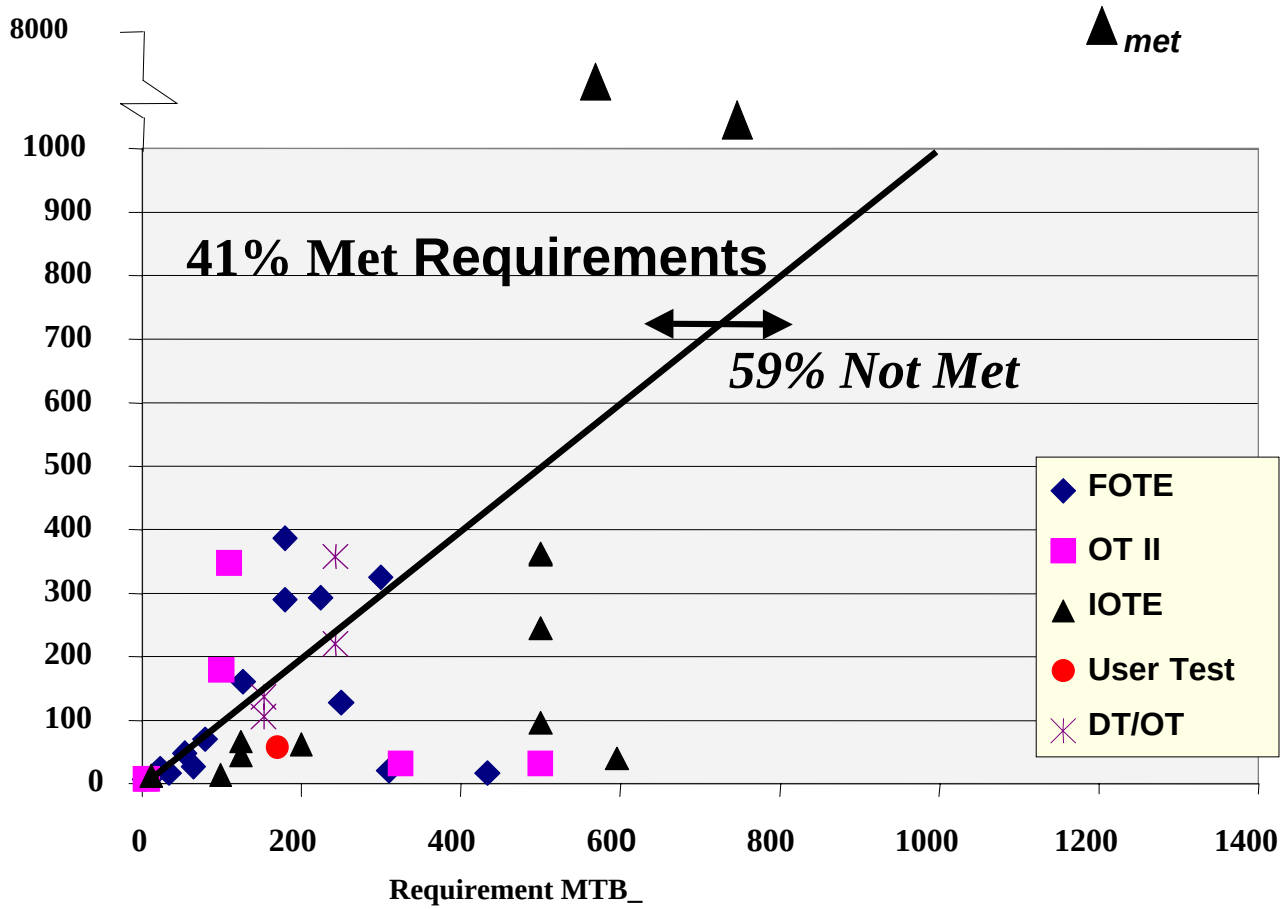
➢ Poor Requirements in ORD/CDD

- Arbitrary values for Reliability Availability Maintainability (RAM) requirements
- In some programs, failure to identify mission context or intended use profile etc.
- Failure to identify when reliability values are required (reliability and availability maturation points)
- Failure to model to ensure harmony between reliability, availability, maintainability, and supportability characteristics
- Failure to appreciate stochastic character of RAM and hence suitably consider statistical confidence issues

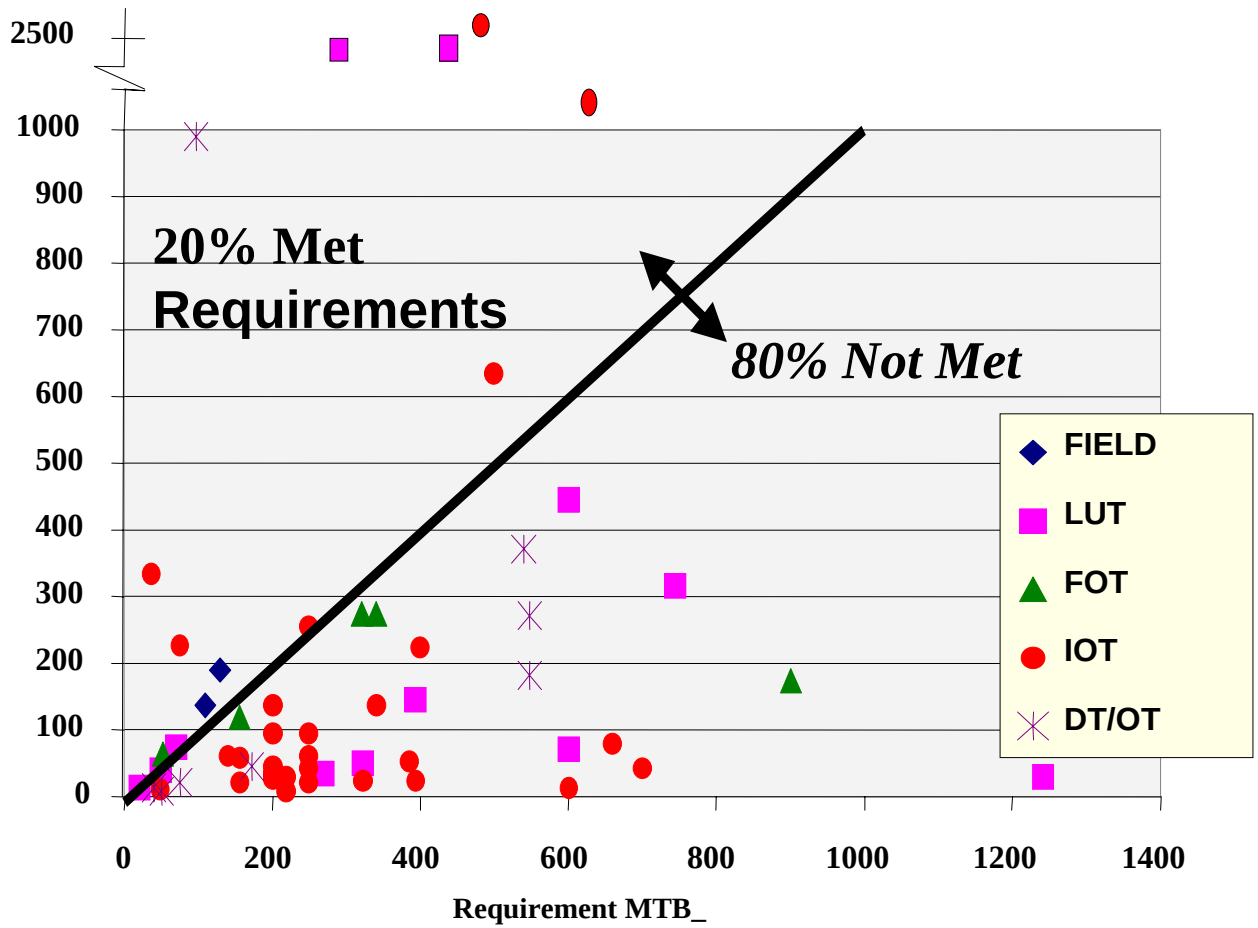
Program Support Reviews
Representative Reliability Issues

- Reliability Growth Program
  - Underestimating difficulty and resources to achieve and sustain reliability growth
  - Lack of proper planning, managing, and executing reliability growth activities
  - Program test design incompatible with reliability growth program aspects
  - Reliability growth program not funded throughout
  - Failure to consider correct use conditions/environment for reliability test
- Reliability Program
  - In some programs, failure to design in reliability up front
  - Inadequate quality and timeliness of root cause analysis and corrective actions
- DT vs OT
  - OT evaluators using arbitrary interpretations of failure or system use vs. early buy-in and agreement on the artifacts that illuminate the requirement (e.g. Operational Mode Summary/ Mission Profile and Failure Definition and Scoring Criteria)
  - Immaturity of scoring conference and process prior to real use

Reliability Trends
1985-1990



Reliability Trends
1996-2000

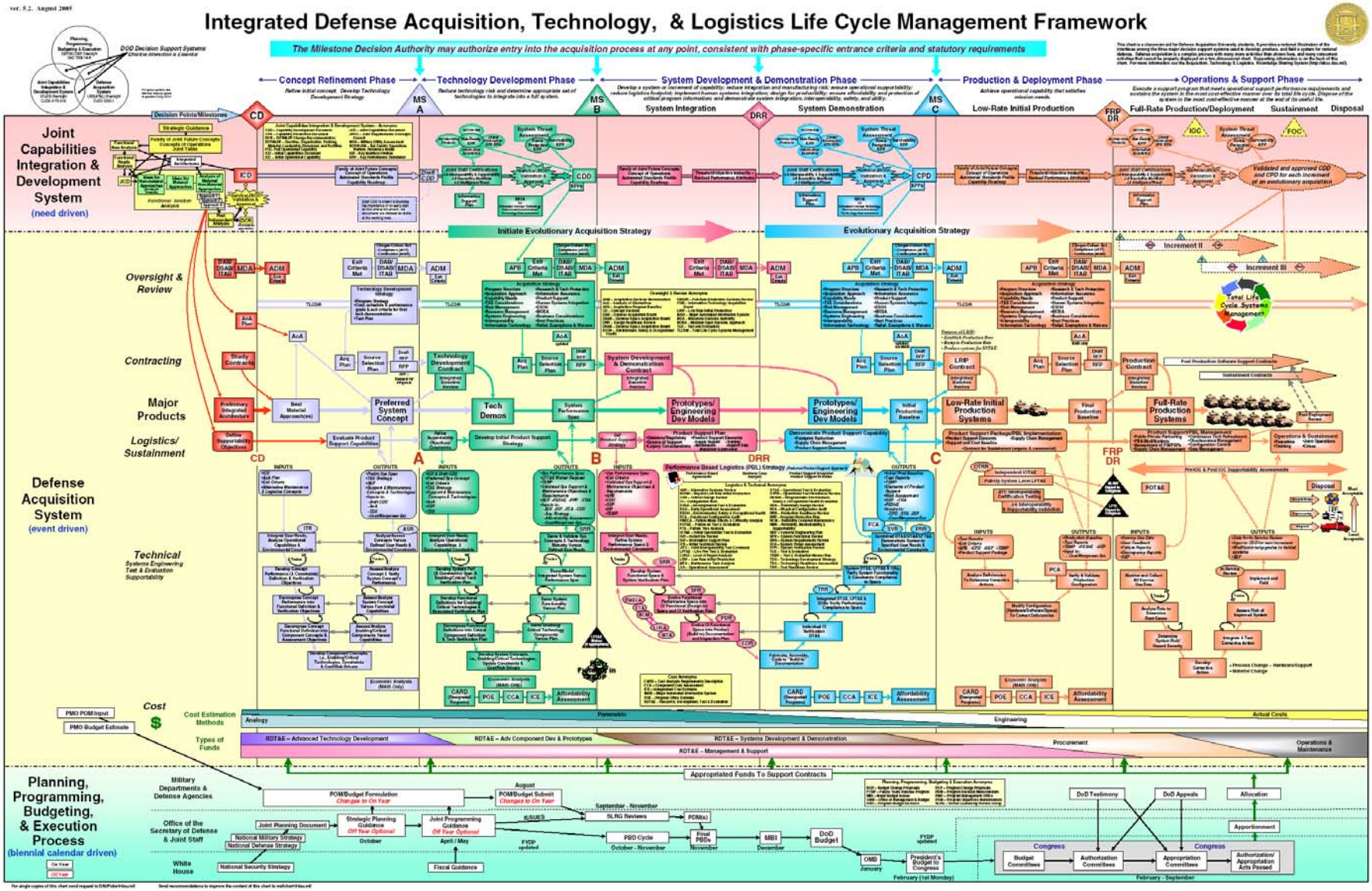


DoD Guide for Achieving Reliability, Availability, and Maintainability

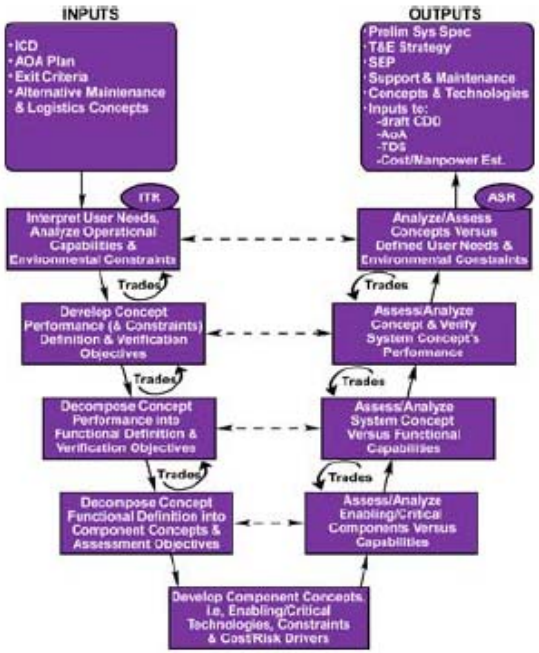
- Defines model for improving RAM management and technical processes
  - Integrates RAM model with other processes
  - Reflects DoD / Industry / Academia best practices
  - Front end of Guide detail appropriate for sr managers
  - Remainder of Guide intended for RAM practitioners
- Focuses on what can be done as part of SE process to:
  - *Achieve* satisfactory levels of RAM
  - *Successfully demonstrate* RAM levels during test and evaluation
  - *Sustain* RAM levels throughout system's life cycle

http://www.acq.osd.mil/ds/se/ed/publications.htm

SE in the System Life Cycle

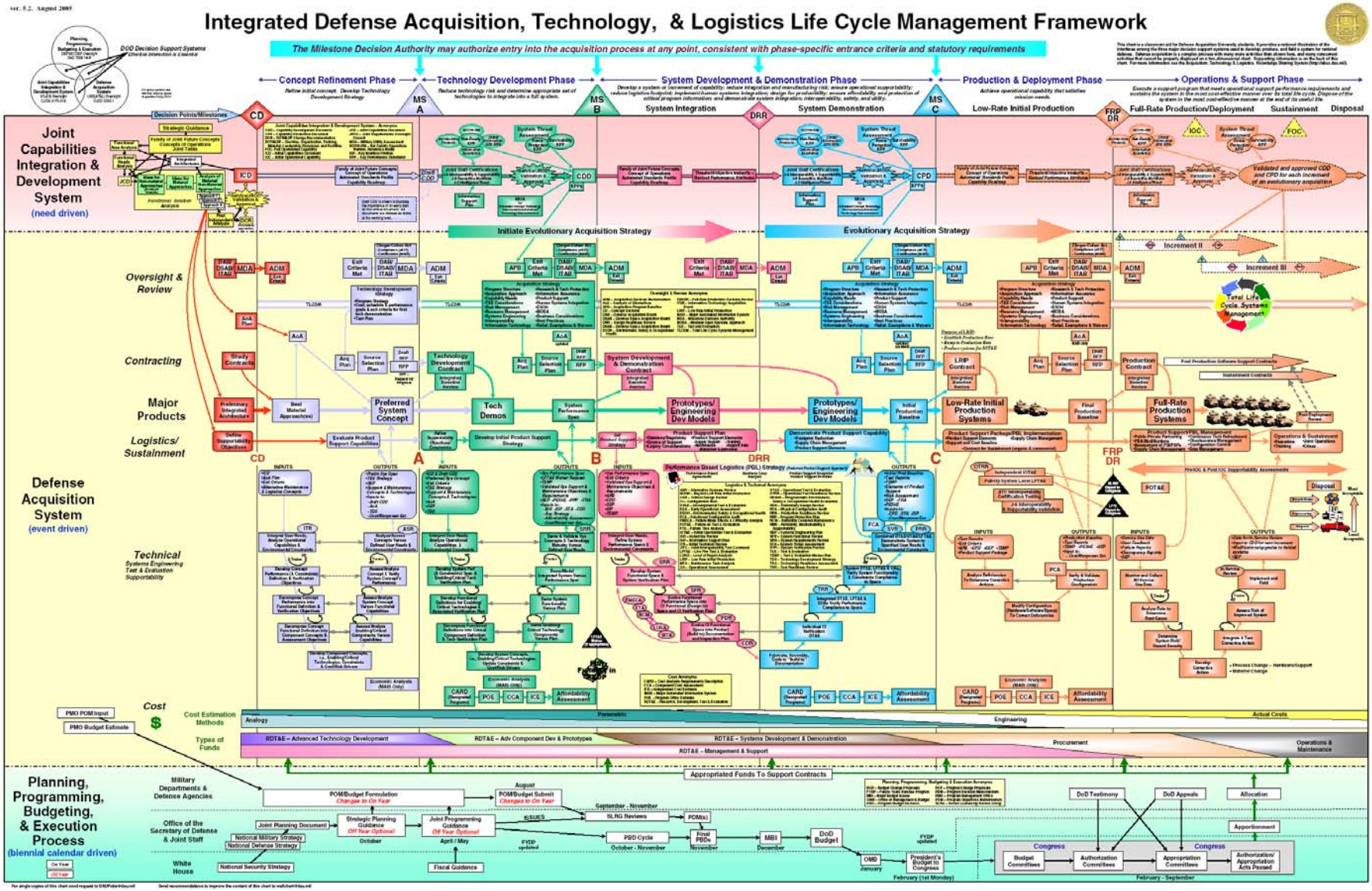


Concept Refinement



Inputs	Outputs
ICD	Prelim Sys Spec
AoA Plan	T&E Strategy
Exit Criteria	SEP
Alternative MX & Logistics Concepts	Support & MX Concepts & Technologies
	Inputs to: draft CDD, AoA, TDS, Cost/Manpower Est.

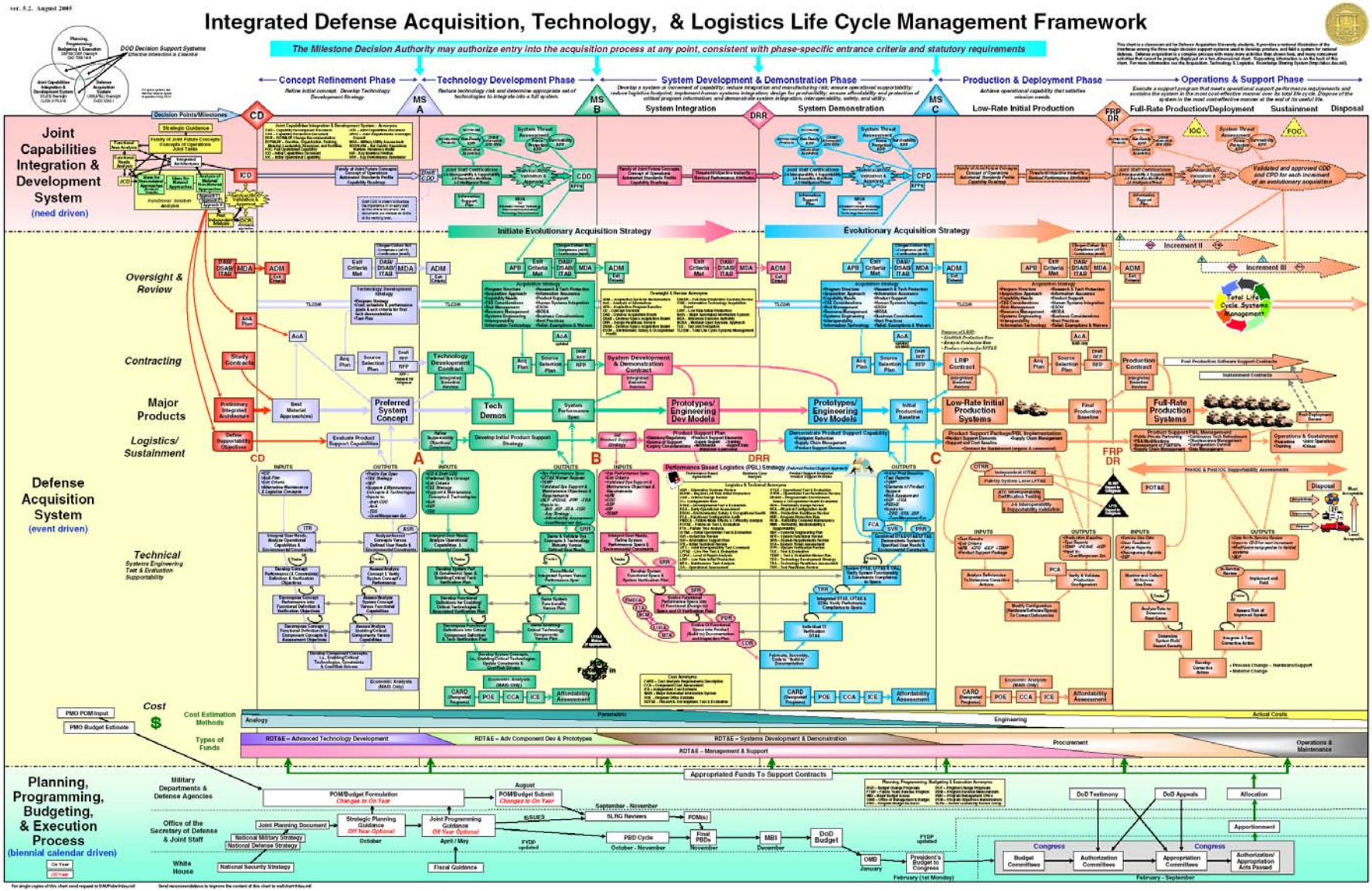
SE in the System Life Cycle



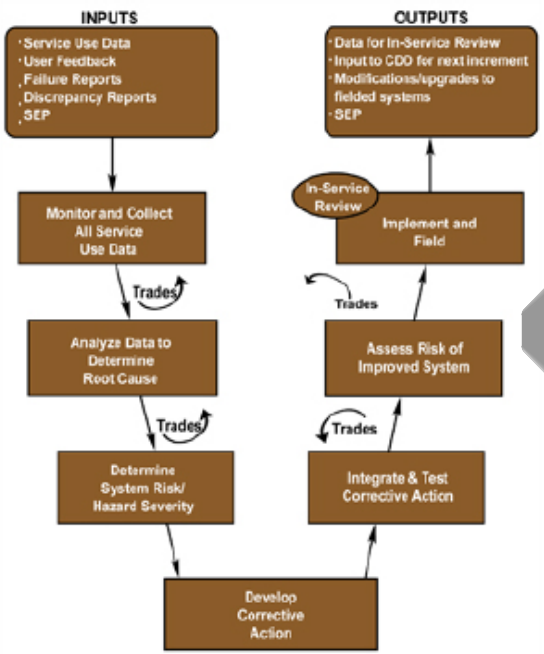
Technology Development

Inputs	Outputs
ICD & Draft CDD	Sys Performance Spec
Preferred Sys Concept	LFT&E Waiver Request
Exit Criteria	TEMP
T&E Strategy	Valiated Sys Support & MX Objectives & Rqmts
Support & MX Concepts & Technologies	SEP PESHE
AoA	PPP
SEP	TRA
TDS	Inputs to: IBR, ISP, STA, CDD, Acq Strategy, Affordability Assessment, Cost/Manpower Est

SE in the System Life Cycle



Operations and Support



Inputs	Outputs
Service Use Data	Data for In-Service Review
User Feedback	Input to CDD for next increment
Failure Reports	Modifications/upgrades to fielded systems
Discrepancy Reports	SEP
SEP	

Approved Sustainment KPP and Mandatory KSAs

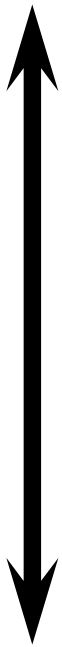
- Single KPP:
  - Materiel Availability: measures percentage of the entire population capable of performing an identified mission

    Requires both system design and sustainment approach to be addressed: Reliability, Maintainability, Service Life, Sustainment Strategy, Preventative Maintenance, Diagnostics, Supply Chain, Distribution, Transportation
- Mandatory KSAs:
  - Materiel Reliability: measures confidence an operational, ready end item will successfully complete its mission without a critical failure when tasked
  - Ownership Cost: measures what it costs to sustain a system after it is placed in service
- Goals:
  - Correct number of operational end items capable of performing the mission when needed
  - Confidence systems will perform the mission and return home safely without failure
  - Cost balance: solutions cannot result in availability and reliability “at any cost”

Report on the
2006 Quadrennial Defense Review (QDR):
Strategic Acquisition Initiatives

What Are We Trying to Achieve?

STRATEGIC
"Big A"



"Little A"
TACTICAL

OBJECTIVES	INITIATIVES
Affordable, Feasible Investments	➢ Concept Decision / Evaluation of Alternatives / Milestone A ➢ Strategic Sourcing (Services)
Making Decisions that Balance the Trade-Space	Tri-Chair Investment Balance Reviews
Starting Programs Right • Improved, Up-Front Planning • Awareness of Risk / Improved Source Selection • More Responsive Acquisition Solutions	➢ DAB / OIPT Process Optimization ➢ Risk-Based Source Selection ➢ Time-Defined Acquisition ➢ Acquisition of Services Policy ➢ Systems Engineering ➢ Award Fee and Incentives
Program Stability • No Downstream Surprises • Issue Awareness	➢ Restructured DAES ➢ Program Baseline Assurance ➢ Capital Accounts

Improving the Full Range of Acquisition Policy

Improving Strategic & Tactical Acquisition

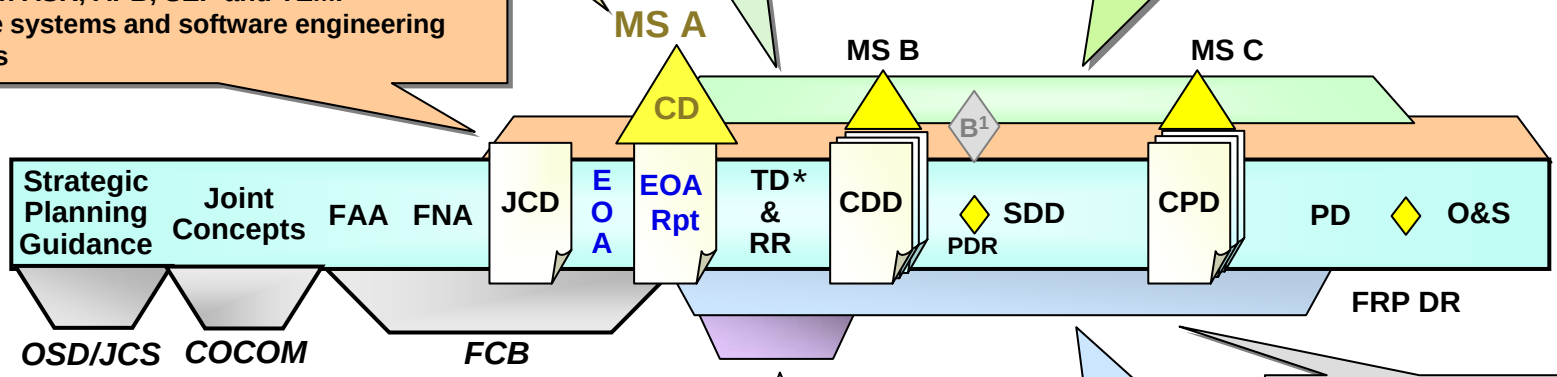
An Evolving and Growing Toolkit

TRI-CHAIR CONCEPT DECISION
- **Improved Process Alignment**
- **Focused on Department Investment Decision Options**

CAPITAL ACCOUNTS
- **Program Funding Stability**

TRI-CHAIR INVESTMENT BALANCE REVIEWS
- **Portfolio Based Review of Capabilities**
- **Convergence of Department Processes to set conditions and/or rebaseline acquisition programs and portfolios**

SYSTEMS AND SOFTWARE ENGINEERING CENTER OF EXCELLENCE
- **Early and continuous technical planning codified in ASR, APB, SEP and TEMP**
- **Adequate systems and software engineering resources**



* Technology Development and Risk Reduction

DAES / OIPT REDESIGN

ACQUISITION OF SERVICES
- **Policy designed to establish and implement a management structure for procurement of contract services**

RISK-BASED SOURCE SELECTION
- **Reducing Risk and Improving Source Selection**

TIME DEFINED ACQUISITION STRATEGY
- **Multiple Customer-Focused Paths to Speed Fielding of Capability**
- **Pre- and Post-Initiation Stability Initiatives**

Striving for Technical Excellence

All programs shall develop a SE Plan (SEP)

Each PEO shall have a lead or chief systems engineer who monitors SE implementation within program portfolio

Event-driven technical reviews with entry criteria and independent subject matter expert participation

OSD shall review program's SEP for major acquisition programs (ACAT ID and IAM)

Technical Planning

Technical Leadership

Technical Execution

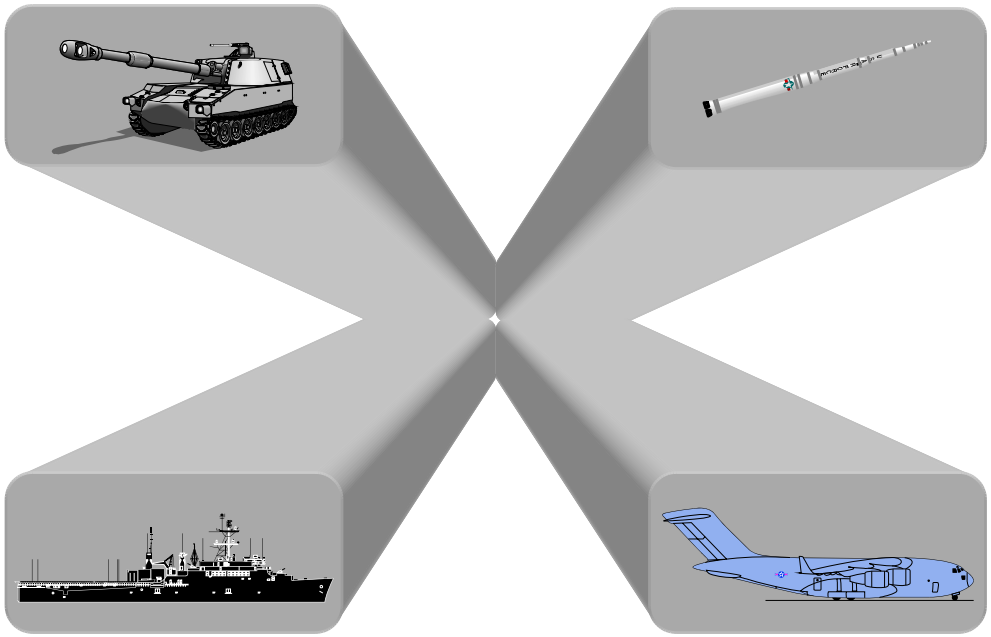
Technical Excellence

Strong technical foundation is the value of systems engineering to the program manager

Systems Supported

~30,000 Combat Vehicles

~900 Strategic Missiles



~280 Ships

~14,000 Aircraft/Helicopters

+ ~ 300,000 Tactical Vehicles
+ Communications/Electronics Equipment
+ Support Equipment
+ Other Systems

National Defense PP&E is valued at ~$700 Billion

Maintained by:

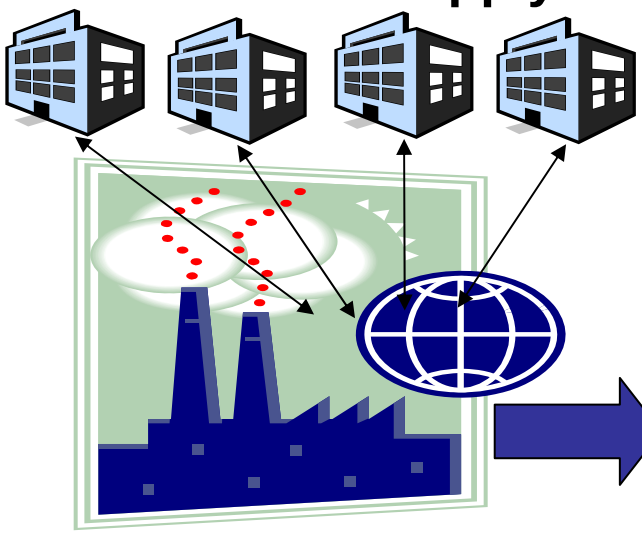
- *659,000 DoD personnel*
- *Private sector companies*

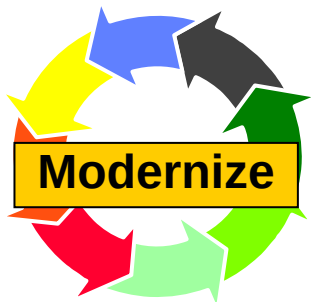
Maintenance cost:
~ $82 billion per year

Source: LMI analysis of DoD data

Materiel Readiness Life Cycle Framework from the Warfighter View

Sources of Supply



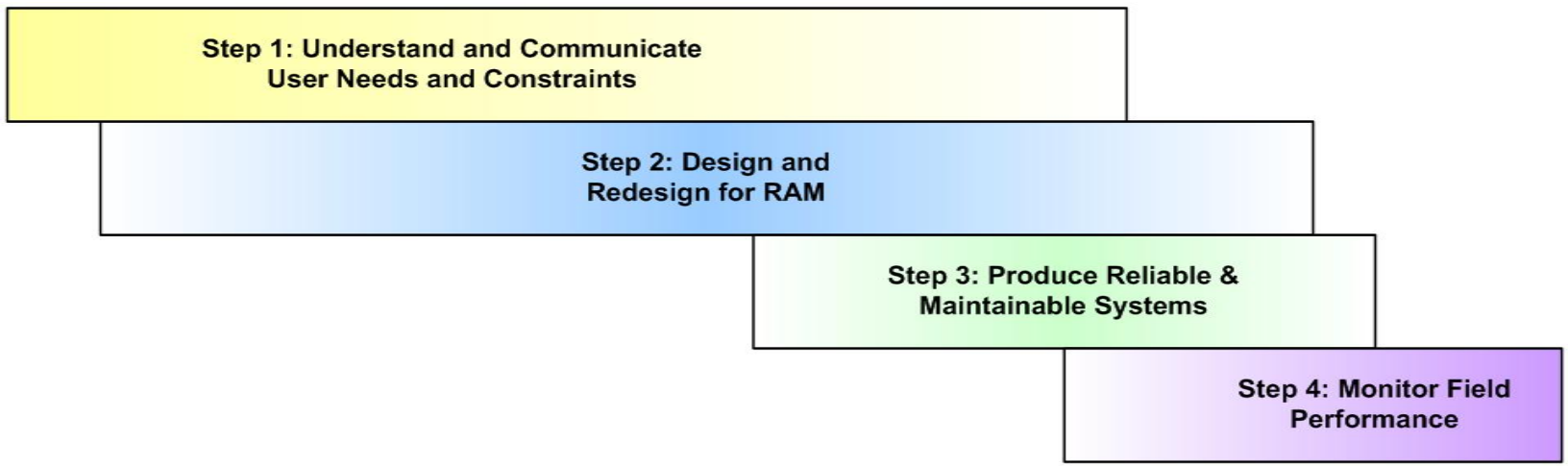


Sustaining the System

- *Ready Available Safe Assets*
- *24/7 Availability*
- Reliability & Maintainability
- Affordable Weapon Systems
- Obsolescence/Tech Refresh
- Reduced Footprint
- Logistics Chain Reliability
- Logistics Chain Effectiveness
- Logistics Chain Cycle Time
- Retrograde Management
- Production Flexibility

Model for Achieving RAM

- Understand and document the User needs and constraints
- Design and redesign for RAM
- Produce reliable, maintainable products
- Monitor field performance

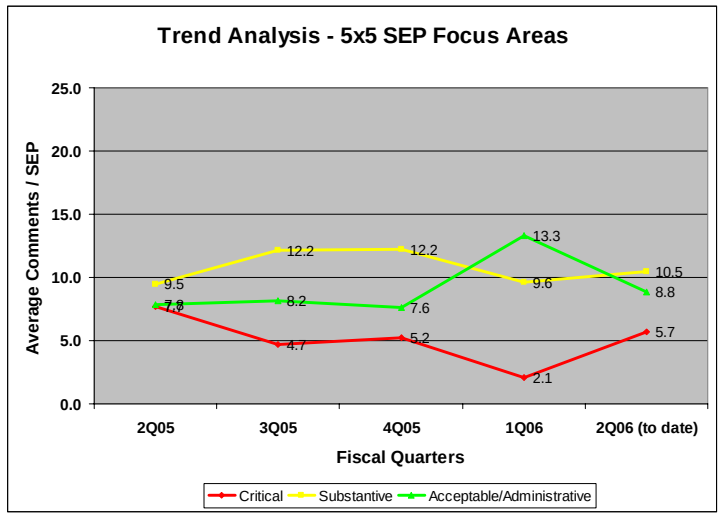


RAM Guide Structure

- Front end of Guide at a level of detail appropriate for senior managers (MDA, PEO, PM, etc.)
  - Chapter 1 → introduces RAM, what it is, why it is important, current problems, activities appropriate to achieving satisfactory levels
  - Chapter 2 → overview of the four-step model, focuses on the management and technical processes
- Remainder of Guide intended for RAM practitioners
  - Chapter 3 → Step 1: Understand and document user needs and constraints
  - Chapter 4 → Step 2: Design and redesign for RAM
  - Chapter 5 → Step 3: Produce reliable and maintainable systems
  - Chapter 6 → Step 4: Monitor field performance and sustain RAM performance
  - Appendices → information on key topic areas related to RAM
    - Proposals and contracts
    - Software Reliability
    - Reliability Growth Management: Planning, Metrics, Tracking, Projection
    - Field Assessment and System Trending

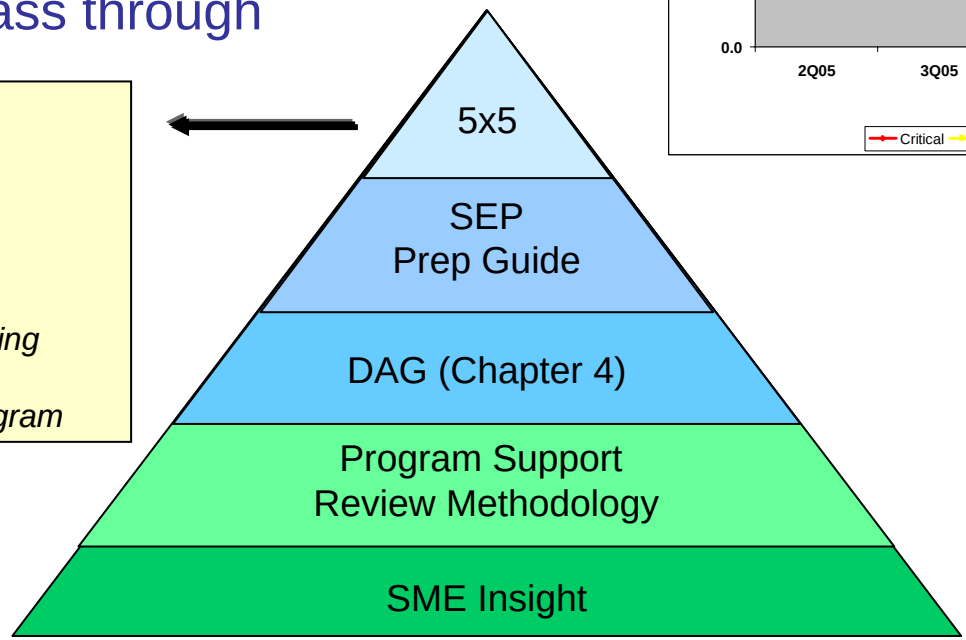
Systems Engineering Plan (SEP) Reviews

- Structured approach with multiple perspectives
- Iterative review process with Program Office; refining SE planning and documentation with each pass through



SEP Review Areas

- *Program Requirements*
- *Technical Staffing and Organization Planning*
- *Technical Baseline Management Planning*
- *Technical Review Planning*
- *Integration w/Overall Management of the Program*

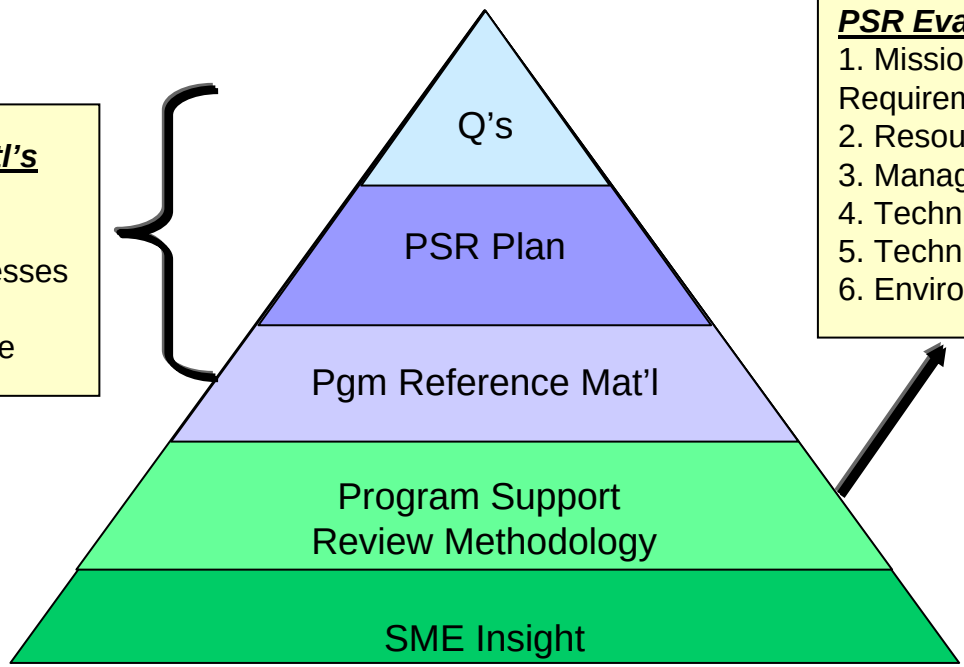


Thorough SE Planning Ensures Fewer "Gotchas" in Program Execution

Program Support Review (PSR)

- Repeatable, tailorable, exportable process
- Trained workforce with in-depth understanding of PMs' program issues

PSR Reference Matl's
- Templates
- Sample Questions
- Documented Processes
- Training Materials
- Execution Guidance



PSR Evaluation Areas
1. Mission Capabilities/ Requirements
2. Resources
3. Management
4. Technical Process
5. Technical Product
6. Environment

"…PSR team serves as 'disinterested 3rd party' that allows [the PM] to approach leadership armed with powerful program truths, reinforce issues." (PM)

PMs Report Process is Insightful, Valuable, and Results Oriented; better than 90% acceptance of recommendations

PSR Representative Issues (1 of 4)

- 1.0 Mission Capabilities/Requirements
  - Reliability requirements lack mission context
  - Lack of growth margins
  - Upgrade programs lack measurable baseline requirements
  - Systems of Systems not well defined; Stovepiped ORDs/CDDs
  - Requirement creep leads to systems engineering churn
  - Difficulty in balancing requirements (e.g., transportability, lethality and survivability requirements)
- 2.0 Resources
  - Small, overworked program offices
  - Plans to evaluate joint interoperability not well defined

PSR Representative Issues (2 of 4)

- 3.0 Management
  - Reluctance to demonstrate key functionality in SDD phase
    - Integration of Mission Equipment Packages onto platforms
  - Success oriented schedules trivialize integration risks
    - COTS poses integration and support challenges
  - Concurrent development and testing schedules
  - Lack of planning for follow-on increments and technical refresh
  - Avoidance of quantifiable Milestone exit criteria
  - PMs not leveraging lessons learned from other programs
  - Lack of overall SoS integrator with authority and resources
    - Poor funding commitment for SoS programs
    - Lack of issue resolution process across program and Service lines
  - Poor communication across IPTs
  - Lack of measures-driven approach to risk management

PSR Representative Issues (3 of 4)

- 4.0 Technical Process
  - Dependence on critical technologies
    - Late Technology Readiness Assessments preclude ITAs
  - Technology Development phase not used properly to mitigate risks
  - Lack of disciplined SE processes and SE reviews, on all programs
    - No “time” to conduct full suite of SE technical reviews
    - Insufficient time between SE technical reviews
  - Limited capability demonstrated by MS C
  - Systems Engineering
    - Lack of disciplined SE process, metrics, missing technical reviews, technology risks not mitigated
  - T&E Planning
    - Success oriented T&E schedules; No time for corrective actions
    - Lack of attention to reliability growth
    - Poor plans to mature suitability during SDD phase
    - Hesitancy to establish exit criteria for test phases
    - Plans to evaluate joint interoperability not well defined

PSR Representative Issues (4 of 4)

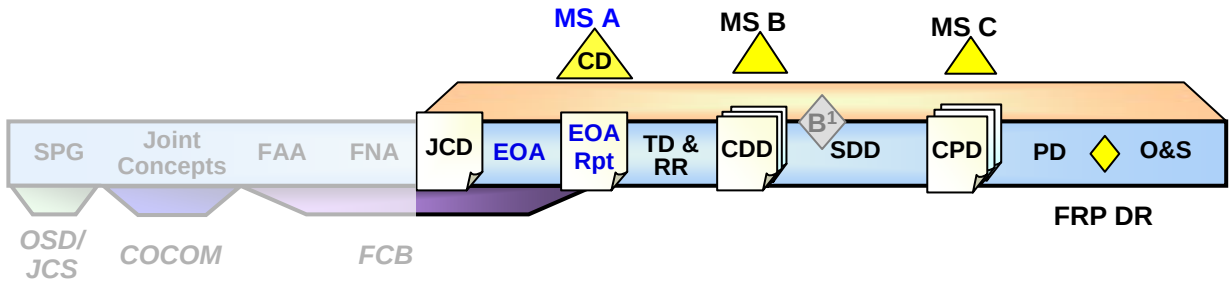
➢ 5.0 Technical Product

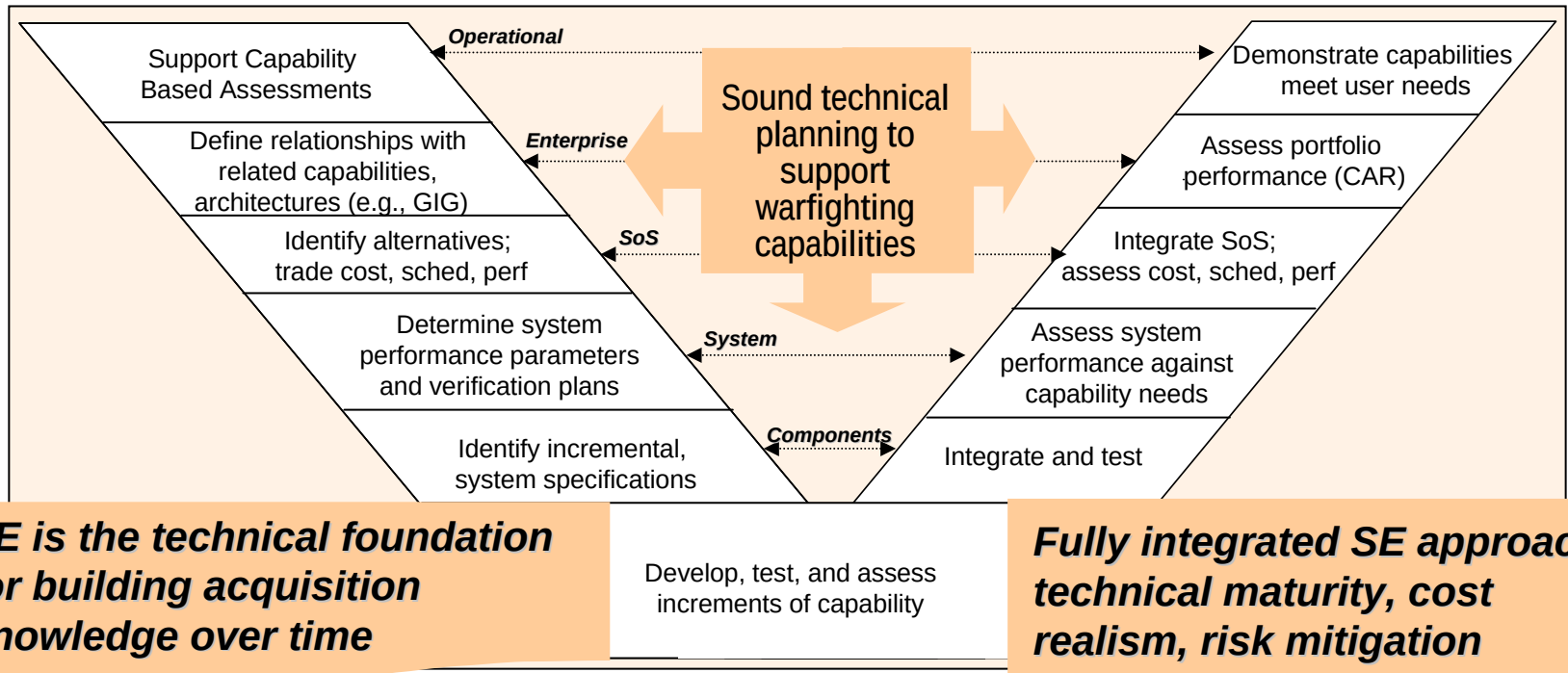
- Production Planning
  - Production Readiness Reviews (PRRs) not always conducted
    - – PRRs at key suppliers not always planned
  - Lack of supplier management plans
  - Movement to improving processes; eliminating waste
- Software
  - Software processes not institutionalized
  - No plans to apply lessons learned into successive builds
  - Systems and spiral software requirements undefined
  - Software reuse strategies are inconsistent across programs
  - Software support plan missing

Reliability Bright Spots

- Good RAM requirements
- Reliability Management Board, with representation from PMO, user representative, operational tester, and prime contractor
- Unity of purpose regarding reliability between PMO and Prime Contractor
- Genuine pursuit of reliability by management of PMO, Prime and Sub-contractors
- Using experienced reliability staff in PMO and Prime
- Well planned approach to RAM
- FMECA undertaken in design phase in a timely manner by design team to identify and remove failure modes from design concepts
- Failure database for failures in DT and OT
- A well funded and supported reliability growth program with active identification and removal of failure modes
- Use of advanced reliability growth models
- Dedicated reliability data collectors
- Provision of early operational testing
- Addressing false alarm rate with multifunctional team in DT
- DT and OT periods commensurate with RAM demonstration requirements

Systems Engineering





SE is the technical foundation for building acquisition knowledge over time

Fully integrated SE approach: technical maturity, cost realism, risk mitigation