8th Annual Systems Engineering Conference
"Focusing on Mission Areas, Net-Centric Operations
and Supportability of Defense Systems"

San Diego, CA

24-27 October 2005

Agenda

Tuesday, 25 October 2005

Open Remarks: by Mr. Bob Rassa, Director, Systems Supportability, Raytheon; Chair, Systems Engineering Division, NDIA
Keynote Address: by Mr. John Landon, Deputy Assistant Secretary of Defense (NII), C3ISR & IT Acquisition

Plenary Session - Revitalization of Systems Engineering Within DoD:

- State of Systems Engineering within DoDs, Mr. Mark D. Schaeffer, Deputy Director, Systems Engineering, OUSD (AT&L)
- USAF Systems Engineering Initiatives, Mr. Terry Jaggers, SAF/AQR (Science & Technology & Engineering)
- System Engineering Re-vitalization within DoN Status, Mr. Carl Siel, ASN(RDA) Chief Engineer
- Army SE Overview, Mr. Douglas K. Wiltsie, Assistant Deputy, Acquisition and Systems Management, Office of the Assistant Secretary of the Army, Acquisition Logistics and Technology
- "Implementation of ESE/A", Mr. Kelly A. Miller, NSA/CSS CSE

Luncheon Keynote Speaker: by Mr. Gregory Shelton, Corporate Vice President, Engineering, Technology, Manufacturing and Quality, Raytheon Company

Tracks 1 & 2 - Systems Engineering Effectiveness:

- Technical Planning for Acquisition Programs: An OSD Perspective, Col Warren Anderson, OUSD (AT&L) Defense Systems
- Implementation of Policy Requiring Systems Engineering Plans for Air Force Programs – Results and Implications, Mr. Kevin Kemper, Air Force Materiel Command
- Systems Engineering Revitalization at SPAWAR Systems Center Charleston, Mr. Michael T. Kutch, Jr., SPAWAR Systems Center
- Systems Engineering for Software Assurance, Ms. Kristen Baldwin, OUSD (AT&L) Defense Systems
- Revitalization of Systems Engineering: Past, Present and Future, Ms. Karen B. Bausman, Air Force Center for Systems Engineering
- Enabling Technology Readiness Assessments (TRAs) with Systems Engineering, Dr. Jay Mandelbaum, Institute for Defense Analyses
- A Taxonomy of Operational Risks, Mr. Brian Gallagher, Software Engineering Institute
- A Method for Reasoning About an Acquisition Strategy, Mr. Joseph Elm, Software Engineerin Institute
- WBS-Based Approach to Understanding and Predicting Program Risk, Bruce M. Heim, DCMA, Boeing Long Beach
- Program Support: Perspectives on Technical Planning and Execution, Mr. Dave Castellano, OUSD (AT&L) Systems Engineering

Track 3 - Test & Evaluation in Systems Engineering:

- Interweaving Test and Evaluation Throughout the Systems Engineering Process - Presentation and Paper, Mr. Josh Tribble, AVW Technologies

Track 4 - Net Centric Operations:

- Net-Centricity & Net-Ready - Beyond Technical Interoperability & C4ISR, Mr. Jack Zavin, ASD(NII), DoD CIO/A&I Directorate
- A Strategy for Managing Development and Certification of Net-Centric Services within the Global Information Grid, Mr. Bernal Allen, DISA, GE 4
- Next Generation Enterprise Information Management Appliances, Mr. Michael Lindow, The MITRE Corp.

Track 5 - Logistics:

- Logistics Transforming: Achieving Knowledge-Enabled Logistics, Mr. Jerry Beck, OSD Office of ADUSD(LPP)
- Condition Based Logistics, Mr. Ron Wagner, CoBaLt Technology
- System Supportability and Life Cycle Product Support: A Systems Perspective, Dinesh Verma, Stevens Institute of Technolog
- The Management of Logistics in Large Scale Inventory Systems to Support Weapon System Maintenance, Mr. Eugene A. Beardslee, SAIC

Track 7 - Systems Safety:

- System Safety in Systems Engineering DAU Continuous Learning Module, Ms. Amanda Zarecky, Booz Allen Hamilton
- Enabling System Safety Through Technical Excellence, Col Warren Anderson, OUSD (AT&L) Defense Systems
- Applying CMMI to System Safety, Mr. Tom Pfitzer, APT Research, Inc.
- System Safety Engineering: An Overview for Engineers and Managers, Mr. Pat L. Clemens, APT Research, Inc.
- Using MIL-STD-882D to Integrate ESOH into SE, Mr. Sherman G. Forbes, USAF - SAF/AQRE

Track 8 - Software Supportability:

- The Proper Specification of Requirements, Mr. Al Florence, The MITRE Corporation
- C-17 Software Development Process, John R. Allen, The Boeing Company 4
- Successful Verification and Validation Based on the CMMI Model, Mr. Tim Olson, Quality Improvement Consultants, Inc.
- "Automated Software Testing Increases Test Quality and Coverage Resulting in Improved Software Reliability.", Mr. Frank Salvatore, High Performance Technologies, Inc.
- Software Supportability: A Software Engineering Perspective, Ms. Stephany Bellomo, SAIC

Wednesday, 26 October 2005

Tracks 1, 2 & 3 - Systems Engineering Effectiveness:

- Decision Analysis and Resolution, Mr Robert Trifiletti, Jr., US Army ARDEC
- Defining System Development Lifecycles to Plan and Manage Projects Effectively, Mr. Bruce A. Boyd, The Boeing Company
- Systems Engineering, Program Management conjoined Disciplines over the Project Life Cycle, Mr. William Lyders, ASSETT, Inc.
- Tailoring USAF Systems Engineering for the Life Cycle: One Shape, Multiple Dimensions, Mr. Jeff Loren, MTC Technologies, Inc. (SAF/AQRE)
- Architecture-Based Systems Engineering and Integration, Dr. Rick Habayeb, Virginia Polytechnic Institute & State University
- A Complementary Approach to Enterprise Systems Engineering, Dr. Brian White, The MITRE Corporation
- Implementing Systems Engineering Processes to Balance Cost and Technical Performance, Dr. Mary Anne Herndon, Transdyne Corporation
- Program Support: Perspectives on Technical Planning and Execution, Mr. Dave Castellano, OUSD (AT&L) Systems Engineering
- Application of Risk Management in a Net-Centric Environment, Ms. Rebecca M. Cowen-Hirsch, DISA
- "Requirements Management Tips and Tricks", Mr. Frank Salvatore, High Performance Technologies, Inc.
- Engineering and Implementing Raytheon Missile Systems Engineering Design to Cost Metric - Presentation and Paper, Mr. Edward Casey, Raytheon Missile Systems
- System Engineering Metrics, Mr. James Miller, Air Foce Materiel Command
- Technical Performance Measures, Mr. Jim Oakes, BAE Systems
- TurboTax® for Systems EngineerinTurboTax® for Systems Engineering, Michael T. Kutch, Jr., SPAWAR
- A Practical Application of A Practical Application of the Non-Advocate Review, Mr. Bruce Nishime, The Boeing Company
- Systems Engineering and the Software Laws of Thermodynamics, Dr. Thomas F. Christian Jr., 402 SMXG
- Unmanned Aerial Vehicle Survivability Influence on System Life Cycle Cost, Mr. Chuck Pedriani, SURVICE Engineering
- Effective SE Metrics Tailored to the Acquisition Life Cycle, Ms. Laura Trioilia, US Army ARDEC
- Innovative Procurement Strategies, Mr. David Eiband, Defense Acquisition University
- Next Generation Combat Systems - An Overview of Key Development Concepts, Mr. Matthew Montoya, The JHU Applied Physics Laboratory Mr. Edward Casey, Raytheon Missile Systems
- Converting High-Level Systems Engineering Policy to a Workable Program, Mr. James Miller, Air Force Materiel Command
- AFRL Systems Engineering Initiative - Risk Managment for Science and Technology, Mr. William Nolte, USAF-AFRL
- System Engineered Research and Development Magement, Dr. Steven Ligon, SAIC
- The Return of Discipline, Ms. Jacqueline Townsend, Air Force Materiel Command

Track 4 - Net Centric Operations:

- Testing Net-Centric Systems of Systems: Applying Lessons Learned from Distributed Simulation, Mr. Doug Flournoy, The MITRE Corp.
- A Multi-Mission Network Centric Warfare Platform, Peder Jungck, CloudSheild Technologies
- Challenges Challenges in Development of System of Systems (SoS) Architectures in a Net Centric Environment, Dr. Abraham Meilich, Lockheed Martin
- Matrix Mapping Tool (MMT), Dr. Judith Dahmann, AT&L/DS MITRE

Track 5 - Logistics:

- Defense Logistics as Chaos Theory, Mr. John Sells, Tobyhanna Army Depot
- Process for Evaluating LogisticProcess for Evaluating Logistics Readiness Levels (LRLs) for Acquisition Systems, Ms. Elizabeth Broadus, Booz Allen Hamilton, Inc.
- The Management of Logistics in Large Scale Inventory Systems to Support Weapon System Maintenance, Mr. Eugene A. Beardslee, SAIC
- System of Systems Analysis of Future Combat Systems Sustainment Requirements, Mr. Ivan W. Wolnek, The Boeing Company
- Readiness & Supportability Program Readiness & Supportability Programs, Mr. Robert M. Cranwell, Sandia National Laboratories (SNL)
- Data Management in a Performance Based Logistics Environment, Denise Duncan, LMI

Track 5 - Best Practices & Standardization:

- CMMI for Services, Mr. Juan Ceva, Raytheon Company
- Out of the Ordinary: Finding Hidden Threats by Analyzing Unusual Behavior, Mr. John Hollywood, RAND

Track 6 - Modeling & Simulation:

- Improving M&S Support to Acquisition: A Progress Report on Development of the Acquisition M&S Master Plan, Mr. Jim Hollenbach, Simulation Strategies, Inc.

- Next Generation Manufacturing Technology Initiative and the Model - Based Enterprise, Mr. Richard Neal - IMTI
- Problem Space Modeling: A Dynamic Future for Requirements Analysis, Mr. Jeffrey O. Grady, JOG System Engineering, Inc.
- Systems Modeling Language Systems Modeling Language (SysML) Overview & Update, Rick Steiner, Raytheon Company
- Data Management Support for Modeling and Simulation, Mr. Denise Duncan, LMI
- Digital Data Management an Update, Ms. Cynthia C. Hauer, Millennium Data Management, Inc.
- The Use of Simulation in the Management of Logistics in Large Scale Inventory Systems to Support Weapon System Maintenance, Mr. Eugene A. Beardslee, SAIC

Track 7 - System Safety:

- Mission Sustainment Through Environment, Safety, and Occupational Health (ESOH) Risk Management, Ms. Trish Huheey, ODUSD (I&E)
- Lessons Learned with the Application of MIL-STD-882D at the Weapon System Explosives Safety Review Board, Ms. Mary Ellen Caro, Ordnance Safety & Security Activity
- Industry Perspectives and Identified Barriers to the Use of MIL-STD-882D for Integrating ESOH Considerations into Systems, Mr. Jon Derickson, BAE Systems
- System Safety in Systems Engineering Process, Dr. Ray C. Terry, SURVICE Engineering Company
- Enabling Army Level Risk Mitigation, Mr. Bill Edmonds, US Army Combat Readiness Center
- Evolution of MIL-STD-882E, Mr. Robert McAllister, US Air Force Materiel Command
- Integrating MIL-STD-882 System Safety Products into the Concurrent Engineering Approach to System Design, Build, Test, and Delivery of Submarine Systems At Electric Boat, Mr. Ricky Milnarik, General Dynamics

Track 8 - Legacy Systems Sustainment:

- Sustaining Software-Intensive Systems - A Conundrum, Ms. Mary Ann Lapham, Carnegie Mellon Software Engineering Institute
- Algorithm Description Documentation and Validation Process, Mr. Mike Bailey, Raytheon Company
- ATSRAC: Background, Results and Future Impact on the Aviation Industry, Mr. Kent V. Hollinger, The MITRE Corp.
- Jammer Integration Roadmap, Mr. Adam McCorkle, GTRI
- Open Systems Architecture (OSA) and Standard Interfaces as Mission Capability Enablers, William H. Mish, Jr., AMSEC
- Naval Air Systems Command Integrated In-Service Reliability Program (IISRP), Mr. Les Wetherington, Integrated In-Service Reliability Program (IISRP)

8th Annual Systems Engineering Conference

"Focusing on Mission Areas, Net-Centric Operations and Supportability of Defense Systems"

Event # 6870

October 24-27, 2005

San Diego, CA

Onsite Program

Sponsored by the National Defense Industrial Association, with Technical Co-Sponsorship by IEEE AES, IEEE Systems Council and INCOSE

Supported by Office of Under Secretary of Defense, Acquisition Technology & Logistics, Defense Systems, Director, Systems Engineering

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

STRENGTH THROUGH INDUSTRY & TECHNOLOGY

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Sunday, October 23, 2005

5:00 PM-7:00 PM Registration for Tutorials and General Conference
(Tutorials are an additional $200 registration fee)

Monday, October 24, 2005

7:00 AM - 5 PM Registration

7 AM Continental Breakfast for Tutorial Attendees ONLY
(Tutorials are an additional $200 registration fee)

8:00 AM - 5 PM Tutorial Tracks (Please refer to following pages for Tutorials Schedule)

12 Noon - 1 PM Buffett Lunch

1:00 PM - 5 PM Tutorial Tracks (Please refer to following pages for Tutorials Schedule)

5:00 PM - 6 PM Reception in Display Area (Open to All Participants)

Tuesday, October 25, 2005

7:00 AM Registration & Continental Breakfast

8:15 AM Introductions
Mr. Sam Campagna, Director, Operations, NDIA

8:30 AM Opening Remarks
Mr. Bob Rassa, Director, Systems Supportability, Raytheon;
Chair, Systems Engineering Division, NDIA

8:40 AM - 9:30 AM Keynote Address
Mr. John Landon, Deputy Assistant Secretary of Defense (NII)
(C3ISR & IT Acquisition)

9:30 AM - 10 AM Break in Display Area

10:00 AM - 12 Noon Plenary Session: Revitalization of Systems Engineering Within DoD
Moderator:
Mr. Mark Schaeffer, Deputy Director, Defense Systems, and Director, Systems Engineering, OUSD (AT&L)
Panelists:
Mr. Terry Jaggers, Director, SAF/AQR (Science, Technology & Engineering)
Mr. Carl Siel, ASN (RDA)CHENG
Mr. Doug Wiltsie, US Army (Invited)
Mr. Kelly Miller, NSA (Invited)

12 Noon - 1:30 PM Luncheon Speaker
Mr. Greg Shelton, Vice President, Engineering Manufacturing Technology & Quality, Raytheon

1:30 PM - 5 PM Concurrent Sessions (Please refer to following pages for session schedule)

5:00 PM - 6:30 PM Reception in Display Area

Monday, October 24, 2005

7:15 AM — Registration & Continental Breakfast

9:45 AM — Break · 12 Noon — Buffet Lunch · 2:45 PM — Break · 5 PM-6 PM — Reception in Display Area

Room	8:00 AM	10:15 AM	1:00 PM	3:15 PM
Regency A	TRACK 1 Tutorial How to Define System Engineering Processes That are Short and Usable Session 1A1 **Mr. Tim Olson, Quality Improvement Consultants, Inc.**	TRACK 1 Tutorial How to Define System Engineering Processes That are Short and Usable (Continued) Session 1B1 **Mr. Tim Olson, Quality Improvement Consultants, Inc.**	TRACK 1 Tutorial Systems Engineering Planning - A Tutorial Session 1C1 **Col Warren Anderson, OUSD (AT&L) Defense Systems**	TRACK 1 Tutorial Systems Engineering Planning - A Tutorial (Continued) Session 1D1 **Col Warren Anderson, OUSD (AT&L) Defense Systems**
Regency B	TRACK 2 Tutorial Integrating Systems Engineering with Earned Value Management Session 1A2 **Mr. Paul Solomon, Northrop Grumman Corp.**	TRACK 2 Tutorial Integrating Systems Engineering with Earned Value Management (Continued) Session 1B2 **Mr. Paul Solomon, Northrop Grumman Corp.**	TRACK 2 Tutorial Using a Measurement Framework to Successfully Achieve Measurable Results Session 1C2 **Mr. Tim Olson, Quality Improvement Consultants**	TRACK 2 Tutorial Using a Measurement Framework to Successfully Achieve Measurable Results (Continued) Session 1D2 **Mr. Tim Olson, Quality Improvement Consultants**
Regency C	TRACK 3 Tutorial Up-To-Date Systems Requirements Tutorial Session 1A3 **Mr. Jeffrey Grady , JOG Systems Engineering, Inc.**	TRACK 3 Tutorial Up-To-Date Systems Requirements Tutorial (Continued) Session 1B3 **Mr. Jeffrey Grady, JOG Systems Engineering, Inc.**	TRACK 3 Tutorial Requirements Development and Management Session 1C3 **Mr. Al Florence, The MITRE Corp.**	TRACK 3 Tutorial Requirements Development and Management (Continued) Session 1D3 **Mr. Al Florence, The MITRE Corp.**
Mission A	TRACK 4 Tutorial Exploring the System Solution Space using Behavior Analysis and Simulation: Applying M&S to System Engineering Session 1A4 **Mr. James Long, Vitech Corp.**	TRACK 4 Tutorial Exploring the System Solution Space using Behavior Analysis and Simulation: Applying M&S to System Engineering (Continued) Session 1B4 **Mr. James Long, Vitech Corp.**	TRACK 4 Tutorial Air Force Integrated Collaborative Environment (AF-ICE) - An Air Force and Industry Partner overview and update Session 1C4 **Mr. Rick Peters, Air Force Material Command**	TRACK 4 Tutorial Air Force Integrated Collaborative Environment (AF-ICE) - An Air Force and Industry Partner overview and update (Continued) Session 1D4 **Mr. Rick Peters, Air Force Material Command**
Mission B	TRACK 5 Tutorial Systems/Software/Hardware Quality Assurance Session 1A5 **Mr. Al Florence, The MITRE Corp.**	TRACK 5 Tutorial Systems/Software/Hardware Quality Assurance (Continued) Session 1B5 **Mr. Al Florence , The MITRE Corp.**	TRACK 5 Tutorial The Return on Investment from Software Engineering Best Practices: An Introduction Session 1C5 **Mr. Thomas McGibbon, ITT Industries**	TRACK 5 Tutorial The Return on Investment from Software Engineering Best Practices: An Introduction Session 1D5 **Mr. Thomas McGibbon, ITT Industries**
Mission C	TRACK 6 Tutorial Innovative Design for Six Sigma (DFSS) Approaches to Test and Evaluation: A Hands-On Experience Session 1A6 **Dr. Mark Kiemele, Air Academy Associates**	TRACK 6 Tutorial Innovative Design for Six Sigma (DFSS) Approaches to Test and Evaluation: A Hands-On Experience (Continued) Session 1B6 **Dr. Mark Kiemele , Air Academy Associates**	TRACK 6 Tutorial What Makes A Simulation Credible? Cost-Effective VV&A in the Systems Engineering Process Session 1C6 **Mr. David Hall, SURVICE Engineering Company**	TRACK 6 Tutorial What Makes A Simulation Credible? Cost-Effective VV&A in the Systems Engineering Process (Continued) Session 1D6 **Mr. David Hall, SURVICE Engineering Company**
Garden A	TRACK 7 Tutorial Object Oriented Systems Engineering Methodology (OOSEM) Session 1A7 **Dr. Abraham Meilich, Lockheed Martin**	TRACK 7 Tutorial Object Oriented Systems Engineering Methodology (OOSEM)(Continued) Session 1B7 **Dr. Abraham Meilich, Lockheed Martin**	TRACK 7 Tutorial Object Oriented Systems Engineering Methodology (OOSEM)(Continued) Session 1C7 **Dr. Abraham Meilich, Lockheed Martin**	TRACK 7 Tutorial Object Oriented Systems Engineering Methodology (OOSEM)(Continued) Session 1D7 **Dr. Abraham Meilich, Lockheed Martin**
Garden F	TRACK 8 Tutorial TBA Session 1A8	TRACK 8 Tutorial TBA Session 1B8	TRACK 8 Tutorial Performability (Performance and Reliability) Modeling Session 1C8 **Dr. Meng-Lai Yin, Raytheon**	TRACK 8 Tutorial Performability (Performance and Reliability) Modeling Session 1D8 **Dr. Meng-Lai Yin, Raytheon**

Tuesday, October 25, 2005

1:30 PM

Regency A	TRACK 1 Systems Engineering Effectiveness	Session 2C1	The Return of Discipline **Dr. Yvette Weber, HQ AFMC, USAF**	Technical Planning for Acquisition Programs: An OSD Perspective **Col Warren Anderson, OUSD (AT&L) Defense Systems**
Regency B	TRACK 2 Systems Engineering Effectiveness	Session 2C2	Technology Readiness Assessments: A Key Aspect of the Systems Engineering Process **Dr. Jay Mandelbaum, Institute for Defense Analyses**	Taxonomy of Operational Risks **Mr. Brian Gallagher, Software Engineering Institute**
Regency C	TRACK 3 Test & Evaluation in Systems Engineering	Session 2C3	Applying the Systems Engineering Approach to the Test and Evaluation Process **Mr. Raymond Beach, NAVAIR**	Intelligent Data Analysis Options to Support Aircraft/Ship Systems Testing **Mr. Dean Carico, Naval Air Warfare Center**
Mission A	TRACK 4 Net Centric Operations	Session 2C4	Guiding DoD's move into the Information Age **Mr. Jack Zavin, ASD(NII)/DoD CIO**	Challenges in Development of System of Systems (SoS) Architectures in a Net Centric Environment **Dr. Abraham Meilich, Lockheed Martin**
Mission B	TRACK 5 Logistics	Session 2C5	Intro to Logistics & Supportability **Mr. Jerry Beck, OSD Office of ADUSD(L&MR)**	Condition Based Logistics **Mr. Ron Wagner, CoBaLt Technology**
Mission C	TRACK 6 Integrated Diagnostics	Session 2C6	Intro to Integrated Diagnostics **Mr. Dennis Hecht, The Boeing Company**	Diagnostic Software - What your average developer doesn't know **Mr. Theodore Marz, Carnegie Mellon University - Software Engineering**
Garden A	TRACK 7 Systems Safety	Session 2C7	System Safety in Systems Engineering DAU Continuous Learning Module Overview **Ms. Amanda Zarecky, Booz Allen Hamilton**	System Safety in the Systems Engineering Process **Dr. Ray Terry, SURVICE Engineering Company**
Garden F	TRACK 8 Software Supportability	Session 2C8	Proper Specification of Software Requirements **Mr. Al Florence, The MITRE Corporation**	C-17 Software Development Process **Mr. Hafez Lorseyedi, The Boeing Company**

3:00 PM

Break in Display Area

3:30 PM

Regency A	TRACK 1 Systems Engineering Effectiveness	Session 2D1	Implementation of Policy Requiring Systems Engineering Plans for Air Force Programs – Results and Implications **Mr. Kevin Kemper, US Air Force**	Systems Engineering Revitalization at SPAWAR Systems Center Charleston **Mr. Michael Kutch, Jr., SPAWAR Systems Center**	Engineering for Software Assurance **Ms. Kristen Baldwin, OUSD(AT&L)**
Regency B	TRACK 2 Systems Engineering Effectiveness	Session 2D2	A Method for Reasoning About an Acquisition Strategy **Mr. Joseph Elm, Software Engineering Institute**	WBS Based Risk Assessment **Mr. Bruce Heim, (DCMA) Boeing Long Beach**	
Regency C	TRACK 3 Test & Evaluation in Systems Engineering	Session 2D3	Interweaving Test and Evaluation throughout the Systems Engineering Process **Mr. Joseph Tribble, AVW Technologies**	Recent Innovations in Design for Six Sigma (DFSS) Testing Approaches to Speed Technology to the Marketplace **Dr. Mark Kiemele, Air Academy Associates**	Flight Testing Airborne Radar Systems to Improve System Performance **Mr. Mark London, NAVAIR**
Mission A	TRACK 4 Net Centric Operations	Session 2D4	Real-Time Tactical Services for the GIG **Mr. John Noble, JHU Applied Physics Laboratory**	Next Generation Enterprise Information Management Appliances **Mr. Michael Lindow, The MITRE Corp.**	
Mission B	TRACK 5 Logistics	Session 2D5	FRACAS Implementation using ITLog **Mr. William Jacobs, Raytheon**	Creating a Logistics Health Management System **Mr. Gary O'Neill, Georgia Tech Research Inst.**	
Mission C	TRACK 6 Integrated Diagnostics	Session 2D6	Designing for Health; A Methodology for Integrated Diagnostics/Prognostics **Mr. Larry Butler, Raytheon**	COTS-Based Solution for Integrated Test and Diagnostics **Dr. Ion Neag, TYX Corp.**	
Garden A	TRACK 7 System Safety	Session 2D7	Revitalizing System Safety as One of the Key Elements to Revitalizing Systems Engineering in Department of Defense Acquisition Programs **Col Warren Anderson, OUSD (AT&L) Defense Systems**	Linking System Safety to Systems Engineering **Ms. Paige Ripani, Booz Allen Hamilton**	Integrating MIL-STD-882 **Mr. Rick Milnarik,**
Garden F	TRACK 8 Software Supportability	Session 2D8	Successful Verification and Validation Based on the CMMI Model **Mr. Tim Olson, Quality Improvement Consultants, Inc.**	Automated Software Testing Increases Test Quality and Coverage Resulting in Improved Software Reliability **Mr. Frank Salvatore, High Performance Technologies, Inc.**	Software Supportability: A Software Engineering Perspective **Mrs. Stephany Bellomo, SAIC**

5:30 - 7:00 PM — Reception in Display Area

Wednesday, October 26, 2005

7:15 AM — Registration & Continental Breakfast

		8:15 AM	8:15 AM	10:15 AM	10:15 AM
Regency A	TRACK 1 Systems Engineering Effectiveness Session 3A1	Tailorable Decision Analysis and Resolution process and tools for enterprise wide application ***Mr. Robert Trifiletti, Jr., US Army ARDEC***	Defining System Development Lifecycles to Plan and Manage Projects Effectively ***Mr. Bruce Boyd, The Boeing Company***	System Engineering, Program Management conjoined Disciplines over the Project Life Cycle ***Mr. William Lyders, ASSETT, Inc.***	Tailoring USAF Systems Engineering for the Life Cycle: One Shape, Multiple Dimensions ***Mr. Jeff Loren, MTC Technologies, Inc. (SAF/AQRE)***
Regency B	TRACK 2 Systems Engineering Effectiveness Session 3A2	Application of Risk Management across Engineering and Acquisition ***Ms. Rebecca Cowen-Hirsch, Defense Systems Agency***	Requirements Engineering Tips and Tricks ***Mr. Frank Salvatore, High Performance Technologies, Inc.***	Engineering and Implementing RMS Engineering DTC Metrics ***Mr. Edward Casey, Raytheon Missile Systems***	System Engineering Metrics ***Mr. James Miller, United States Air Force***
Regency C	TRACK 3 Systems Engineering Effectiveness Session 3A3	Effective SE Metrics Tailored to the Acquisition Life Cycle ***Ms. Laura Troiola, US Army - ARDEC***	Innovative Procurement Strategies ***Mr. David Eiband, Defense Acquisition University***	Using Systems Engineering Principles to Transform R & D Into a Military System Solution ***Dr. James Dill, Foster-Miller***	Next Generation Combat Systems - An Overview of Key Development Concepts ***Mr. Matthew Montoya, The JHU Applied Physics Laboratory***
Mission A	TRACK 4 Net Centric Operations Session 3A4	Joint Battle Management Command & Control RoadMap - Panel ***Moderators: Dr. Vitalij Garber, Ms. Robin Quinlan, DUSD (AT&L) DS/SI*** ***Panelists: Maj Gen Charles Simpson, USAF; MG Michael Vane, USA***	Joint Battle Management Command & Control RoadMap - Panel ***Moderators: Dr. Vitalij Garber, Ms. Robin Quinlan, DUSD (AT&L) DS/SI*** ***Panelists: Maj Gen Charles Simpson, USAF; MG Michael Vane, USA***	Network-Centric Capabilities Development for Ground Mobile Forces ***Ms. Diane Hanf, The MITRE Corp.***	Testing Net-Centric Systems of Systems: Applying Lessons Learned from Distributed Simulation ***Mr. R. Douglas Flournoy,***
Mission B	TRACK 5 Logistics Session 3A5	Improving Supportability on Currently Deployed Weapon Systems ***Mr. John Sells, Tobyhanna Army Depot***	Process for Evaluating Logistics Readiness Levels (LRLs) for Acquisition Systems ***Mr. Robert Ernst, NAVAIR***	The Management of Logistics in Large Scale Inventory Systems to Support Weapon System Maintenance ***Mr. Eugene Beardslee, SAIC***	System of Systems Analysis of Future Combat System Sustainment Requirements ***Mr. Ivan Wolnek, The Boeing Company***
Mission C	TRACK 6 Modeling & Simulation Session 3A6	Improving M&S Support to Acquisition ***Mr. James Hollenbach, Simulation Strategies, Inc.***	Improving M&S Support to Acquisition (Continued) ***Mr. James Hollenbach, Simulation Strategies, Inc.***	Next Generation Manufacturing Technology Initiative and the Model-Based Enterprise ***Mr. Richard Neal, IMTI***	Problem Space Modeling ***Mr. Jeffrey O. Grady, JOG Systems Engineering, Inc.***
Garden A	TRACK 7 System Safety Session 3A7	A Model Linking Safety, Threat and Other Critical Causal Factors to Their Mitigators" Relative to (Software, Hardware, and Human System Integration ***Ms. Janet Gill, NAVAIR***	Mission Sustainment Through Acquisition Environment, Safety, and Occupational Health (ESOH) Risk Management ***Ms. Karen Gill, Booz Allen Hamilton***	Army Acquisition Programs' Installations, Environmental, Safety, and Occupational Health Considerations ***Mr. Donald Artis, Jr., Office of the DASA(ESOH)***	Current DoD Acquisition Policies and Guidance on the use of MIL-STD-882D to Integrate Environment, Safety, and Occupational Health (ESOH) Considerations into the Systems Engineering Process ***Mr. Sherman Forbes, USAF - SAF/AQRE***
Garden F	TRACK 8 Software Supportability (8:15 AM) / Legacy Systems Sustainment (10:15 AM) Session 3A8 (8:15 AM) / Session 3B8 (10:15 AM)	Sustaining Software-Intensive Systems – A Conundrum ***Ms. Mary Ann Lapham, SEI***	Algorithm Description Documentation and Validation Process ***Mr. Michael K. Bailey, Raytheon***	The Integration of Systems Engineering and Enterprise Architecture with respect to the Modernization of Legacy Systems - Panel ***Mr. Owen Williams, Science Applications International Corp.***	The Integration of Systems Engineering and Enterprise Architecture with respect to the Modernization of Legacy Systems - Panel (Continued) ***Mr. Owen Williams, Science Applications International Corp.***

10:15 AM sessions: Track 1 – Session 3B1; Track 2 – Session 3B2; Track 3 – Session 3B3; Track 4 – Session 3B4; Track 5 – Session 3B5; Track 6 – Session 3B6; Track 7 – Session 3B7; Track 8 – Session 3B8.

9:45 AM — Break in Display Area

12 Noon — Lunch Speaker: Dr. Dale Uhler, Acquisition Executive, US SOCOM

Wednesday, October 26, 2005

1:30 PM

Regency A	TRACK 1 Systems Engineering Effectiveness Session 3C1	Architecture Based Systems Engineering And Integration **Dr. Rick Habayeb, Virginia Tech**	A Complementary Approach to Enterprise Systems Engineering **Dr. Brian White, The MITRE Corp.**
Regency B	TRACK 2 Systems Engineering Effectiveness Session 3C2	Technical Performance Measures **Mr. Jim Oakes, BAE Systems**	Turbo Tax for Systems Engineering **Mr. Michael Kutch, Jr., SPAWAR**
Regency C	TRACK 3 Systems Engineering Effectiveness Session 3C3	Converting High-Level Systems Engineering Policy to a Workable Program **Mr. James Miller, US Air Force**	Revitalization of Systems Engineering; Past, Present and Future **Ms. Karen Bausman, USAF Center for Systems Engineering**
Mission A	TRACK 4 Net Centric Operations Session 3C4	What is the difference between Multi-Level Security (MLS) and Multiple Secure Levels (MSL) Architectures and why do you care? **Mr. Paul Vazquez, Jr., Raytheon NCS**	A Network Centric Warfare Platform With Multiple Missions in Mind **Mr. Peder Jungck, CloudShield Technologies**
Mission B	TRACK 5 Logistics Session 3C5	Reaping the benefits of PBL/CSL **Ms. Denise Duncan, LMI**	Priming & Tuning the ERP/MRO Engine: Integrated Through-life Supportability Data Management **Mr. Patrick Read, Pennant Canada, Ltd**
Mission C	TRACK 6 Modeling & Simulation Session 3C6	Update on SysML **Mr. Rick Steiner, Raytheon**	Data Management to support M&S **Ms. Denise Duncan, LMI**
Garden A	TRACK 7 System Safety Session 3C7	Lessons Learned with the Application of MIL-STD-882D Within the Navy's Weapon System Explosives Safety Review Board **Ms. Mary Caro, Naval Ordnance Safety & Security Activity**	Industry perspectives and identified barriers to the use of MIL-STD-882D for integrating ESOH considerations into Systems **Mr. Jon Derickson, United Defense**
Garden F	TRACK 8 Legacy Systems Sustainment Session 3C8	The Aging Transport Systems Rulemaking Advisory Committee: Background, Results and Future Impact on the Aviation Industry **Mr. Kent Hollinger, The MITRE Corp.**	Jammer Integration Roadmap **Mr. Adam McCorkle, Georgia Tech Research Institute**

3:00 PM Break in Display Area

3:30 PM

Regency A	TRACK 1 Systems Engineering Effectiveness Session 3D1	Implementing SE Processes to Balance Cost and Technical Performance **Dr. Mary Anne Herndon, SAIC**	A Revolutionary Model to Support Early CAIV Trades and Cost Predictions **Mr. Bryan Piggott, InfoEdge**	
Regency B	TRACK 2 Systems Engineering Effectiveness Session 3D2	A Practical Application of the Non-Advocate Review **Mr. Bruce Nishime, The Boeing Company**	Systems Engineering and the Software Laws of Thermodynamics **Dr. Thomas Christian, Jr., 402 SMXG**	Unmanned Aerial Vehicle Survivability Influence on System Life Cycle Cost **Mr. Charles Pedriani, SURVICE Engineering**
Regency C	TRACK 3 Systems Engineering Effectiveness Session 3D3	AFRL Systems Engineering Initiative – Risk Management for Science and Technology **Mr. William Nolte, USAF-AFRL**	System Engineered Research and Development Management **Dr. Steven Ligon, SAIC**	
Mission A	TRACK 4 Net Centric Operations Session 3D4	Systems Engineering Analysis and Control Methods to Assure Electromagnetic Spectrum Access **Mrs. Renae Carter, DISA Defense Spectrum Office**	A Strategy for Managing the Development and Certification of Net-Centric Services within the Global Information Grid **Mr. Bernal Allen, Defense Systems Agency**	
Mission B	TRACK 5 Best Practices & Standardization Session 3D5	On the Shoulders of CMM: CMMI + COTS + OA + nNIH = less (cost) + more (capability) **Mr. Luke Campbell, NAVAIR**	CMMI for Services **Mr. Juan Ceva, Raytheon RIS**	
Mission C	TRACK 6 Modeling & Simulation Session 3D6	Enterprise Digital Data Management **Ms. Cynthia Hauer, Millennium Data Management, Inc.**	The Use of Simulation in the Management of Logistics in Large Scale Inventory Systems to Support Weapon System Maintenance **Mr. Eugene Beardslee, SAIC**	Ensuring Accomplishment of Performance Based Logistics Objectives Using Model-Based Systems Engineering **Mr. Timothy Tritsch, Vitech Corp.**
Garden A	TRACK 7 System Safety Session 3D7	Comparisons and Contrasts Between ISO 14001, OHSAS 18001, and MIL-STD-882D and their Suitability for the Systems Engineering Process **Mr. Kenneth Dormer, USAF Contractor (SAF/AQRE)**	Evolution of Military Standard 882E **Mr. Jimmy Turner, Raytheon**	USMC Expeditionary Fighting Vehicle (EFV): A Vehicle Designed with Environmental, System Safety, and Occupational Health (ESOH) in Mind **Ms. Sandra Fenwick, USMC DRPM AAA**
Garden F	TRACK 8 Legacy Systems/ Open Systems Session 3D8	NAVAIR Integrated In-Service Reliability Program - Aging Aircraft/Keeping Legacy Systems Viable **Ms. Debbie Vergos, Naval Air Systems Command**	Delivering Effective Solutions in the Age of Open Source Technology **Mr. Edward Beck, Computer Sciences Corp.**	

5:30 PM — Conference Adjounrs for the Day

Thursday, October 27, 2005

7:15 AM — Registration & Continental Breakfast

8:15 AM

Regency A	TRACK 1 Systems Engineering Effectiveness	Session 4A1	A Systems Affordability Approach Using Raytheon Six Sigma Design — ***Ms. Yvette Thornton, Raytheon***	Requirements Engineering Tips and Tricks — ***Mr. Frank Salvatore, HPTI***
Regency B	TRACK 2 Systems Engineering Effectiveness	Session 4A2	Surveying SE Effectiveness — ***Mr. Joseph Elm, Software Engineering Institute***	Integrated Survivability Assessment (ISA) in the Systems Engineering Process — ***Mr. David H. Hall, SURVICE Engineering Company***
Regency C	TRACK 3 Systems Engineering Effectiveness	Session 4A3	10 Golden Questions for Concept Exploration and Development — ***Dr. Dan Surber, Raytheon Technical Services Co.***	The C-17 Systems Engineering Experience — ***Mr. Kenneth Sanger, The Boeing Company***
Mission A	TRACK 4 Net Centric Operations	Session 4A4	Net Centric Test & Evaluation — ***Mr. Ric Harrison, DISA***	Profiling and Testing Procedures for a Net-Centric Data Provider — ***Mr. Derik Pack, Space & Naval Warfare Systems Center - Charleston***
Mission B	TRACK 5 Best Practices & Standardization	Session 4A5	Process Architecture and Criteria for Lessons Learned — ***Mr. Thomas Cowles, Raytheon Space & Airborne Systems***	Successful Strategies To Improve Your Requirements — ***Mr. Tim Olson, Quality Improvement Consultants, Inc.***
Mission C	TRACK 6 Modeling & Simulation	Session 4A6	Application of a State-Machine Model for the Analysis & Optimization of Task-Post-Process-Use [TPPU] and Task, Process, Exploitation and Disseminate [TPED] Processes — ***Mr. Richard Sorensen, Vitech Corp.***	A Heuristics Systems Engineering Approach to Modeling and Analysis of the U.S. Strategic Highway Network (STRAHNET) — ***Mr. Gerard Ibarra, Southern Methodist University***
Garden A	TRACK 7 Education & Training in SE	Session 4A7	Educating Future Systems Engineers: US Military Academy Reception-Day Simulation and Optimization — ***LTC Simon Goerger, Department of Systems Engineering***	
Garden F	TRACK 8 Net Centric Operations	Session 4A8	The Role of the Operator and System Engineer in the Force Modernization Environment — ***Mr. Thomas Nelson, Jacobs Sverdrup***	TBA

9:45 AM — Break in Display Area

10:15 AM

Regency A	TRACK 1 Systems Engineering Effectiveness	Session 4B1	How the Pro-Active Program (Project) Manager uses a Systems Engineer's Trade Study as a Management Tool, and not just a Decision-Making Process — ***Mr. Art Felix, US Navy***	Experience in Supporting Systems Engineering Project Management Using CORE — ***Mr. George Blaine, United Dfense, LP***
Regency B	TRACK 2 Systems Engineering Effectiveness	Session 4B2	A systems approach to Accelerating Testing, a case study — ***Mr. Douglas Chojecki, Stewart & Stevenson, TVSLP***	Applying the Systems Engineering Method to the Joint Capabilities Integration and Development System (JCIDS) — ***Mr. Christopher Ryder, JHU Applied Physics Laboratory***
Regency C	TRACK 3 Systems Engineering Effectiveness	Session 4B3	Performance-Based System Architecture Design in Global Hawk UAV — ***Mr. Deepak Shankar, Mirabilis Design, Inc.***	X-47, Joint Unmanned Air Systems (J-UCAS) Program Update — ***Mr. Rick Ludwig, Northrop Grumman Corp.***
Mission A	TRACK 4 Net Centric Operations	Session 4B4	Joint Integrated BMC4I Systems Research for Upgrading Current and Legacy BMC4I Systems — ***Mr. Billy Bradley, Jr., Raytheon Integrated Defense Systems***	Model Driven Architecture - Lessons Learned in Model Assessments for Large Scale Joint Implementation — ***Ms. Denise Bagnall, Naval Surface Warfare Center***
Mission B	TRACK 5 Best Practices & Standardization	Session 4B5	Mature and Secure: Creating a CMMI and ISO/IEC 21827 Compliant Process Improvement Program — ***Mr. Michele Moss, Booz Allen Hamilton***	Performance-Based Earned Value — ***Mr. Paul Solomon, Northrop Grumman Corp.***
Mission C	TRACK 6 Modeling & Simulation	Session 4B6	Systems Engineering Approach to Research, Analyze, Model and Simulate the Interdependencies of Container Shipping and the United States Critical Infrastructure System-of-Systems — ***Ms. Susan Vandiver, Southern Methodist University***	Using Commercial Simulation Software to Model Linear and Non-Linear Processes: US Military Academy Reception-Day Simulation and Optimization — ***LTC Simon Goerger, Department of Systems Engineering***
Garden A	TRACK 7 Education & Training in SE	Session 4B7	Systems Engineering Professional Development and Certification — ***Mr. Gerard Fisher, The Aerospace Corp.***	Education and Training in Systems Engineering Support Processes — ***Ms. Cynthia Hauer, Millennium Data Management, Inc.***
Garden F	TRACK 8 Net Centric Operations	Session 4B8	JCIP: The JBMC2 Roadmap's SoSE-Based Process for Identifying and Developing Capabilities Improvements — ***Dr. John Hollywood, RAND Corp.***	Matrix Mapping Tool (MMT) — ***Dr. Judith Dahmann, The MITRE Corp.***

12 Noon — Lunch at the Islandia Restaurant

Thursday, October 27, 2005

		1:00 PM		3:00 PM
Regency A	TRACK 1 Systems Engineering Effectiveness Session 4C1	Standard Approach to Trade Studies for the Systems Engineer **Mr. Art Felix, US Navy**	Effective Implementation of Systems Engineering at the Aeronautical Systems Center: A Systems Engineering Tool Set **Mr. Edward Kunay, US Air Force**	Conference Adjourns
Regency B	TRACK 2 Systems Engineering Effectiveness Session 4C2	Systems Engineering to Enable Capabilities-based Acquisition **Ms. Kristen Baldwin, OUSD/(AT&L) DS/Systems Engineering**	Are New Acquisition Programs Taking Longer to Develop/Field and If so Why? **Dr. Dennis Strouble, Air Force Institute of Technology**	
Regency C	TRACK 3 Systems Engineering Effectiveness Session 4C3	A Systems Architectural Model for Man-Packable Intelligence, Surveillance, and Reconnaissance Micro Aerial Vehicles **Maj Joerg Walter, AFIT/SYE**	EW Integration Roadmap **Mr. Byron Coker, Jr., Georgia Tech/GTRI**	
Mission A	TRACK 4 Net Centric Operations Session 4C4	Enabling Net Centric Capability through Secured Integrated Networks of Modular and Open Architectures **Dr. Cyrus Azani, OSJTF/NGC**	Open Systems Architecture & Standard Interfaces as Mission Capability Enablers **Mr. William Mish, Jr., AMSEC**	
Mission B	TRACK 5 Best Practices & Standardization Session 4C5	*TBA*	What CMMI Can Learn From the PMBOK **Mr. Wayne Sherer, US Army ARDEC**	
Mission C	TRACK 6 Modeling & Simulation Session 4C6	MS2 Moorestown Modeling and Simulation (M&S) Support Approach **Mr. David Henry, Lockheed Martin MS2**	Science-Based Modeling and Simulation on DoD High Performance Computers **Dr. Larry Davis, High Performance Computing Modernization Program**	
Garden A	TRACK 7 Education & Training in SE Session 4C7	Training Your Systems Engineering Workforce **Mr. Michael Kutch, Jr., SPAWAR**	Filling the Expertise "Gap" **Mr. John White, US Air Force**	
Garden F	TRACK 8 Net Centric Operations Session 4C8	TBA	TBA	

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Building Proven Reliability: ATK rocket motors represent a national asset, offering an affordable and sustainable way to implement America's new space exploration initiative.

Reaching New Frontiers: AK space systems are vital to reaching new frontiers in space and furthering our knowledge of the universe.
Providing Homeland Security: ATK advanced technologies and law enforcement ammunition are critical to America's efforts to defend our homeland and our citizens.

Expanding Platform Capabilities: ATK advanced weapon systems are expanding the capabilities of today's ships, aircrafts, and ground vehicles - and are preparing the way for the platforms of tomorrow and beyond.
Defending our Nation: ATK ammunition for the U.S. armed forces is playing a key role in the global war on terrorism.

Find out more at www.atk.com.

Moving to a Service Oriented Architecture

Why it's Different

A Strategy for Managing Development and Certification of Net-Centric Services within the Global Information Grid

Bernal Allen
DISA, GE 4
25 Oct 2005

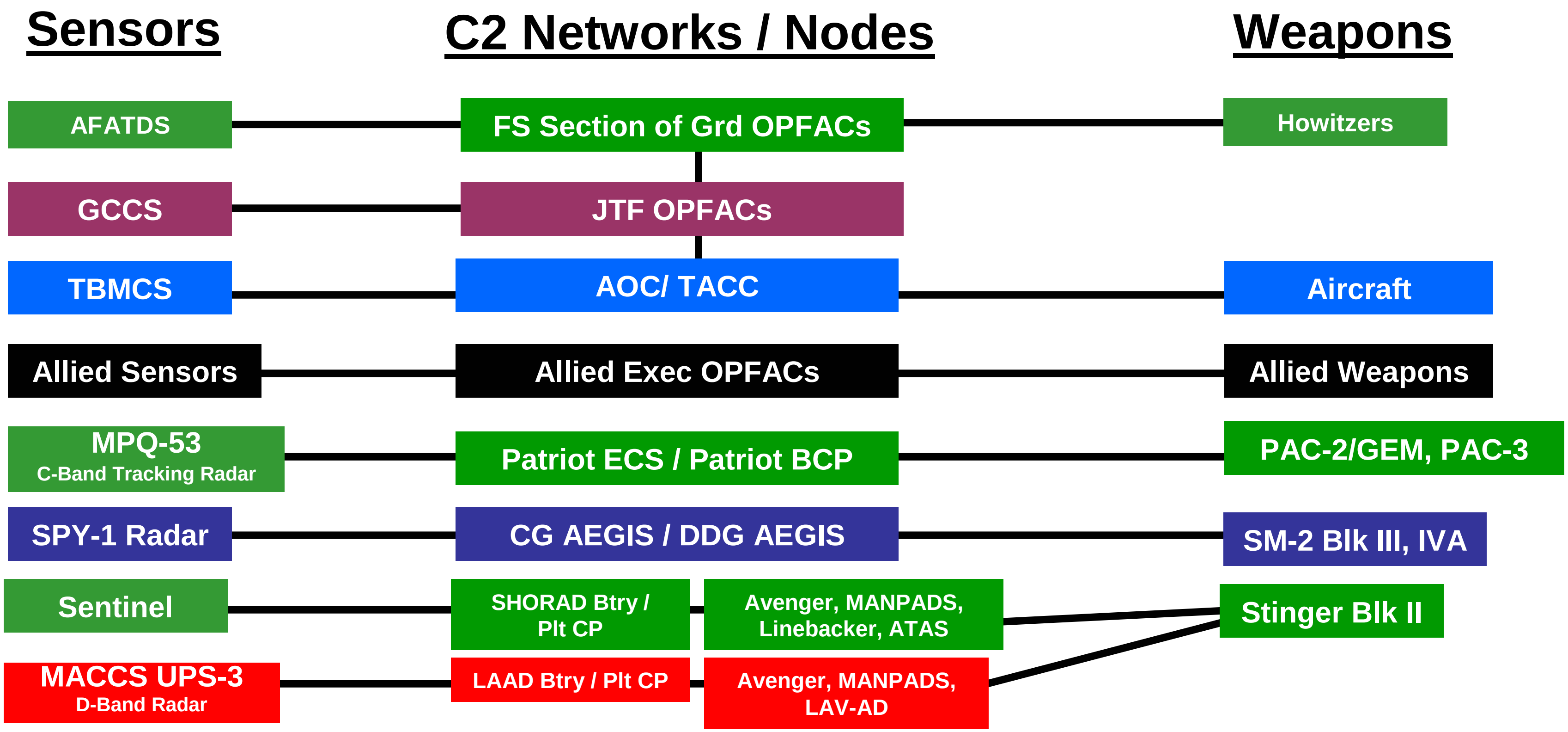
Strategic Planning Guidance

- "(U) Developing Command and Control to Exploit the GIG. **The Department must develop a unified command and control capability that can fuse available information and allow decision makers at all levels to act on this information. To help accomplish this, Components will fund the GCCS Family of Systems programs to deliver C2 capabilities specified in their respective requirements documents. Components will plan to transition GCCS to a joint, net-centric C2 capability.**"

Task # 21: "(U) Transition GCCS to joint, net-centric capability."

C4 Transformation: From System-centric to Web Service-centric Why Change?

Today's C4 is system-centric

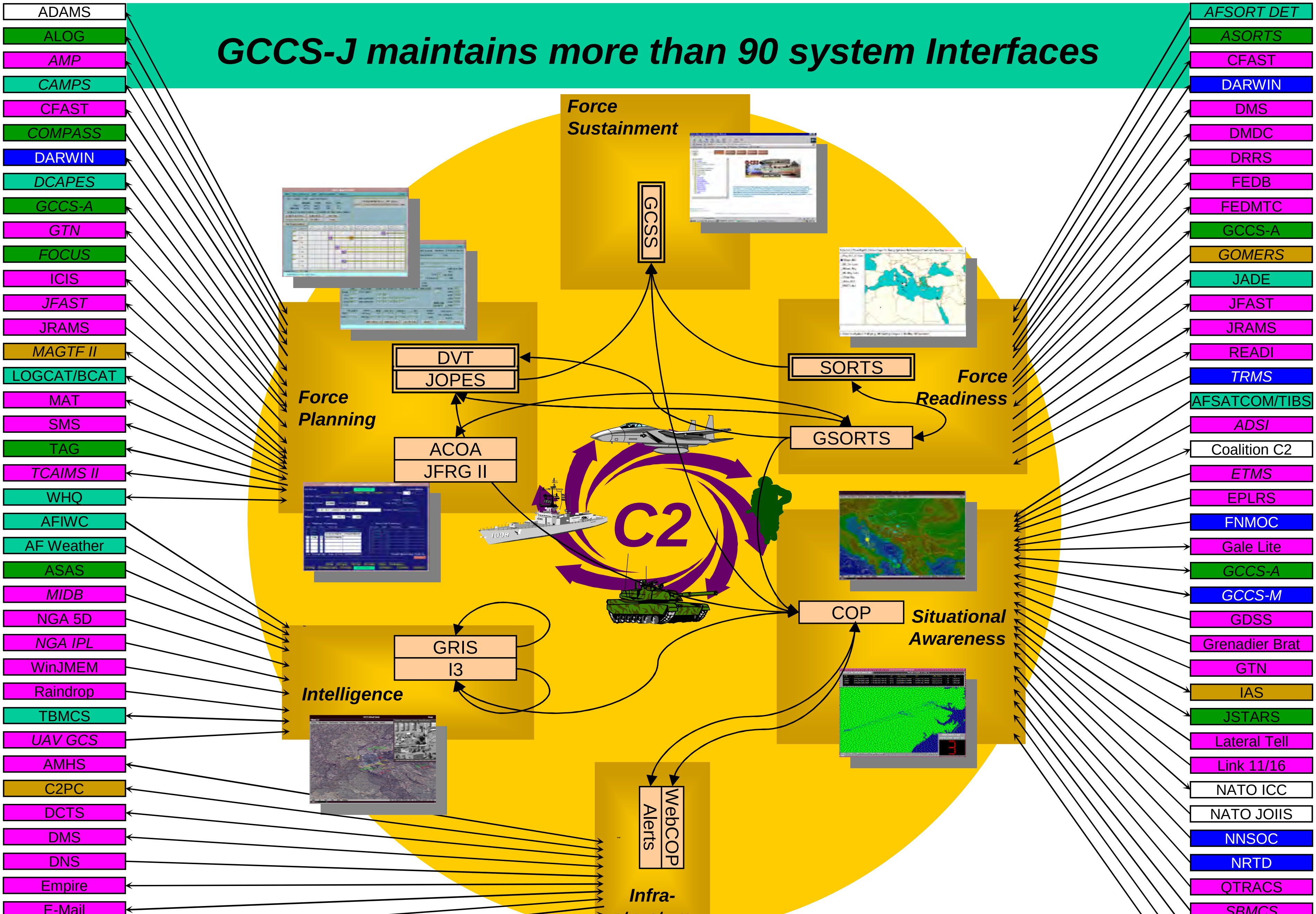


AFATDS – Army Field Artillery Tactical Data System
TBMCS – Theater Battle Management Core System
GCCS – Global Command and Control Systm
CG / DDG – Guided Missile Cruiser / Guided Missile Destroyer
LAAD – Low Altitude Air Defense

LAV-AD – Light Armored Vehicle Air Defense
MACCS – Marine Air Command and Control System
SM-2 – Land Attack Standard Missile
THAAD – Terminal High-Altitude Area Defense

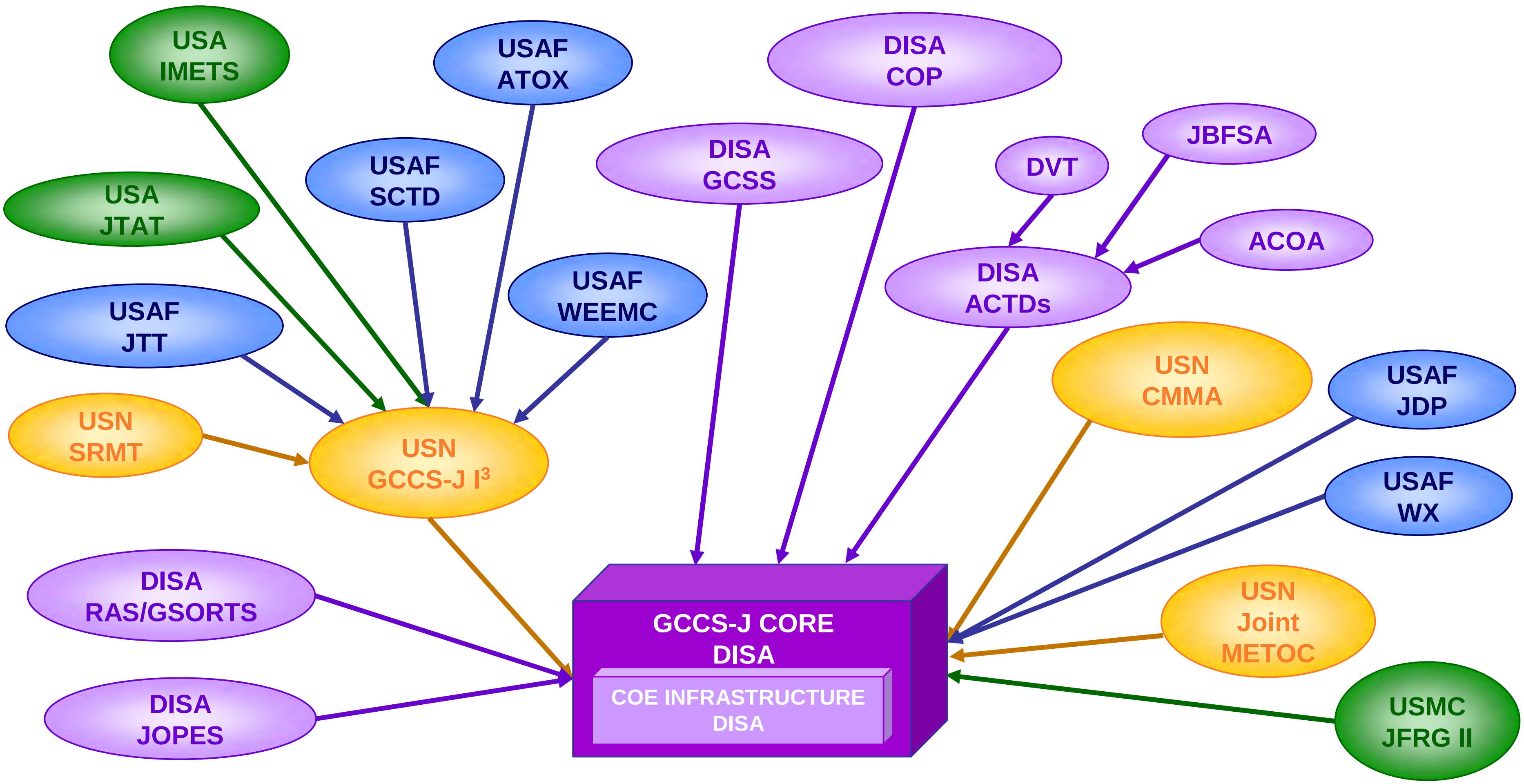
Information is bound to multiple system of systems

GCCS-J maintains more than 90 system Interfaces



Maintaining system of systems technical interfaces

GCCS-J has 23 Executive Agents



Maintaining system of systems program baseline synchronization

Joint Mission Threads are derived from C2 Systems of Systems

Proposed JBMC2 JMT Assessment Schedule

Joint Mission Threads	2005	2006	2007	20	2009	201	1	2012	2013
Joint Close Air Support									
Joint Task Force Command & Control (JTFC2)									
Integrated Air / Missile Defense (IADM)									
Time Sensitive Targeting (TST)									
Joint Ground Maneuver (JGM)									
Integrated Fires (IF)									
Focused Logistics (FL)									

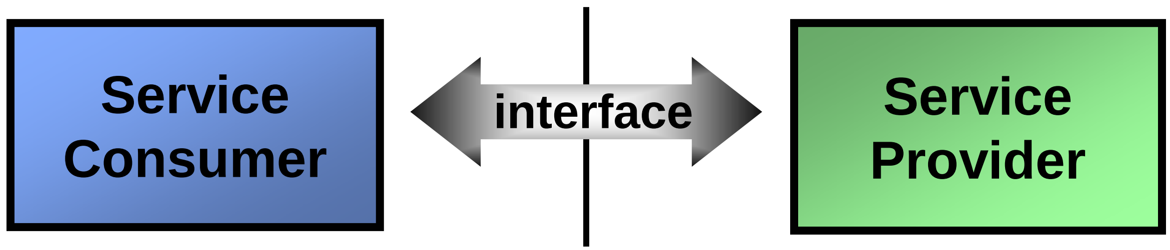
Yesterday's system-based techniques and technologies are too brittle to meet today's demands for cross system integration

System of System integration is a long and complex process

A Service-centric Architecture

Service Oriented Architecture (SOA)

A set of principles that together define an architecture that is loosely coupled and comprised of service providers and service consumers that interact according to a negotiated contract or interface.



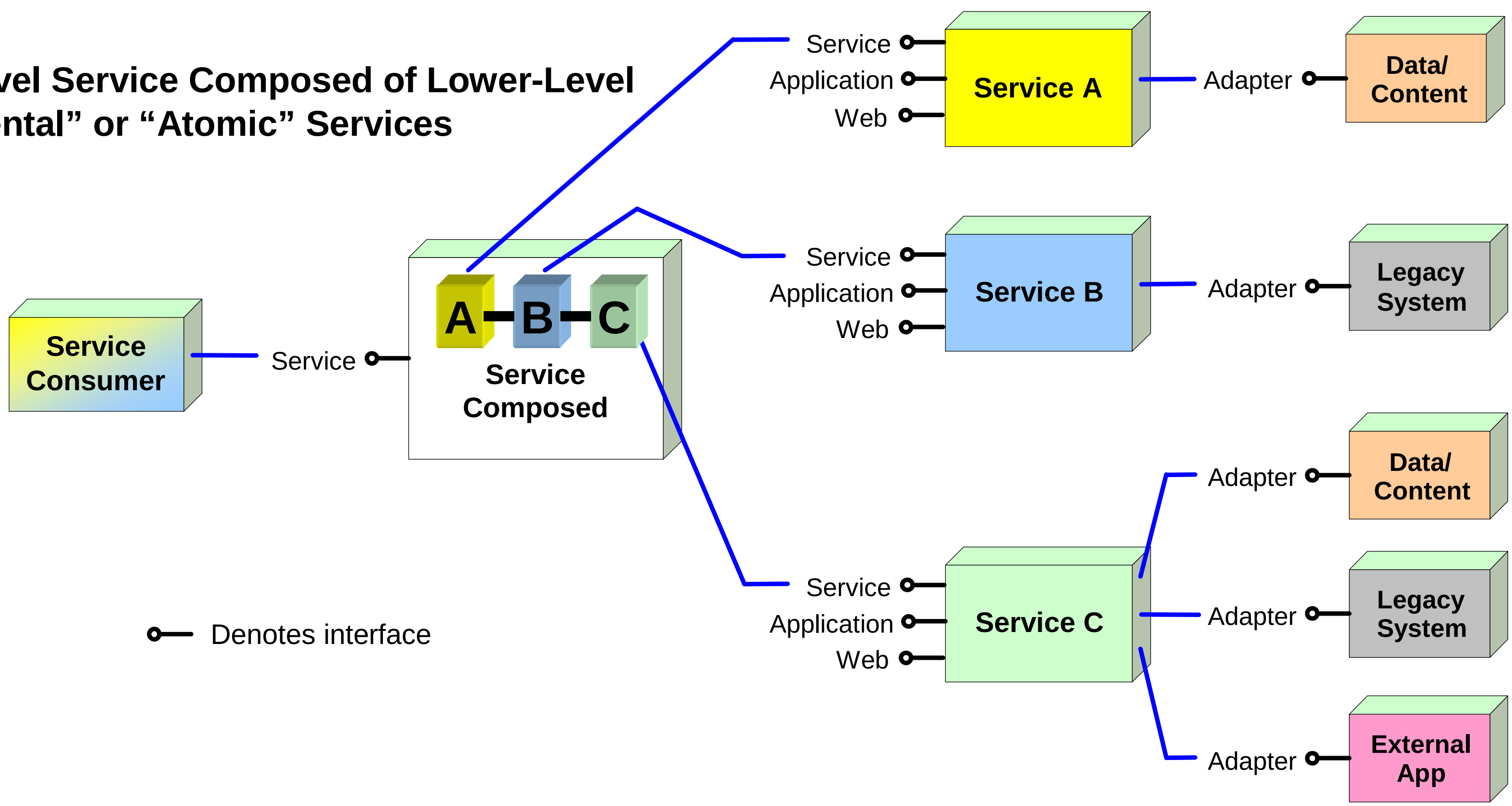
- Can search and find a Service
- Has a need or want that determines context of use
- Not concerned with how service is developed only how it is provided

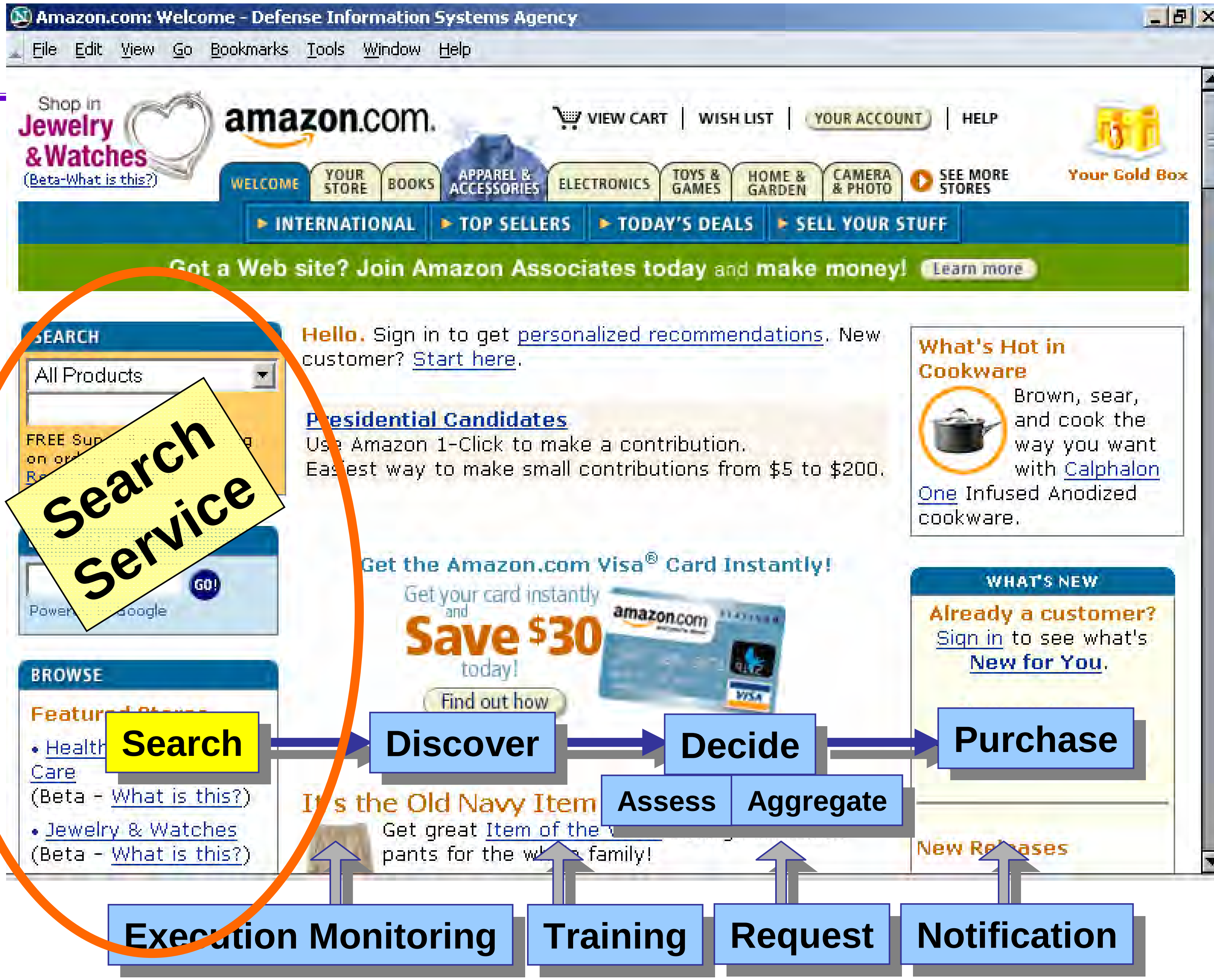
- Can be found in a registry
- Fulfills a need or want
- Abstracts the details of production
- Can be upgraded or replaced transparently

Service Oriented Architecture Provides Composable Services

for Just-in-time Capabilities!

Higher-Level Service Composed of Lower-Level "Fundamental" or "Atomic" Services




Amazon.com: Welcome - Defense Information Systems Agency
File Edit View Go Bookmarks Tools Window Help
Shop in Jewelry & Watches
(Beta-What is this?)
amazon.com.
VIEW CART | WISH LIST | YOUR ACCOUNT | HELP
WELCOME
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ELECTRONICS
TOYS & GAMES
HOME & GARDEN
CAMERA & PHOTO
SEE MORE STORES
Your Gold Box
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TOP SELLERS
TODAY'S DEALS
SELL YOUR STUFF
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Learn more
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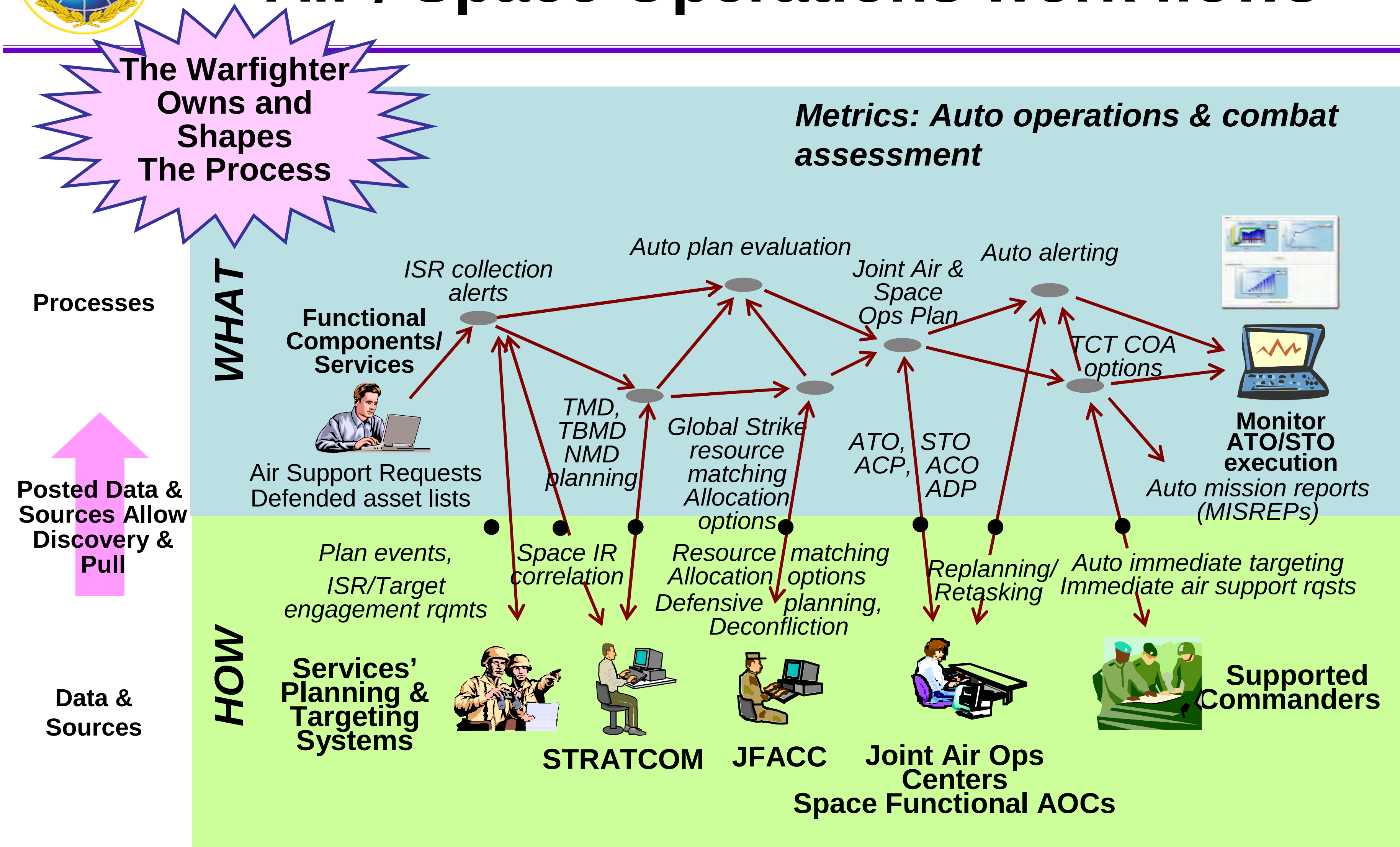
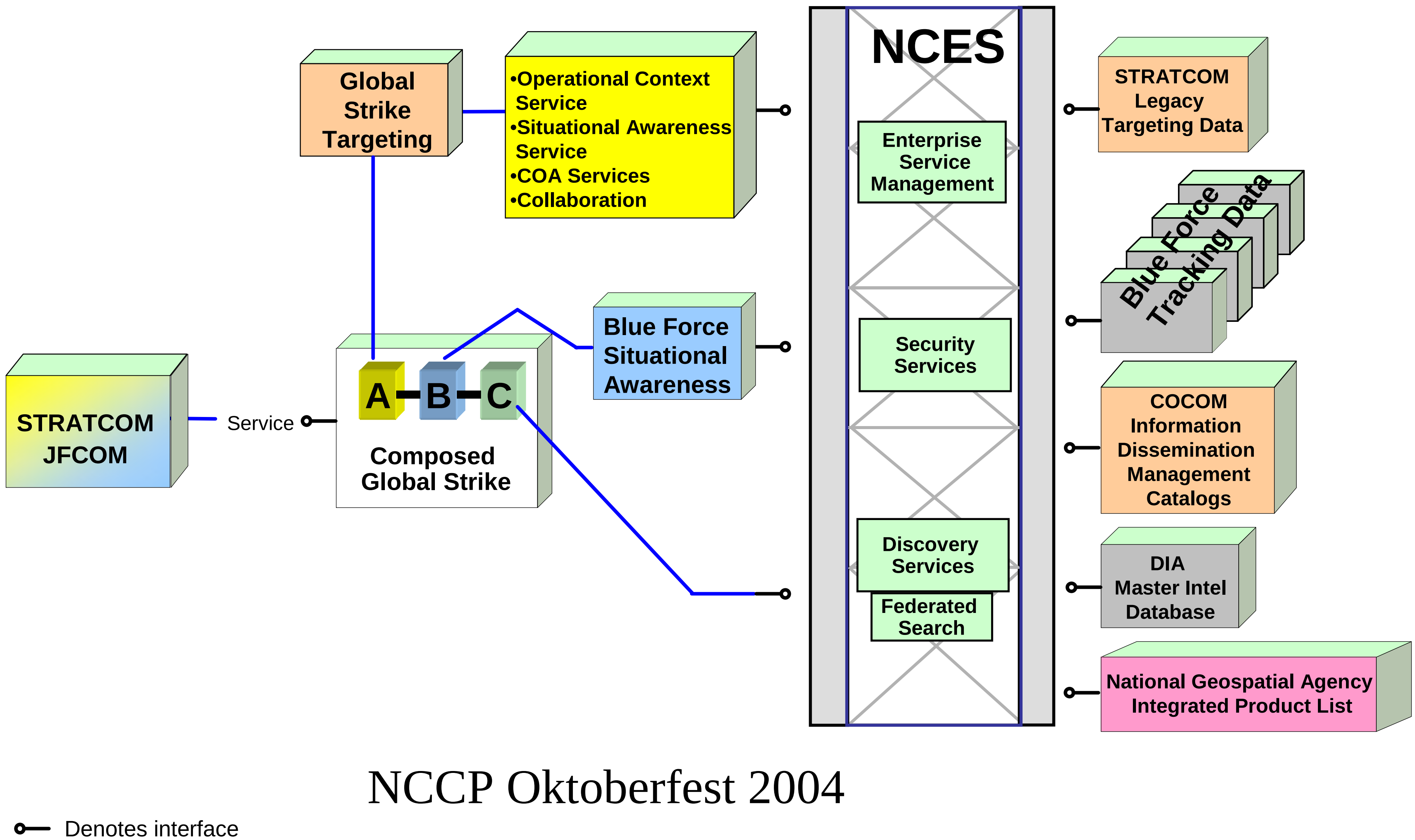
WHAT'S NEW
Already a customer? Sign in to see what's New for You.
BROWSE
Health Care
(Beta - What is this?)
Jewelry & Watches
(Beta - What is this?)
It's the Old Navy Item
Get great Item of the
pants for the family!
New Releases
Search
Discover
Decide
Purchase
Assess
Aggregate
Execution Monitoring
Training
Request
Notification

Air / Space Operations work flows



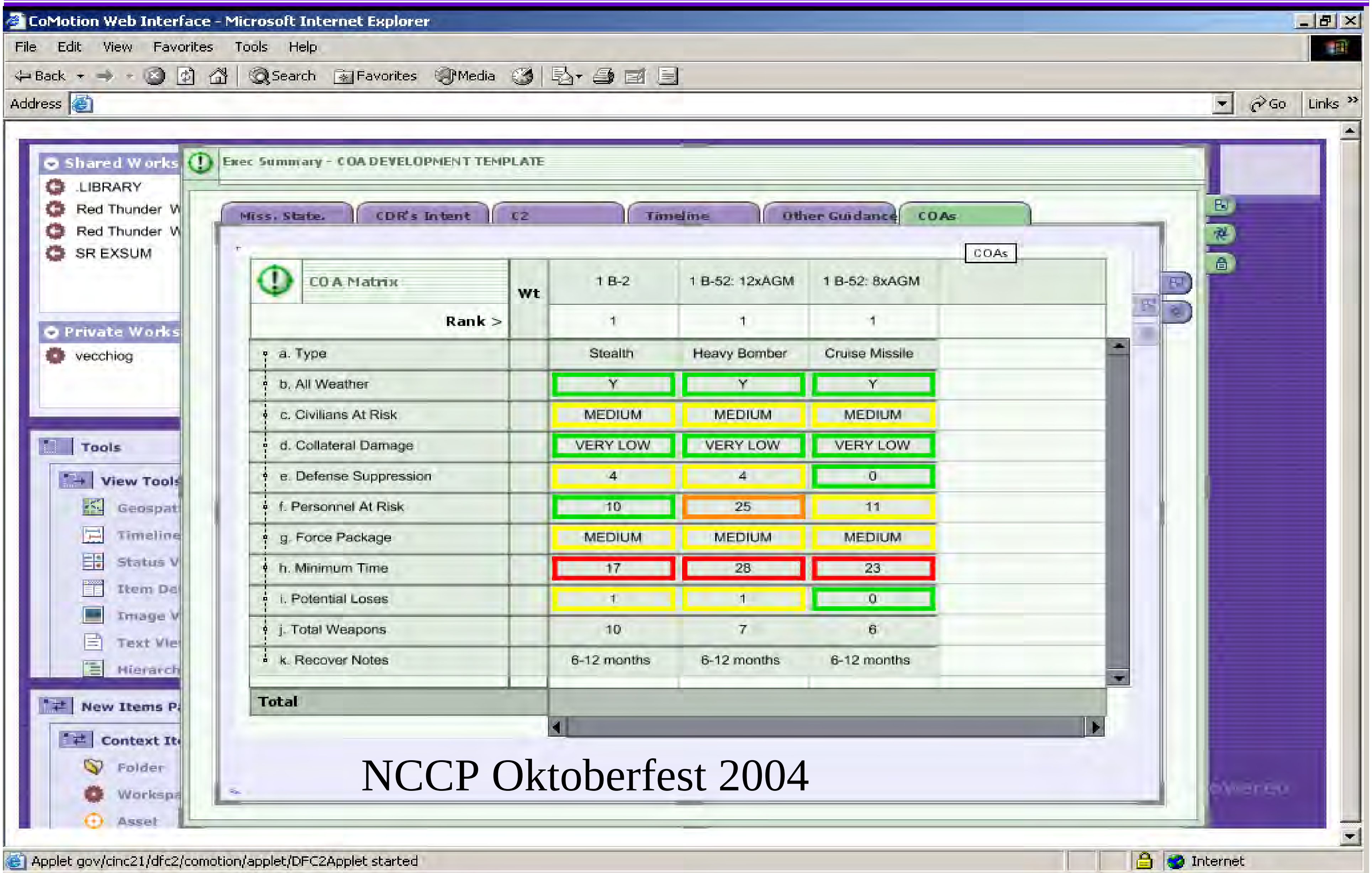
Data Centric & Process Oriented: Information flows across multiple, OPFACs, platforms, and sensors

Task: Global Strike Mission Planning



NCCP Oktoberfest 2004

Task: Global Strike Mission Planning



NCCP Oktoberfest 2004

C4 Capability Development with Service Oriented Architectures

How it's Different

Taking a Chapter from the Commercial World

eBay.com

- **WWW-based E-Commerce Leader ***
  - **$8 Billion quarterly sales**
  - **1.7 Billion dynamic content page views per day**
  - **50 million active traders / user**
  - **Localized to 27 countries**

- **eBay Infrastructure ***
  - **25 million items listed at any given time**
  - **Over 2,000 application servers**
  - **Over 100 Oracle database**
  - **3+ Terabytes of storage**

- **KEY POINT:**
  - **<u>40% of all business transactions</u> conducted via eBay's Web Service Platform ***

*** Source: "Web Service in Action: Integrating with the eBay Marketplace", O'Reilly, June 2004**

eBay's Core Entities
(a very terse architecture!)

All of eBay's Web Service methods revolve around these entities

Item
sellable on eBay.

Listing
(noun) An entry on eBay with one or more items; (verb) The action of creating such a listing. An auction is a type of listing that enables competitive bidding.

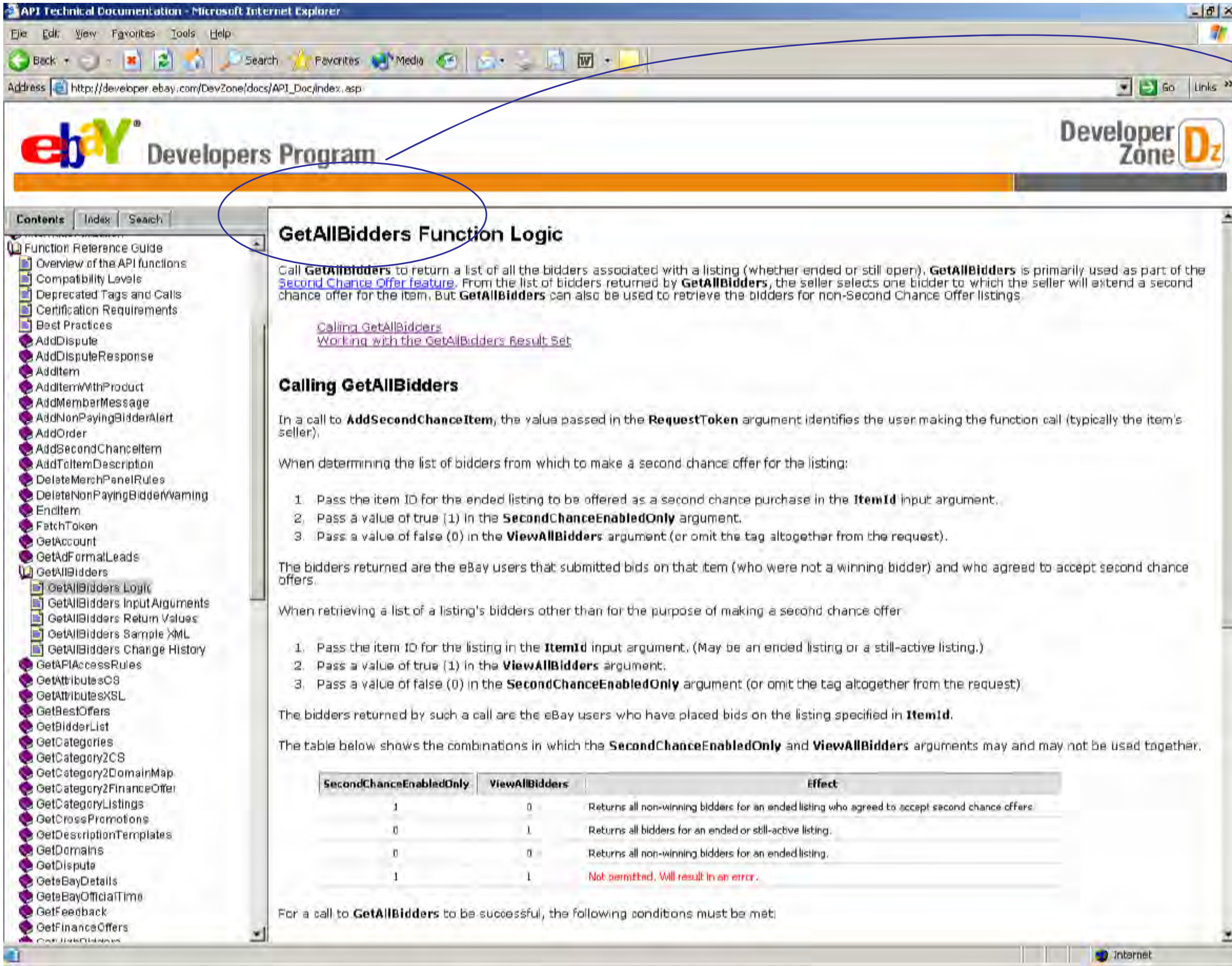
Categories
A hierarchical set of groups on eBay in which items of a similar nature are listed.

User
Someone who has registered with eBay. There are **user roles** such as bidder, buyer, seller, store owner and application developer.

Transaction
The data for the purchase of one or more items by one buyer from one listing. Some listings enable a seller to offer multiple items in the same listing; thus there could be multiple buyers purchasing items from the same listing and therefore multiple transactions for the same listing.

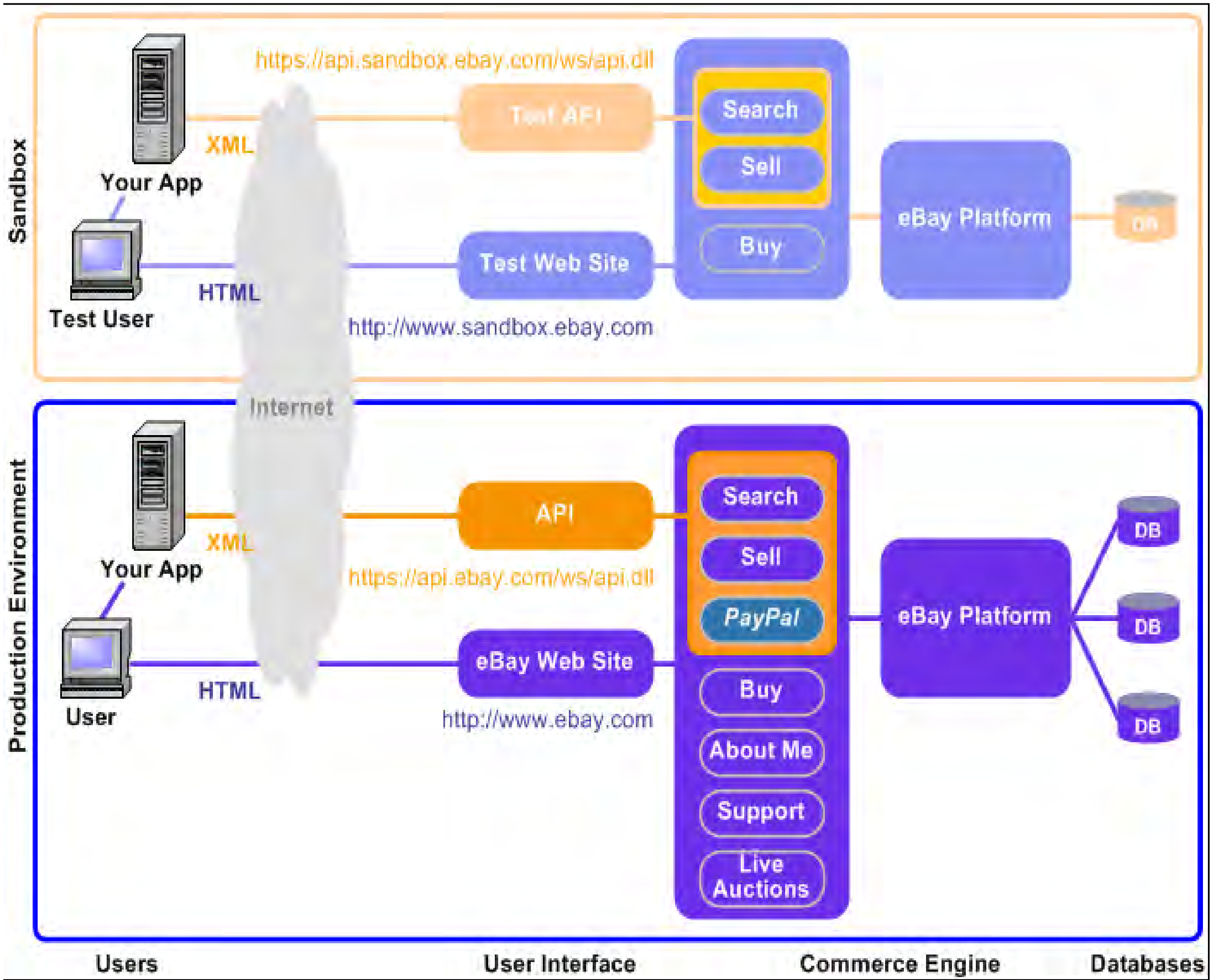
Feedback
An eBay mechanism or system by which one user may rate another user, enabling other users to know how well or how poorly a transaction went.

All eBay Web Service are available for Partner Developers



Technical on-line documentation available for all EBay web services, including sample code on how to use them in an contextual example

eBay's Development/Production Environment



A web accessible development environment available to all partners

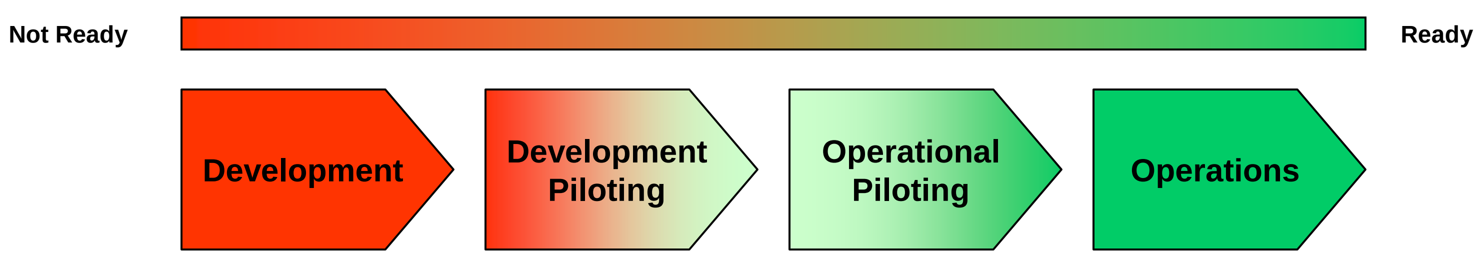
eBay's Development Environment & Support

- **Key Elements for Take Away:**
  - **Simple and understandable architecture**
    - **Seven nouns and verbs**
  - **Development Web Site (http://developer.ebay.com)**
    - **Extensive documentation available on web service**
      - **API Specifications, Code Samples, How-to-docs**
    - **Software Development Kit (SDK) available**
      - **.NET, JAVA, and other programming language support**
    - **Forums and Technical Support available on-line**
  - **Development Sandbox**
    - **Area to test applications against sample data sets**
    - **Area to field new eBay APIs and conduct alpha testing**
    - **Certificate process to validate user access**
    - **Process in place to help developers determine simple functionality and performance characteristics**
    - **Module certification program to provide some assurance before developer roles capability into production**

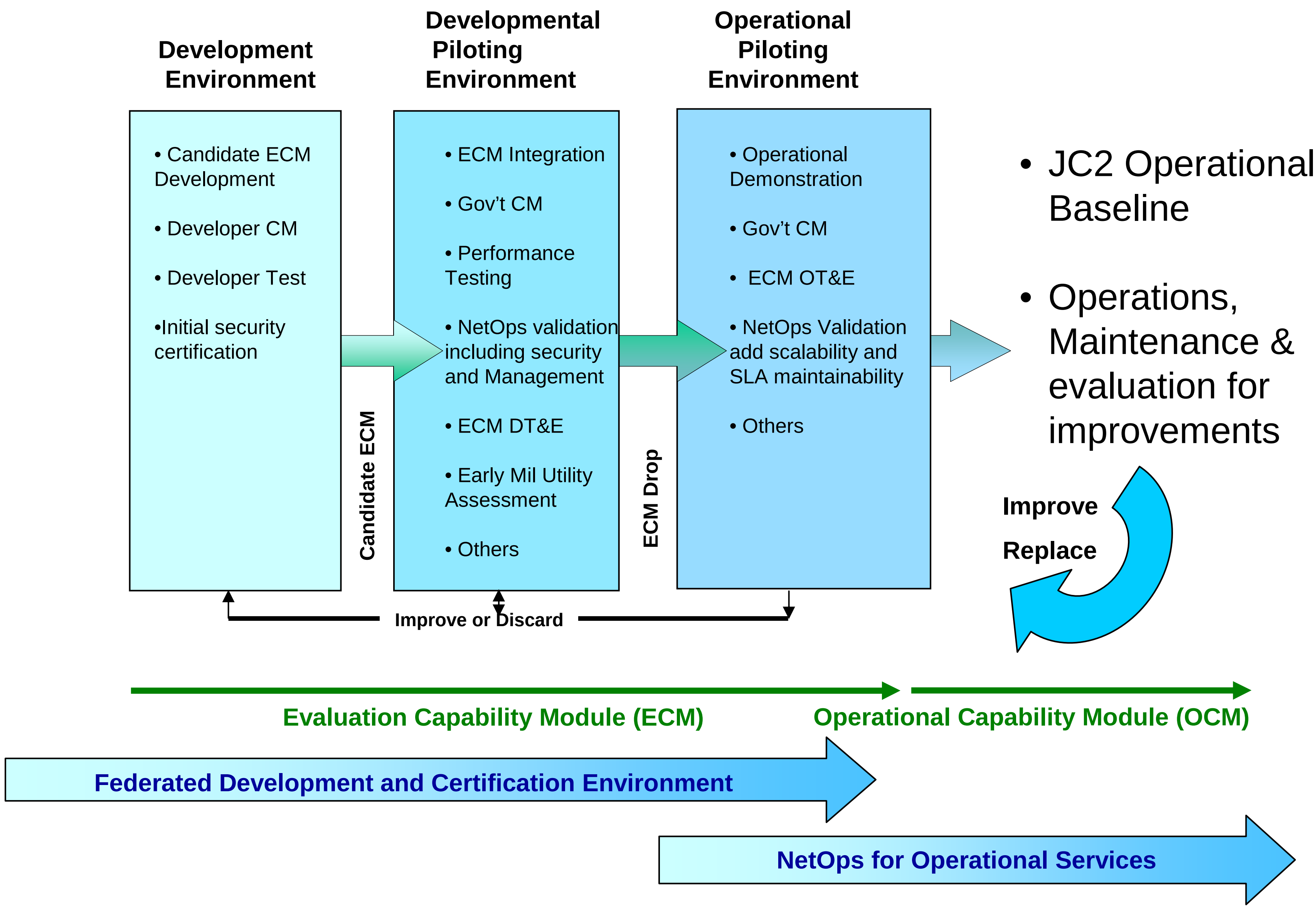
eBay started with a federated development mindset!

"The Strategy"

- **Establish a Federated Development & Certification Environment (FDCE) as a distributed and collaborative environment addressing the challenges associated with concurrent and distributed Service Management.**
- **Its purpose is to establish the**
  - **Infrastructure, Processes, and Policies**
- **so that Services can be progressively**
  - **Developed, Tested, Refined, and Certified**
- **with increasing rigor leading to operational deployment.**



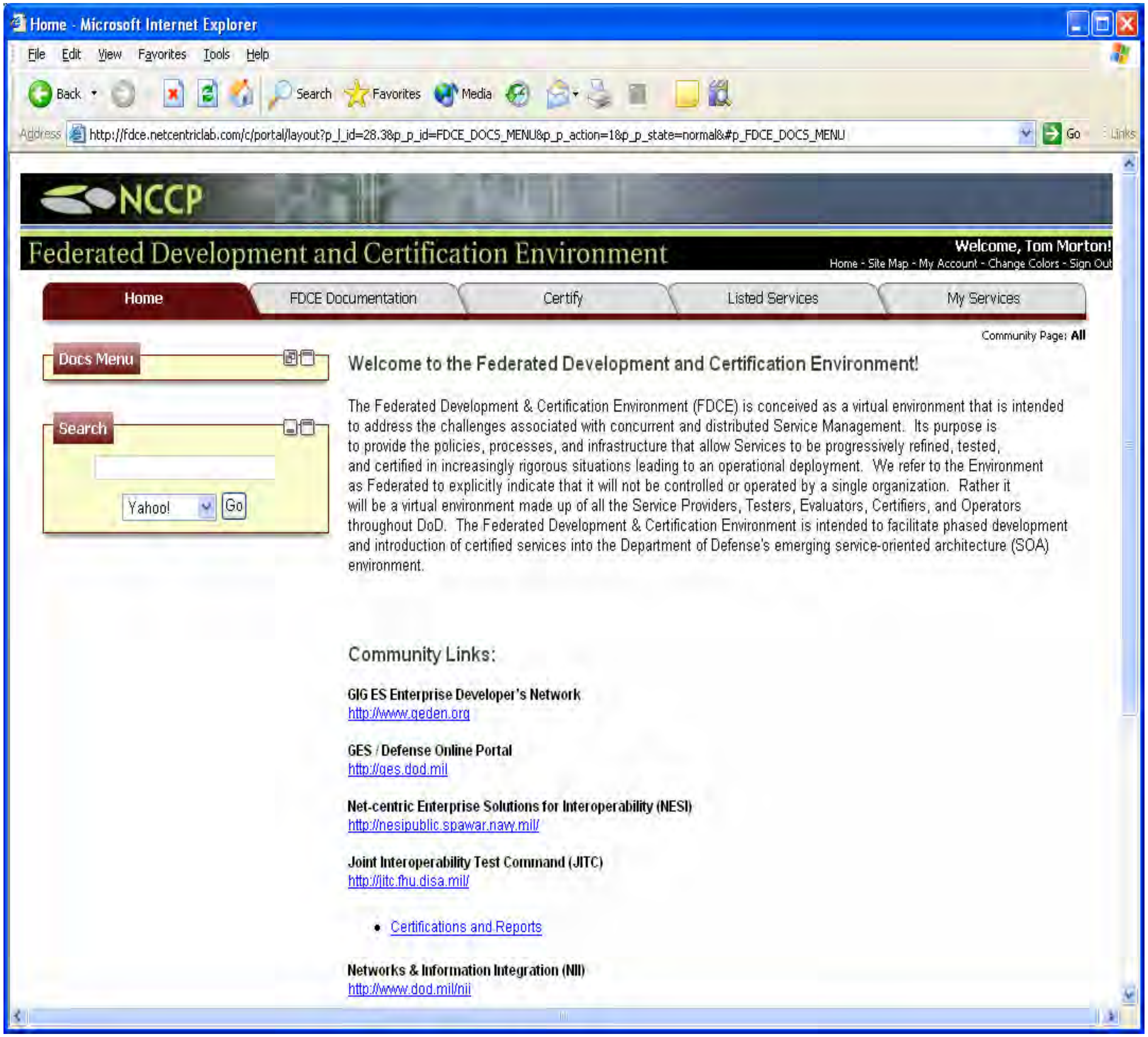
Proposed JC2 Federated Development and Certification



Notional Certification Requirements

	Development Tier	Development Piloting Tier	Operational Piloting Tier	Operational Tier
Registration	Yes	Yes	Yes	Yes
Security	No	Yes	Yes	Yes
Configuration Mgt	No	Yes	Yes	Yes
ESM Enabled	No	Yes	Yes	Yes
Availability Guarantees	No	No	Yes	Yes
Response Time Guarantees	No	No	Yes	Yes
Reliability/Surv Guarantees	No	No	Yes	Yes
NETOPS Ready	No	No	Yes	Yes
On-Line Help	No	No	Yes	Yes
Life Cycle Commitments	No	No	No	Yes

FDCE pilot as part of FY04-05 NCCP initiative



- http//fdce.net
- 57 participants representing all Components
- 34 web services registered and undergoing initial certification

* As of 12 Aug 05

Cultural Change
And
Next Steps

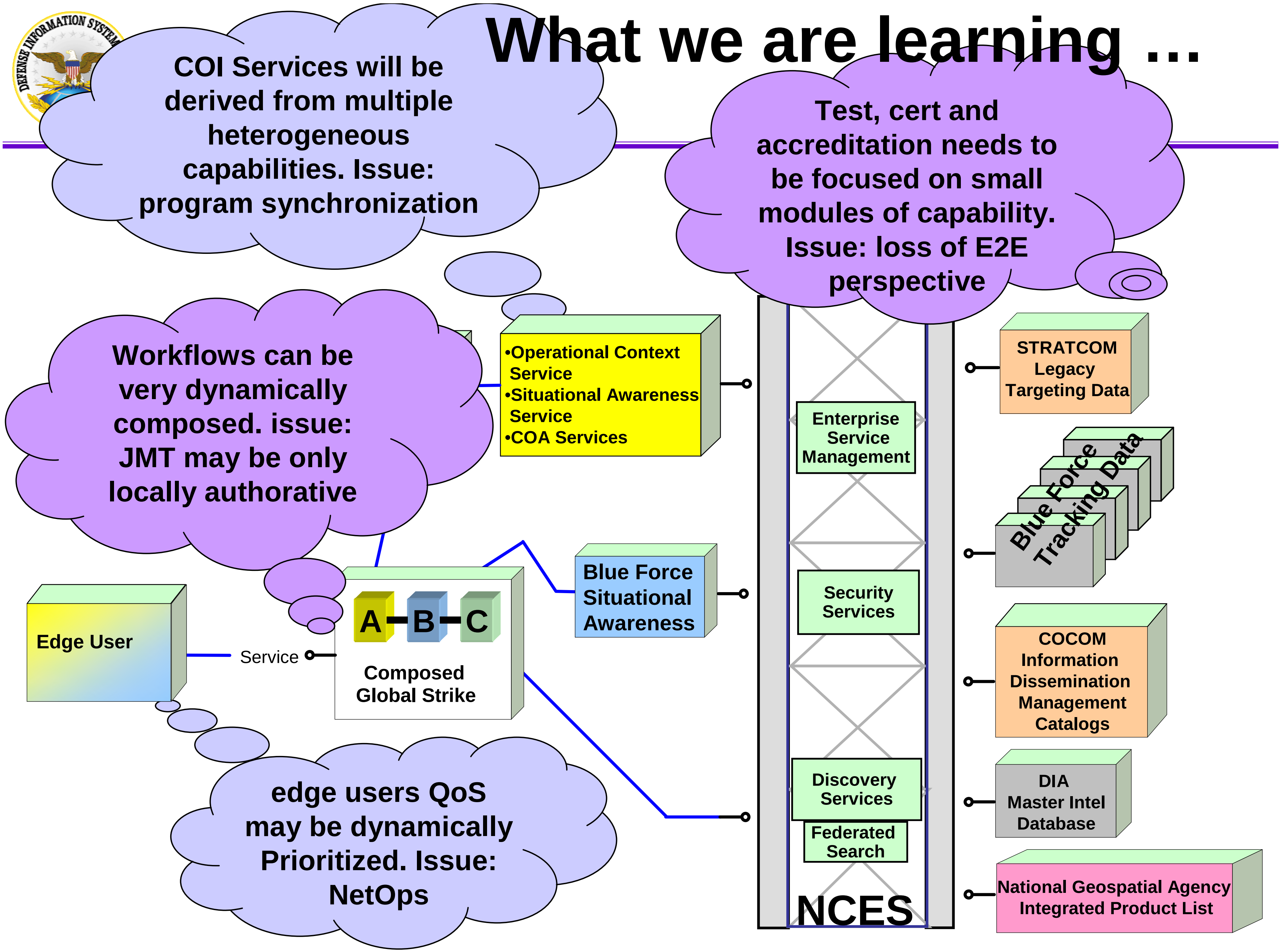
SOA Evolution: Think Differently

Becoming Net-Centric means ….

Participating as a part of a continuously evolving ecosystem of people, devices, information and services; interconnected by a communications network to achieve optimal benefit of resources and better synchronization of events and their consequences.

This is about Culture Change…

What we are learning …



DEFENSE INFORMATION SYSTEMS AGENCY

C-17 Software Development Process

Hafez M. Lorseyedi
Director
C-17 Systems Architecture
The Boeing Company

John R. Allen
Senior Manager
C-17 Systems Architecture
Mission Assurance
The Boeing Company

JRA
20 October 2005

Introduction

- The C-17 airlifter is a software intensive system with an ongoing avionics upgrade program
- Software process is inseparable from Systems engineering process
  - —Robust avionics systems and software engineering processes are critical to success
  - —Process improvement is an essential component of performance improvement

Topics

- C-17 Program
- Avionics Systems and Software Engineering Process
- Challenges, Lessons Learned and Improvement Strategies
- Summary

C-17: A High Performance Program

MEETING OUR COMMITMENTS

- **Excellent Quality**
- **Ahead of Schedule**
- **On Price**
- **180 Aircraft Program**

MEETING OUR COMMITMENTS

- **141 USAF Aircraft - 6 Bases**
- **Worldwide Operations**
- **Best Fleet Reliability**
- **4 UK C-17s Delivered**

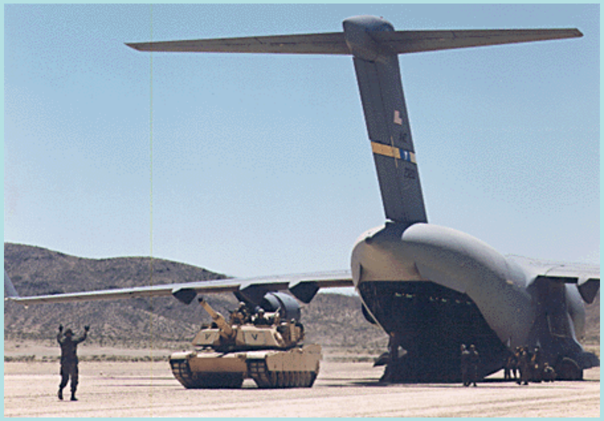
Over 898,750 Flight Hours!

USAF Fleet – 872,885 UK Fleet – 23,085

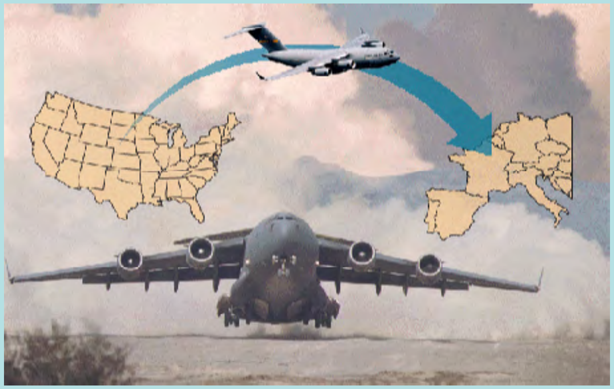
As of 3 August 2005

Unique C-17 Capability

Delivers Heavy and Outsize Cargo into Short Runways **and/or** **Semi-prepared Runways** **through** **Small Ramps or Narrow Body Slots**



Direct Deliveries Over Intercontinental Distances into Small Austere Airfields

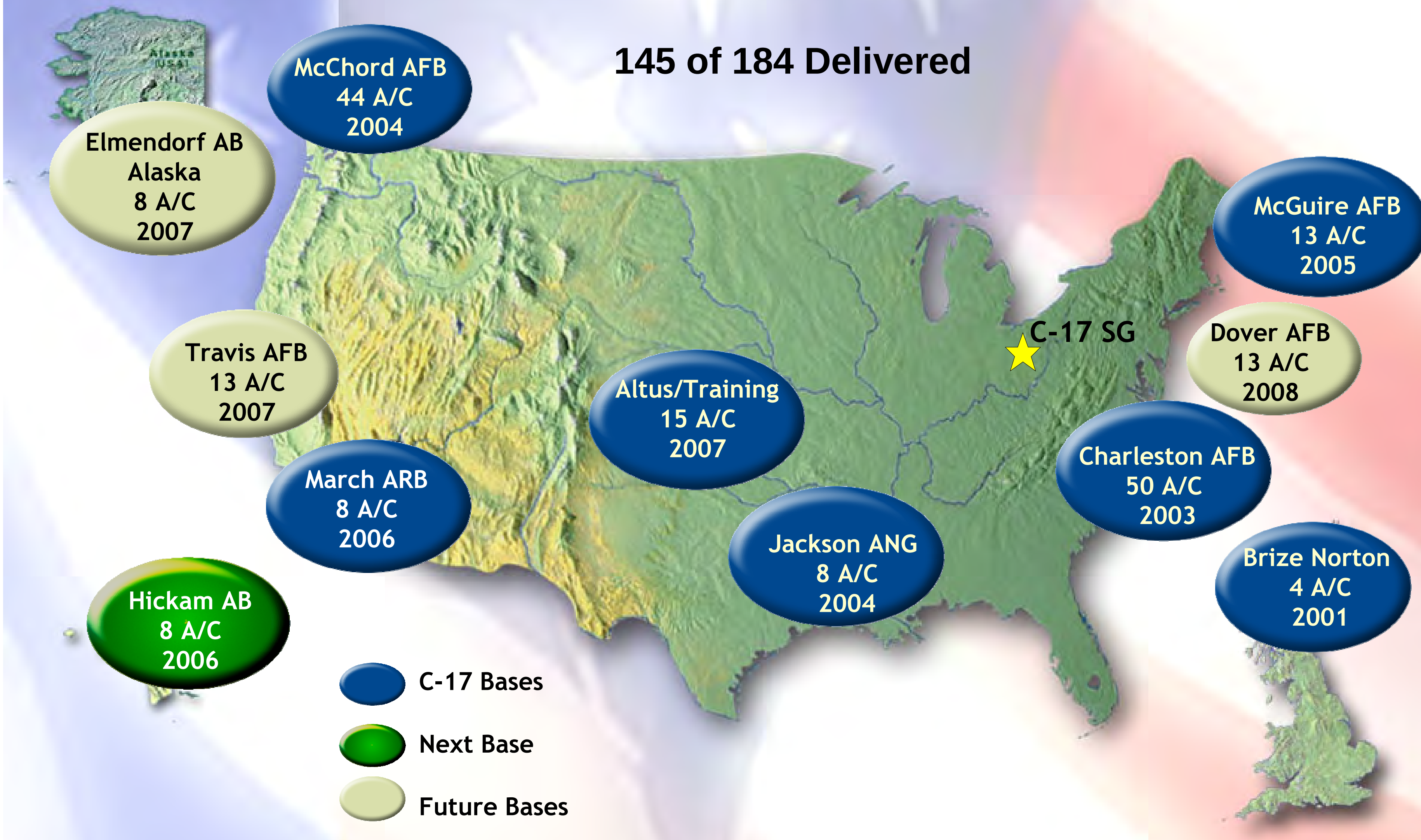


Carries Airborne Troops Anywhere: "Long Flight, Ready to Fight"

Reduces Manpower: 3-Person Aircrew; Breaks Less and is Easier to Fix

JRA
20 October 2005

C-17 Bed Down Locations

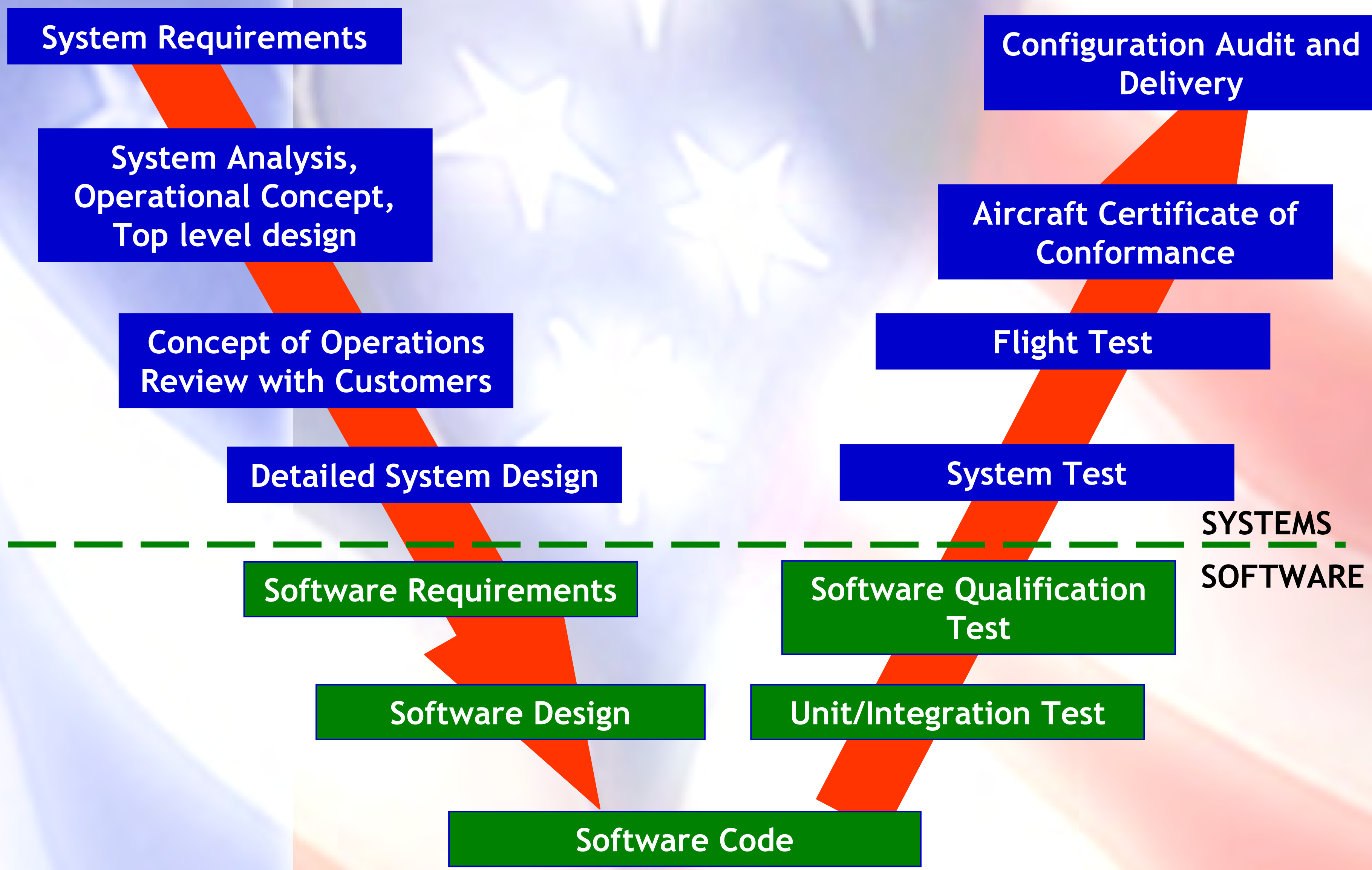


C-17 Flight Software Summary

- Over 2 million source lines of code
- Mix of military and commercial software
- Software development/maintenance
  - Approximately 50%-50% Boeing/Supplier split
  - Over 20 suppliers
- Many software languages
  - Migrating to Ada 95 and C/C+ as equipment is modernized

Avionics Systems and Software Engineering Process

Systems and Software Engineering Process



Software Development Process

DO-178B

Mil-Std-498

- Software Requirements Analysis
- Software Architectural Design
- Software Detailed Design
- Software Implementation (coding)
- Software Unit Test
- Software Unit Integration
- Software Qualification Test

Software

Life Cycle Data

Contractual process documented in C-17 Software Development Plan

Quality Journey

1998
Malcolm Baldrige Win

1999
CMM Lvl 3
Best Practice Exchange
Quest for Excellence and speaking engagements

2000
Internal Assessment
Deployment of best practices to new site tenants

2001
CMM Lvl 5
Internal Assessment
Industry Week Top 25 Finalist
Incorporation of high-leverage actions into strategic planning

2002
ISO
CAPE* Applicant
Industry Week Top 10 Finalist
Trained Examiners developed in-house

2003
CMMI Lvl 5
CCE Team Excellence Applicant
Internal Assessment
Use CAPE feedback to improve using internal Examiners

2004
Malcolm Baldrige Applicant

2005
CCE Team Excellence Applicant

Software process improvement is a key component in the quality journey

*CAPE = California Awards for Performance Excellence

C-17 Software Process Evolution

MIL-STD-498 → ← MIL-STD-498/DO-178B →

1999 2000 2001 2002 2003 2004 2005 2006

CMM Level 3 (1999)

CMM Level 5 (2001)

CMMI Level 5 (2003)

CMMI Reassessment (2006)

CMM to CMMI Transition

Airlift and Tankers Organizational Process
C-17 Tailored Process
Process Compliance Artifacts

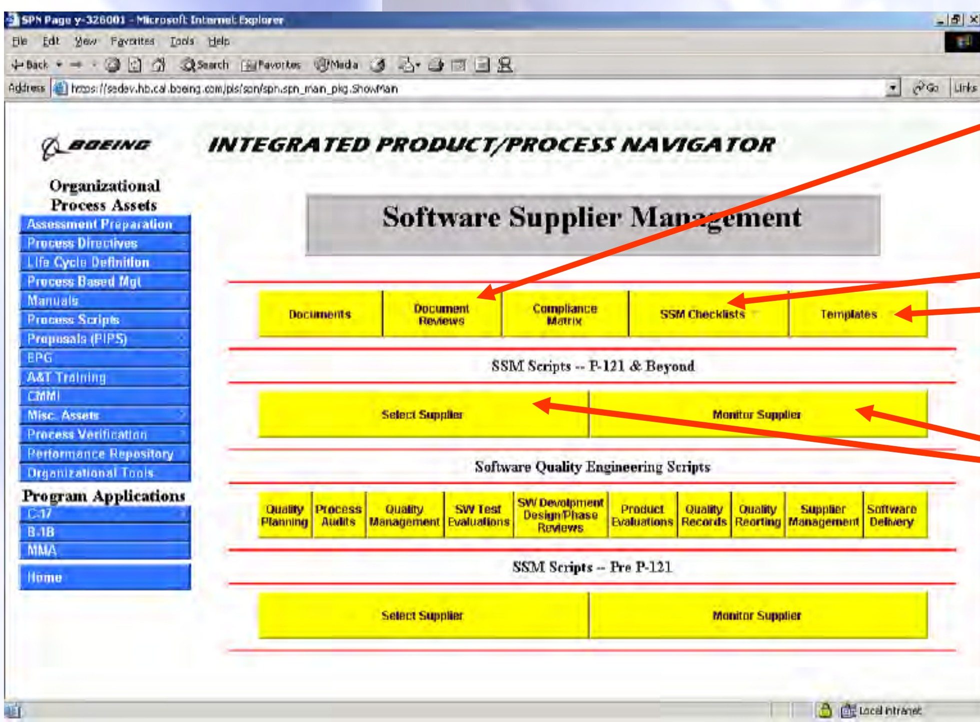
Challenges, Lessons Learned and Improvement Strategies

Challenges and Lessons Learned

- Supplier SW management
- Documentation
- Managing overlapping development
- Maintaining process discipline

Supplier Software Management

- Approximately half of C-17 software is developed and maintained by suppliers
- Boeing-Supplier teamwork is essential for success
- Supplier Software Management Team
  - —Software engineering experience
  - —Software acquisition experience



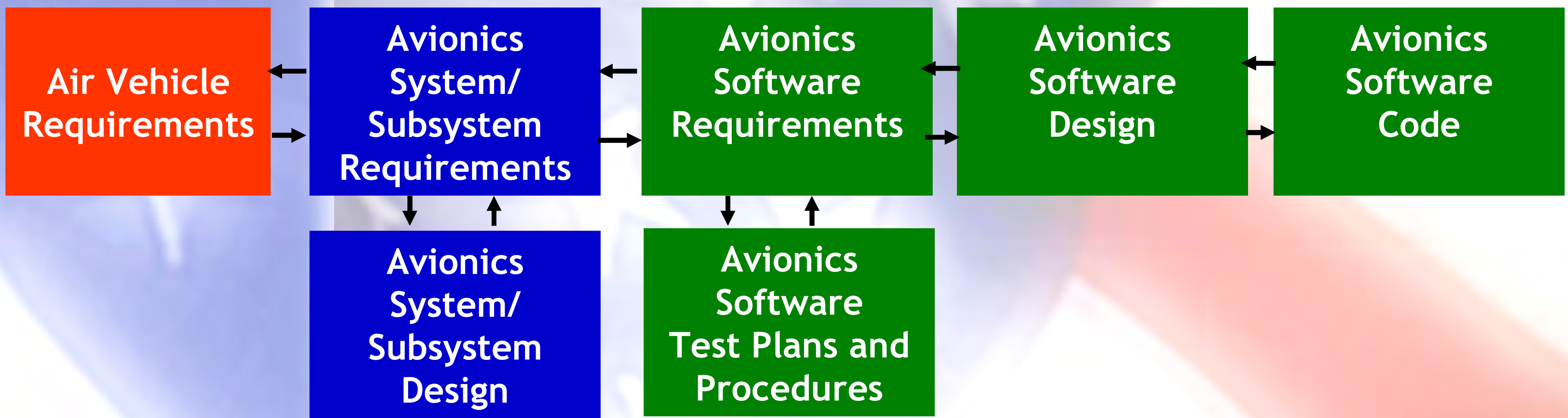
Repository for review artifacts

Software acquisition tools
-Lifecycle data/product review checklists
-Template Statement of Work

Supplier Selection
and Monitoring Processes

Supplier Software Metrics

Documentation

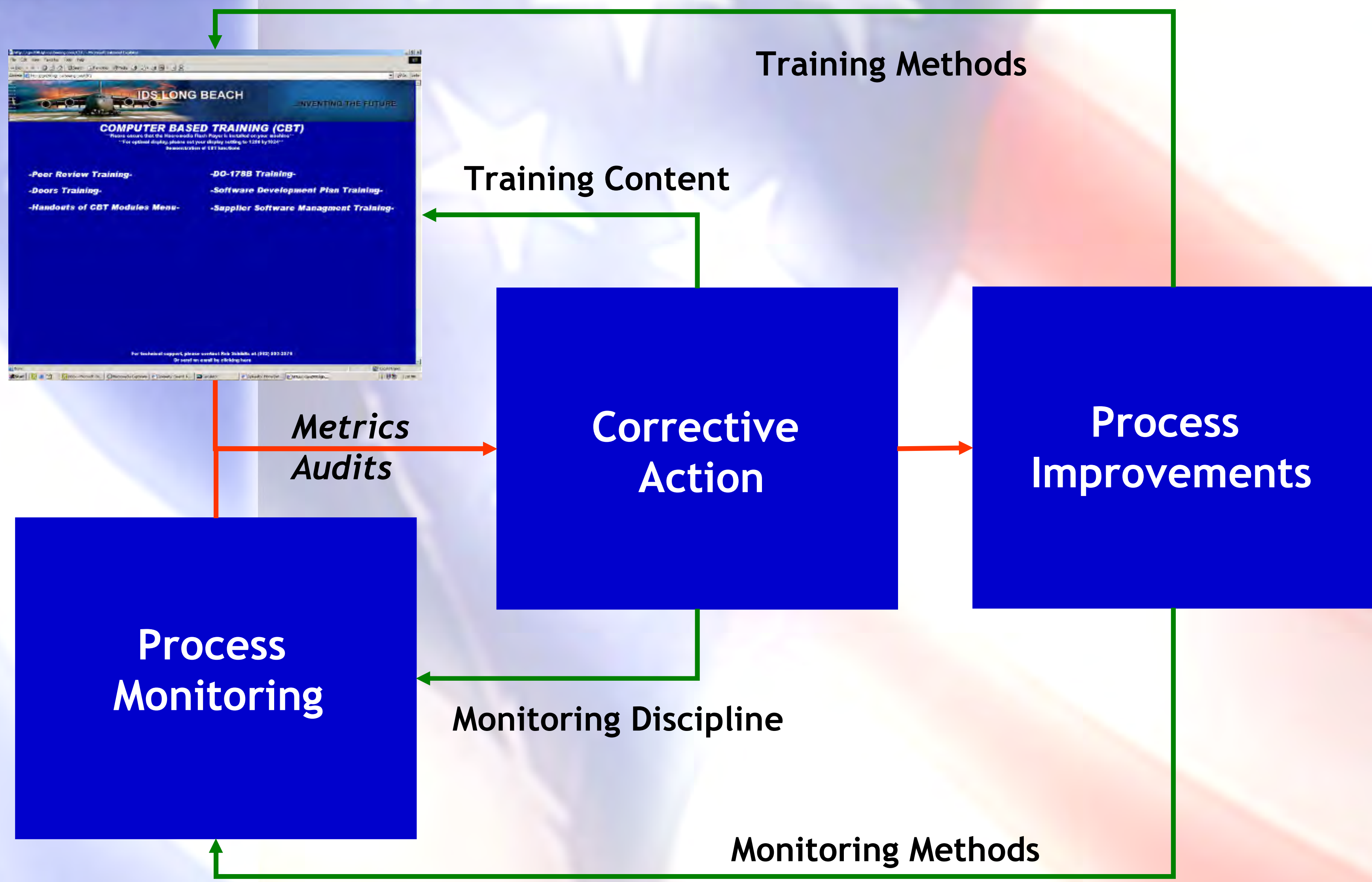


- Capturing and verifying airborne software life cycle data is a complex task
  - —Thousands of requirements
  - —Thousands of pages
  - —Traceability
  - —Milestone review entry criteria
- Solutions
  - — Implemented DOORS
  - — Improved product evaluations

Overlapping Development

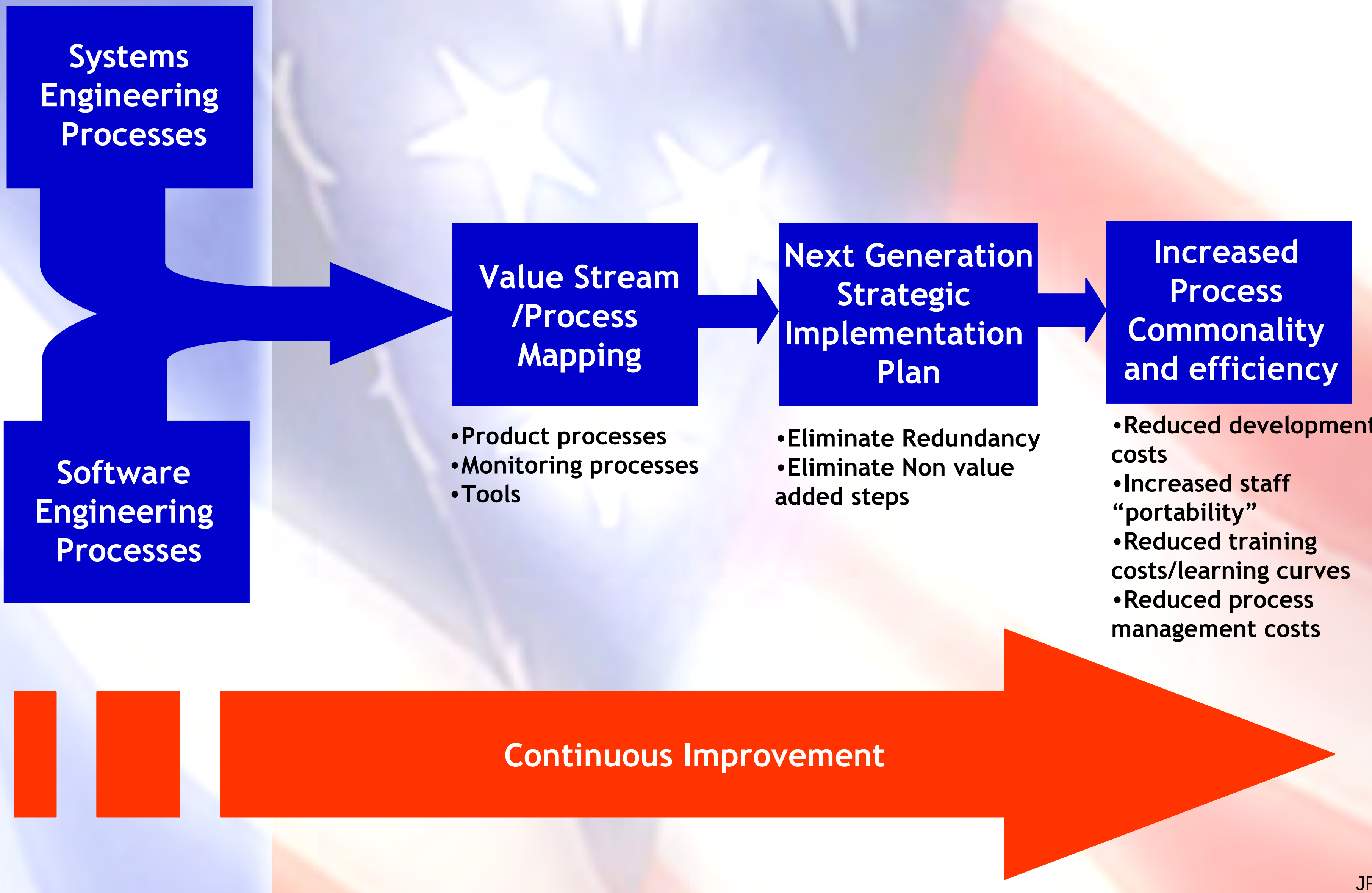
- Multiple Software block upgrades occur simultaneously with different effectivity
- Challenges
  - —Laboratory Capacity
  - —Flight Test Capacity
  - —Manpower availability
- Solutions
  - —Integrated block planning
  - —Block Integration
  - —Alternate test resources
  - —Staff versatility
  - —Earlier error detection *-reducing late phase rework*

Maintaining Process Discipline



JRA
20 October 2005

Strategic Process Improvement



Summary

Summary

- Systems and software processes are inseparable
  - —Both directly affect product delivery
  - —Both directly affect product quality
- C-17 Software process has evolved through the Boeing quality journey
  - —Current plans are to further optimize systems and software processes for improved commonality and efficiency
- Process discipline is an integral part of the C-17 software mission assurance strategy

Technical Planning for Acquisition Programs: An OSD Perspective

8th NDIA SE Conference
October 25, 2005

Warren M. Anderson, Col, USAF
Deputy for Systems Engineering Plans and Policy,
Office of the Under Secretary of Defense (AT&L)
Defense Systems, Systems Engineering, Enterprise Development

Top Five Systems Engineering Issues

- Lack of awareness of the importance, value, timing, accountability, and organizational structure of SE on programs
- Adequate, qualified resources are generally not available within government and industry for allocation on major programs
- Insufficient SE tools and environments to effectively execute SE on programs
- Poor initial program formulation
- Requirements definition, development, and management is not applied consistently and effectively

NDIA Study in January 2003

DoD Systems Engineering Shortfalls*

- Root cause of failures on acquisition programs include:
  - Inadequate understanding of requirements
  - Lack of systems engineering discipline, authority, and resources
  - Lack of technical planning and oversight
  - Stovepipe developments with late integration
  - Lack of subject matter expertise at the integration level
  - Availability of systems integration facilities
  - Incomplete, obsolete, or inflexible architectures
  - Low visibility of software risk
  - Technology maturity overestimated

Major contributors to poor program performance

* DoD-directed Studies/Reviews

USD(ATL) 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 practices back into the way we do business."

No Course Change from Mr. Krieg—Press On

DoD Response
Policy

- 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)

Two Policy Memos: Feb 20 and Oct 22, 2004

Striving for Technical Excellence

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- Technical planning
- Technical leadership
- Technical execution

Technical excellence

Strong technical foundation is the value of SE to the program manager

DoD Response
Guidance and Tools

- Defense Acquisition Guidebook:
  - SE in DoD Acquisition
  - SE Processes
  - SE Implementation in the System Life Cycle
  - SE Tools and Techniques, and SE Resources

  (above four items) → Chapter 4
  - Test & Evaluation → Chapter 9
- Systems Engineering Plan:
  - Interim guidance
  - Preparation Guide—Version 1.0 in coordination
  - Twenty-five focus areas to address in technical planning
    - One each, tailored for Milestones A, B, and C

Driving Technical Rigor Back into Programs "Importance and Criticality of the SEP"

- Program's SEP provides insight into every aspect of a program's technical plan, focusing on:
  - What are all the program requirements?
  - Who has responsibility and authority for managing technical issues—what is the staffing and organization to support the effort?
  - How will the technical baseline be managed and controlled?
  - What is the technical review process?
  - How is that technical effort linked to overall management of 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
SEP Focus Areas for Milestone B

- Program Requirements
  - Capabilities, CONOPS, KPPs
  - Statutory/regulatory
  - Specified/derived performance
  - Certifications
  - Design considerations
- Technical Staffing/Organization
  - Technical authority
  - Lead Systems Engineer
  - IPT coordination
  - IPT organization
  - Organizational depth
- Technical Baseline Management
  - Who is responsible
  - Definition of baselines
  - Requirements traceability
  - Specification tree and WBS link
  - Technical maturity and risk
- Technical Review Planning
  - Event-driven reviews
  - Management of reviews
  - Technical authority chair
  - Key stakeholder participation
  - Peer participation
- Integration with Overall Management of the Program
  - Linkage with other program plans
  - Program manager's role in technical reviews
  - Risk management integration
  - Test and logistics integration
  - Contracting considerations

Driving Technical Rigor Back Into Programs
SEP Focus Areas for Milestone A

- Program Requirements
  - **Desired capabilities; required attributes**
  - **Potential statutory/regulatory, specified/derived performance, certifications, design considerations**
  - **Enabling technologies**
  - **Cost/schedule constraints**
  - **Future planning**
- Technical Staffing/Organization
  - Technical authority
  - Lead Systems Engineer
  - **SE role in TD IPT**
  - IPT organization and coordination
  - Organizational depth
- Technical Baseline Management
  - Who is responsible
  - Definition of baselines
  - **ICD/CDD traceability**
  - Technical maturity and risk
- Technical Review Planning
  - Event-driven reviews
  - Management of reviews
  - Technical authority chair
  - Key stakeholder participation
  - Peer participation
- Integration with Overall Management of the Program
  - Linkage with other program plans
  - Program manager's role in technical reviews
  - Risk management integration
  - Test and support strategy
  - Contracting considerations

Driving Technical Rigor Back Into Programs
SEP Focus Areas for Milestone C

- Program Requirements
  - **Technical surveillance approach**
  - **Tracking of actual vs. planned usage**
  - **Monitoring of system hazards, risks, certifications**
  - **Tracking of usage, corrosion-related maintenance and repair costs, and total ownership costs**
  - **Management of configuration changes and incremental modifications**
- Technical Staffing/Organization
  - Technical authority
  - Lead Systems Engineer
  - **Coordination of sustaining engineering with operational, maintenance, and repair domains**
  - **Sustaining support organization**
  - Organizational depth
- Technical Baseline Management
  - Who is responsible
  - Definition of baseline management
  - **Requirements and certification traceability and verification of changes**
  - Specification tree and WBS link
  - **Tracking of operational hazard risk against baseline**
- Technical Review Planning
  - **In-service reviews**
  - Management of reviews
  - Technical authority chair
  - Key stakeholder participation
  - Peer participation
- Integration with Program Management
  - **Linkage with overall sustainment**
  - **Program manager's role in in-service reviews**
  - Risk management integration
  - Logistics integration
  - Contracting considerations

DoD Response
Guidance and Tools

- SE in the Integrated Defense AT&L Life Cycle Management Framework Chart (v5.1)
- Guides:
  - Reliability, Availability, and Maintainability—published August 3, 2005
  - Integrated Master Plan/Integrated Master Schedule—in coordination
  - Contracting for SE—distributed for comment
  - Risk Management—in internal development
- Tools:
  - Defense Acquisition Program Support
  - Initial Operational T&E (IOT&E) Readiness
  - Capability Maturity Model Integrated Acquisition Module (CMMI-AM)

http://www.acq.osd.mil/ds/se

DoD Response
Education, Training, and Outreach

- Formal training updates across key career fields: SE, T&E, Acquisition, Program Management, Contract Management, Finance Management
- Continuous learning, on-line courses
  - Reliability and Maintainability, Technical Reviews, and System Safety already available
  - Trade Studies, Technical Planning, Modeling and Simulation, and Contracting for SE in development
- University engagement
- Director-level outreach to industry
  - Hosting of and speaking at conferences and symposia
  - Speaking to industry at senior leadership levels

http://www.dau.mil/basedocs/continuouslearning.asp

Driving Technical Rigor Back into Programs "Portfolio Challenge"

- Defense Systems was tasked to:
  - Review program's SE Plan (SEP) and T&E Master Plan (TEMP) for major acquisition programs (ACAT ID and IAM); conduct program support reviews (PSRs)
- Portfolio includes:
  - Business Systems
  - Communication Systems
  - C2ISR Systems
  - Fixed Wing Aircraft
  - Unmanned Systems
  - Rotary Wing Aircraft
  - Land Systems
  - Ships
  - Munitions
  - Missiles

Systems Engineering Support to Over 130 Major Programs in Ten Domains

Driving Technical Rigor Back Into Programs "Program Specific"

Topic	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

Driving Technical Rigor Back Into Programs "Emerging SEP Comments (First Drafts)"

(not systemic across all programs)

- Incomplete discussion of program requirements
  - Missing categories such as statutory, regulatory, or certifications
- Minimal discussion of program IPTs
  - Need to identify technical authority, lead systems engineer, and key stakeholders
  - Addresses part of SE organization, such as prime; no mention of government, subcontractors, or suppliers
- Incomplete technical baseline
  - How does the program go from CDD to product—traceability?
  - Linkage to EVM—not able to measure technical maturity via baselines
- Incomplete discussion of technical reviews
  - How many, for what (should tie to baselines and systems/subsystems/configuration items), and by whom (should tie to staffing)?
  - Lacking specific entry criteria
  - Peer reviews
- Integration with other management planning
  - Linkage with acquisition strategy, IMP, IMS, logistics, testing, and risk management
  - Schedule adequacy—success-oriented vice event-driven; schedule realism
  - Contracting for SE

58 SEPs reviewed from 36 programs

Compelling Need to Engage with Programs Early in Process

SEP Observations

- Descriptions vice plans
  - Regurgitated theory
  - Generic text, applicable to _______
  - Disconnected discussion
  - No numbers or specifics
  - No names
  - No timeframes or ordered relationships
  - What
  - Why
  - How
  - Who
  - When
  - Where
- Not reflective of known industry best practice
  - Technical baselines
  - Technical reviews
    - Entry criteria for technical reviews
    - Peer participation

Technical Planning Drivers

- System Complexity
- Integration Unknowns
- Total Life Cycle Implications
- Technology Maturity
- Derivation Issue
- Cost Basis
- Technical Baseline
- Multitude of Design Considerations
- Mismatched Expectations
- Technical Execution
- Trade Space
- SE versus T&E
- Constrained Resources ($, people, tools)
- Organizational Complexities

What does "SE" mean on your program?

SEP Stakeholders

Program Manager

PEO

Lead Systems Engineer

Other Programs

Prime Contractor

Statutory and Regulatory Bodies

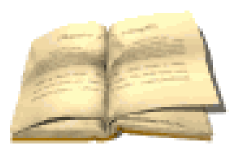
Subcontractors

Certifiers

Lower-tier Suppliers

Functional Leadership

IPTs



Cost Estimators

Testers

New Program Personnel

Logisticians

Milestone Decision Authority

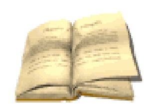
A SEP Provides a Means for Collective Understanding Among All Stakeholders as to Program's Technical Approach

Technical Planning Timeline

Milestone

- RFP Preparation
  - Acquirer’s Technical Approach as Documented in Draft SEP
  - Written by Program Manager, Lead SE, Lead Tester, and Lead Logistician

- Source Selection
  - Offeror’s Proposed Technical Approach based on Draft SEP
  - Evaluated by Source Selection Evaluation Board

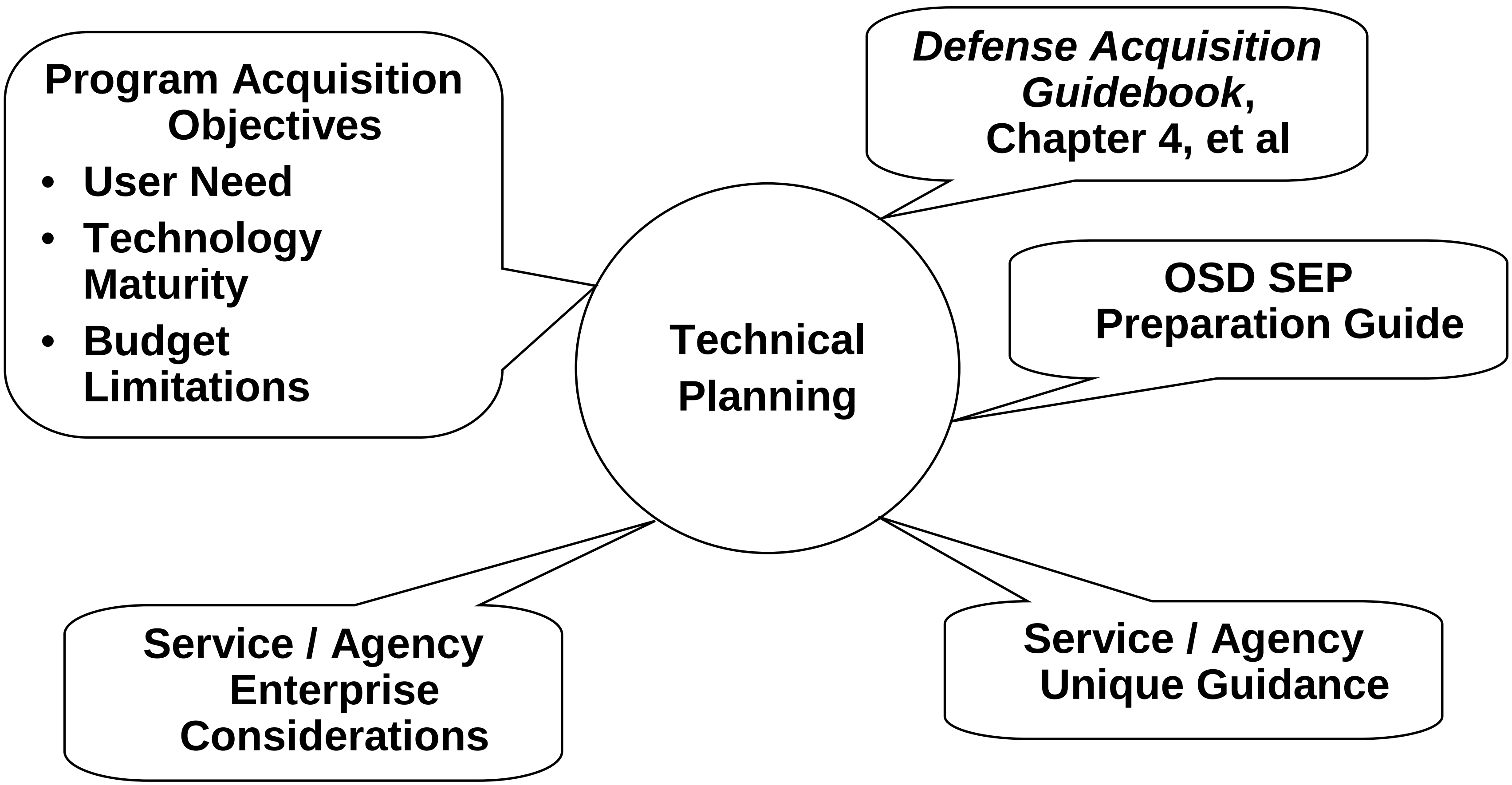


- Post-Award Planning
  - Program Team’s Technical Approach as Documented in Program SEP
  - Written by Program Manager, Lead SE, Lead Tester, and Lead Logistician from Government, Prime, Subs, and Suppliers

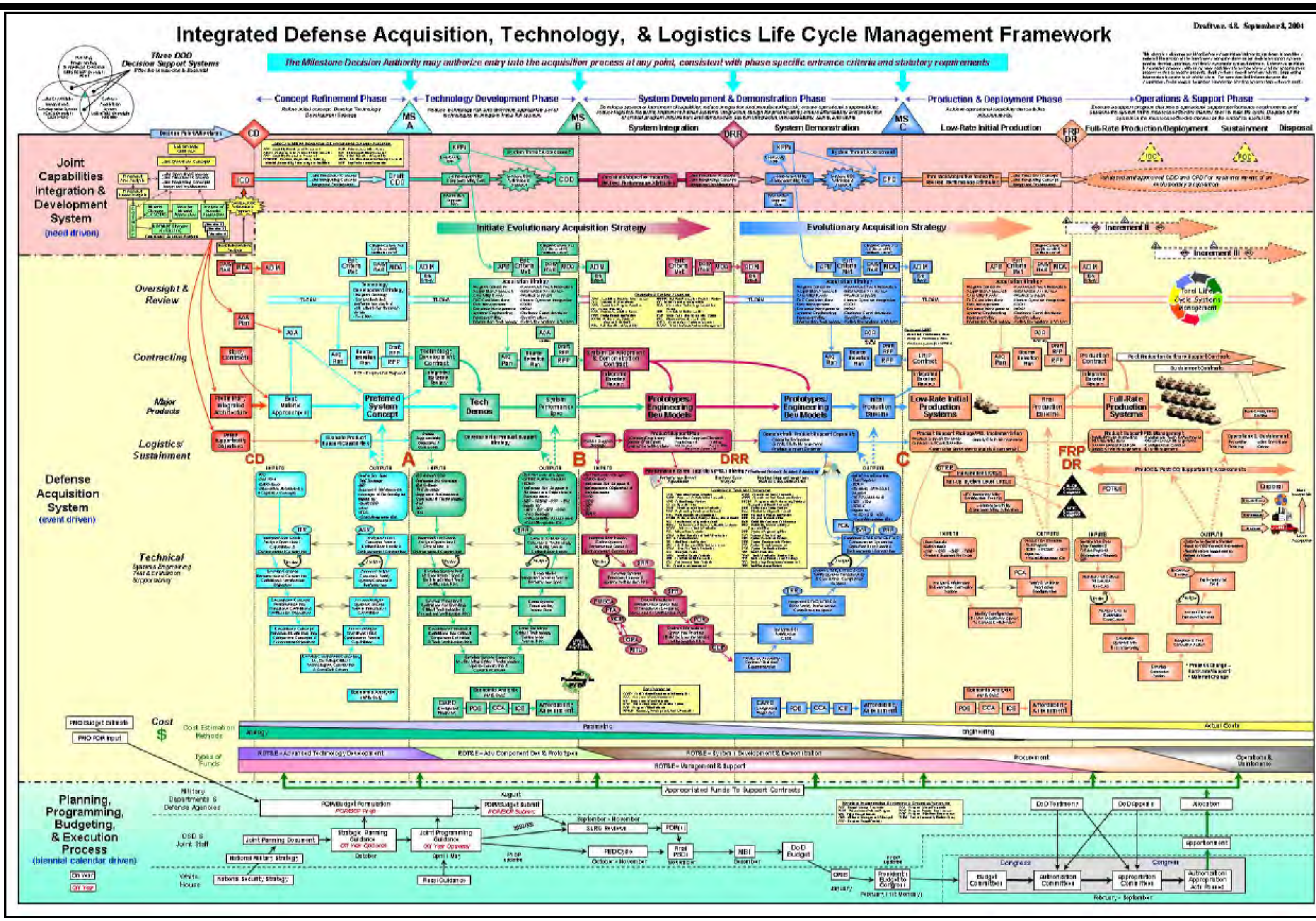
- Execution
  - Execute the Technical Approach
  - Updated by Program Team

A shared “vision” of SE on your program.

Technical Planning Considerations



SE in the System Life Cycle
"The Wall Chart"



SE in the *Defense Acquisition Guidebook*

4.1 SE in DoD Acquisition

4.2 SE Processes: How SE is Implemented

4.3 SE in the System Life Cycle

4.4 SE Decisions: Important Design Considerations

4.5 SE Execution: Key SE Tools and Techniques

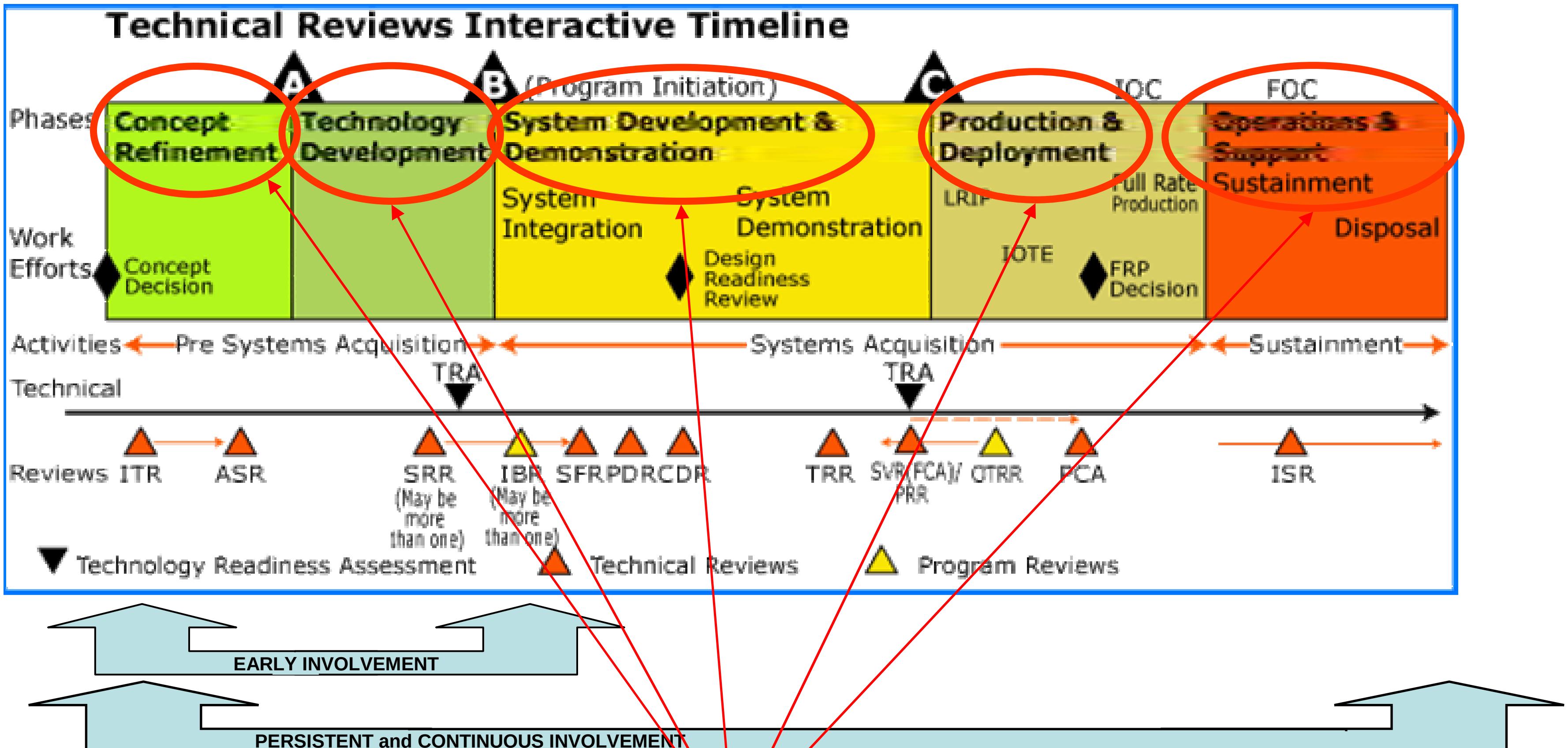
4.6 SE Resources

Systems Engineering Plan Preparation Guide

- Program description, technical status, and approach for updating the SEP
- SE applied and tailored to life cycle phases
  - System capabilities, requirements, and associated design considerations to be addressed
  - SE organizational integration and technical authority
  - SE processes selected and rationale
  - Technical management and control, including technical baseline implementation / control and technical reviews planned
  - Integration with overall program management control efforts—linkage with other programmatic management efforts, such as acquisition strategy, integrated master planning and schedule, risk management, earned value management, and contract management

http://www.acq.osd.mil/ds/se/index.html

Scope of Technical Planning



Sound technical planning is needed in EVERY acquisition phase

Summary

- Sound technical planning is fundamental to program success
- A well-written, comprehensive SEP enables collective understanding of the program's technical approach across all program stakeholders

"In preparing for battle I have always found that plans are useless, but planning is indispensable."
Dwight D. Eisenhower

Enabling System Safety Through Technical Excellence

8th NDIA SE Conference
October 25, 2005

Warren M. Anderson, Colonel, USAF
Deputy for Systems Engineering Plans and Policy
Office of the Under Secretary of Defense (AT&L), Defense Systems, Systems Engineering, Enterprise Development

Top Five Systems Engineering Issues

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NDIA Study in January 2003

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- “Help drive good systems engineering practices back into the way we do business.”

No Course Change from Mr. Krieg—Press On

What We Have Done To Revitalize Systems Engineering

- Issued Department-wide systems engineering (SE) policy
- Issued guidance on SE and test and evaluation (T&E)
- Established SE Forum—senior-level focus within DoD
- Instituted system-level assessments in support of OSD major acquisition program oversight role
- Working with Defense Acquisition University to revise SE, T&E, and enabling career fields curricula (Acq, PM, CM, FM)
- Integrating Developmental T&E with SE policy and assessment functions—focused on effective, early engagement of both
- Instituting a renewed emphasis on modeling and simulation
- Leveraging close working relationships with industry and academia

Necessary but not sufficient!

Striving for Technical Excellence

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Technical excellence

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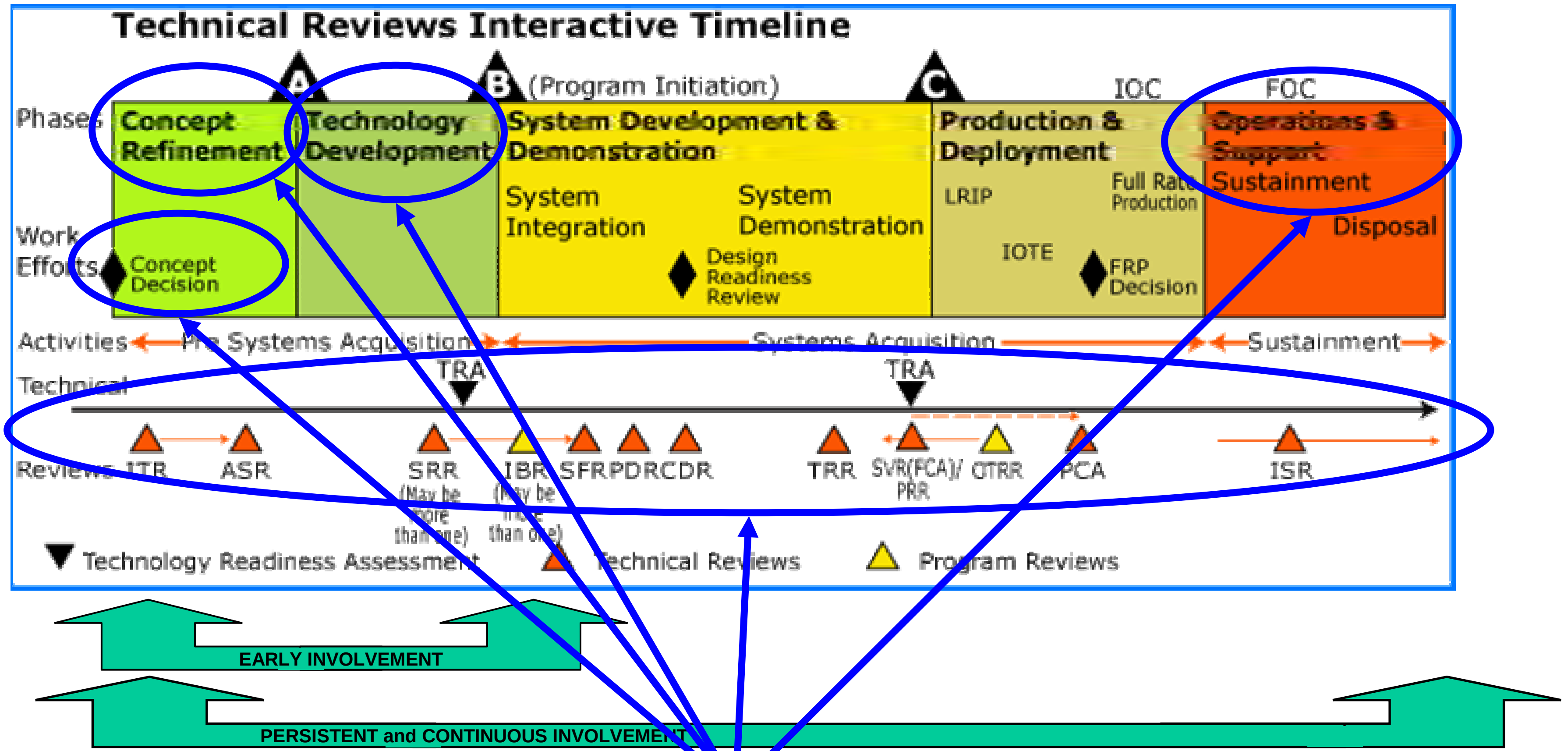
SE Role in Acquisition



Increased use of disciplined Systems Engineering, including formal technical reviews, to effectively address technical issues

Reducing Preventable Accidents

- In FY 2002 DoD mishaps resulted in:
  - 550+ active duty fatalities
    - 308 were POV accidents
    - 67 were aviation-related deaths

1 military death every 16 hours

  - Over 1,474,000 military injury cases
    - 348,683 cases with duty limitations
    - 31,631 cases with hospitalization or quarters
    - 91,448 days lost

168 active duty injuries every hour

  - 2.0 Class A Aviation accident rate
    - Losses valued at $1.8 billion

1 aircraft destroyed every 5.2 days

"We need to turn this situation around."

SECDEF Memo, May 19, 2003

Defense Safety Oversight Council Governance Role

- Ensure personal involvement of senior leadership
- Promote the 50% accident reduction effort to all levels of military and civilian leadership
- Execute the specific initiatives to reduce accidents and time lost due to injuries
- Garner the resources to support the initiatives
- Manage progress toward goal
- Provide periodic updates to the Secretary

DSOC Membership

- **Principal Members**
  - Under Secretary of Defense for Personnel and Readiness (as Chair)
  - Under Secretary of Defense for Acquisition, Technology, and Logistics
  - Under Secretary of Defense (Comptroller)/Chief Financial Officer
  - Vice Chairman of the Joint Chiefs of Staff
  - Assistant Secretary of Defense for Health Affairs
  - Under Secretary of the Army
  - Under Secretary of the Navy
  - Under Secretary of the Air Force
- **Associate members**
  - Deputy Under Secretary of Defense (Installations and Environment)
  - Deputy Under Secretary of Defense (Readiness)
  - Deputy Under Secretary (Civilian Personnel Policy)
  - Deputy Inspector General of the Department of Defense
  - Deputy Assistant Secretary of Defense (Clinical and Program Policy)
  - Deputy Director (Administration & Management), OSD
- **Executive Secretary**
  - Joseph J. Angello, Jr., Director, Readiness Programming & Assessment

7

Improving Safety Performance

- Eight DSOC Task Forces
  - Deployment and Operations
  - Aviation Safety Improvements
  - Military Training
  - Personal Motor Vehicle Accident Reduction
  - Installation and Industrial Operations
  - Worker's Compensation
  - Enterprise Information and Data
  - Acquisition and Technology Programs (ATP)

Acquisition and Technology Programs (ATP) Task Force

- Purpose
  - Recommend or implement changes to policies, procedures, initiatives, education and training, and investments to ensure programs address safety throughout the life cycle
- Goals
  - Ensure acquisition policies and procedures for all systems address safety requirements
  - Review and modify, as necessary, relevant DoD standards with respect to safety
  - Recommend ways to ensure acquisition program office decisions consider system hazards
  - Recommend ways to ensure milestone decision reviews and interim progress reviews address safety

Establish dialogue between System Safety and Systems Engineering communities

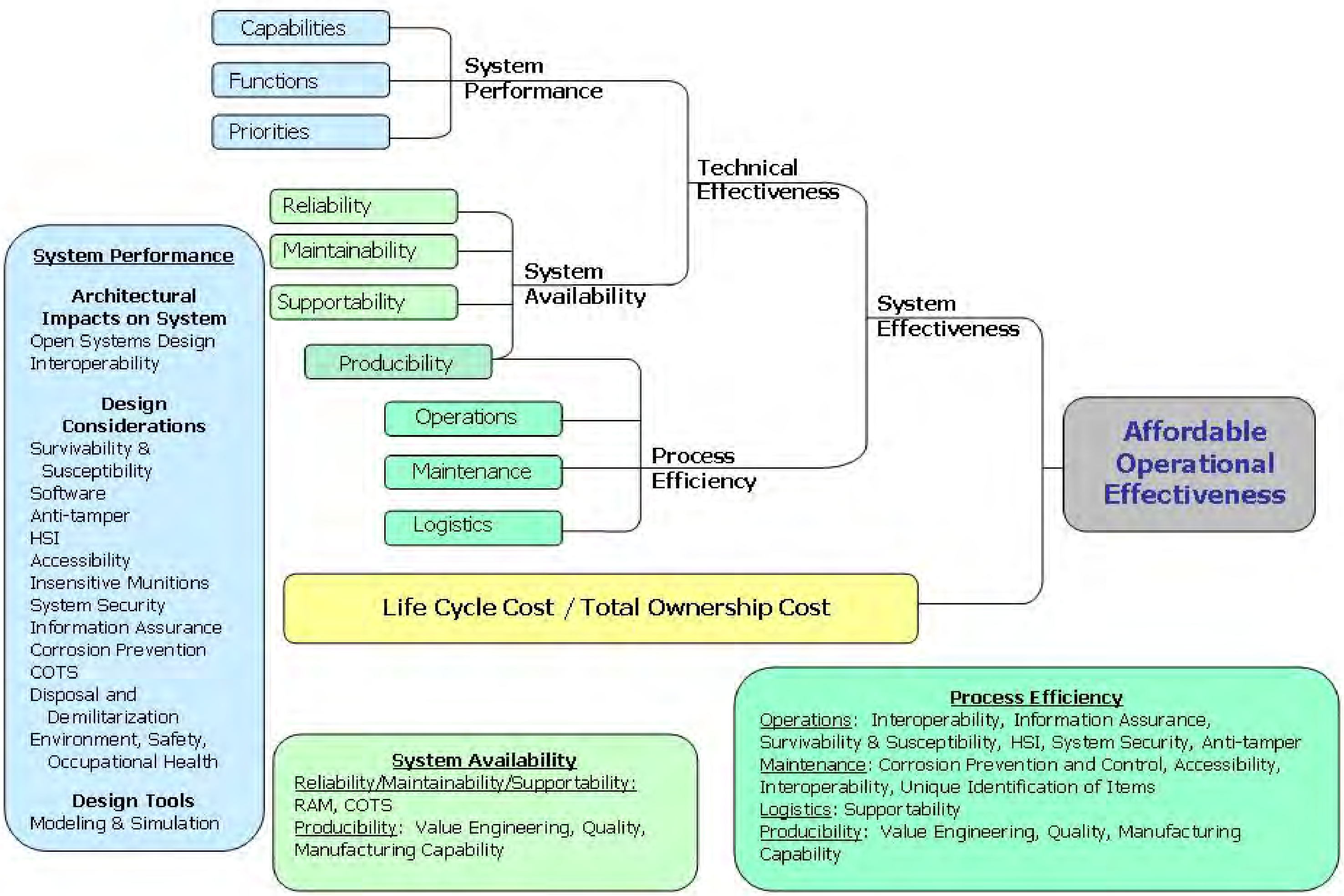
How the ATP Task Force Has Responded

- Issued DoD-wide policy on “Defense Acquisition System Safety” (USD(AT&L) Memo, Sep 23, 2004)—Program Managers shall:
  - Integrate system safety risk management into their overall systems engineering and risk management processes
  - Use Standard Practice for System Safety, MIL-STD-882D, in all developmental and sustaining engineering activities
  - Ensure the Environment, Safety, and Occupational Health (ESOH) risk management strategy is integrated into the SE process and incorporated in the Systems Engineering Plan
  - Identify ESOH hazards, assess the risks, mitigate the risks to acceptable levels, and report status of residual risk decisions at appropriate program reviews per MIL-STD-882D

How the ATP Task Force Has Responded (con't)

- Incorporated ESOH into *Defense Acquisition Guidebook*
  - Programmatic ESOH evaluation (PESHE)
  - ESOH risk management process
- Developed Defense Acquisition University continuous learning course, "System Safety in Systems Engineering" (CLE009)
  - Based on use of MIL-STD-882D
  - Provides roadmap for linking System Safety into SE process
  - Maps System Safety tasks into SE process for each phase

Important Design Considerations "The Fishbone"



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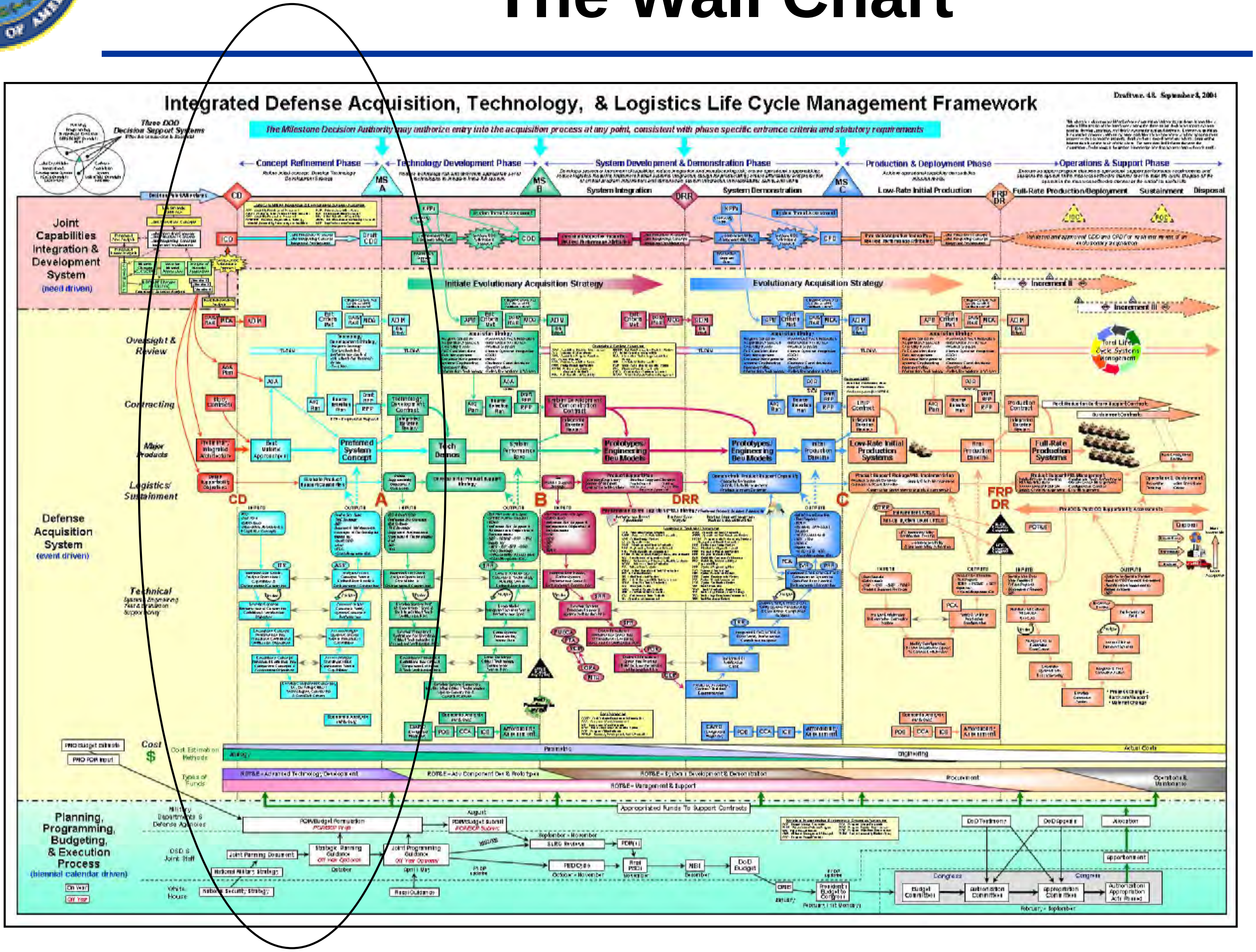
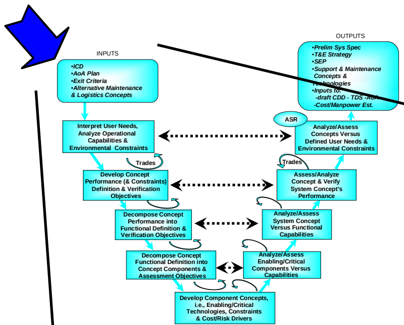
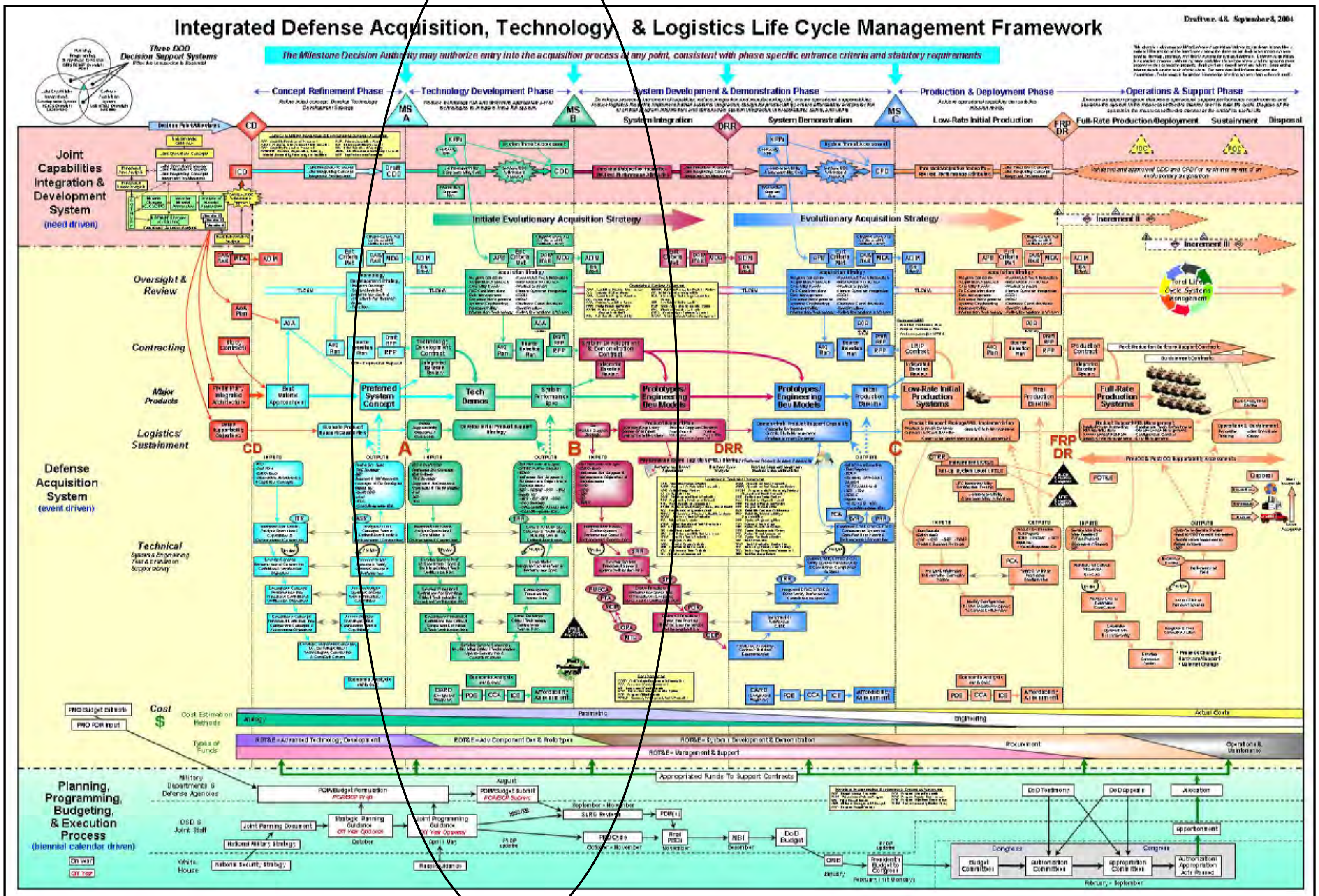


System Safety in SE Process Concept Refinement Phase

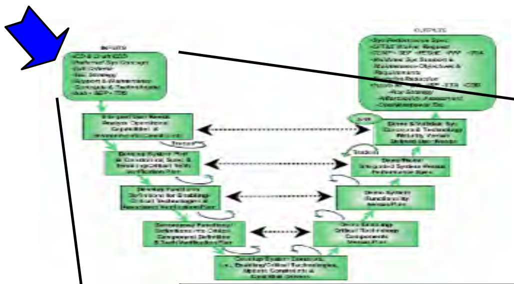


Inputs	System Safety Should:
Initial Capabilities Document (ICD)	Provide inputs as requested
Analysis of Alternatives (AoA) Plan	Participate in AoA development
Exit Criteria	Provide the following exit criteria: 1. Preliminary Hazard List (PHL) 2. Strategy for integrating Environment, Safety, and Occupational Health (ESOH) risk management into systems engineering (SE)
Alternative Maintenance and Logistics Concepts	Provide inputs as requested

SE in the System Life Cycle "The Wall Chart"

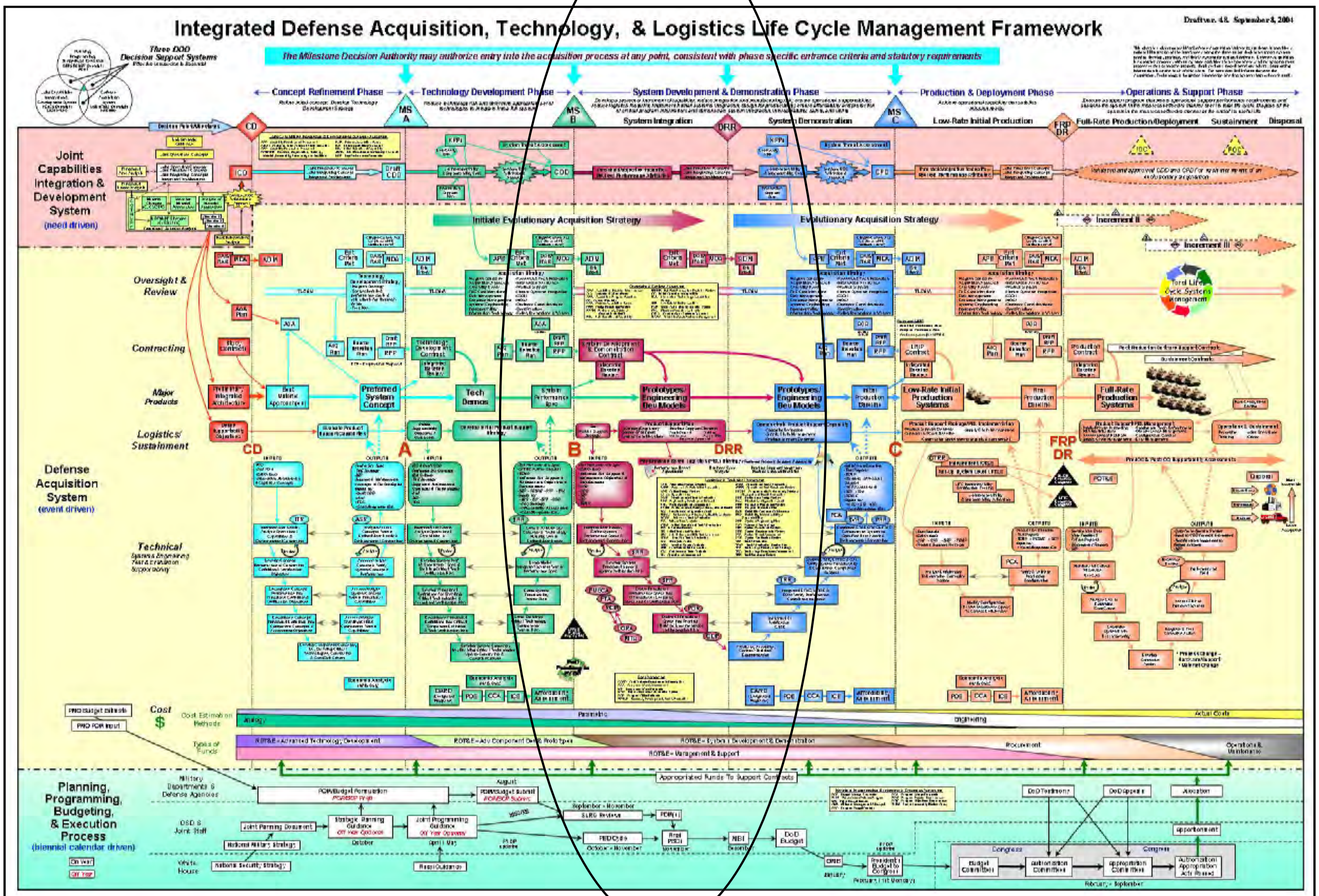


System Safety in SE Process Technology Development Phase

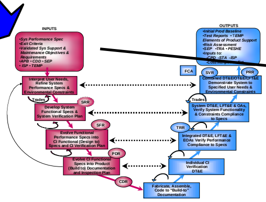


Inputs	System Safety Should:
Initial Capabilities Document (ICD) and Draft Capability Development Document (CDD)	Develop system safety criteria and requirements
Preferred System Concept	Evaluate system concept against identified system safety criteria
Exit Criteria	Provide the following exit criteria: 1. Update Preliminary Hazard List (PHL) 2. Update strategy for integrating Environment, Safety, and Occupational Health (ESOH) risk management into systems engineering (SE)
Test and Evaluation (T&E) Strategy	1. Incorporate hazard risk mitigation test and verification methodologies 2. Provide approach toward obtaining safety release(s)
Support and Maintenance Concepts and Technologies	Provide inputs as requested
Analysis of Alternatives (AoA)	Characterize ESOH footprints or risks for AoA development
Systems Engineering Plan (SEP)	Update strategy for integrating ESOH risk management into SE
Technology Development Strategy (TDS)	1. Include strategy to identify hazards 2. Identify needed ESOH technology development

SE in the System Life Cycle
“The Wall Chart”

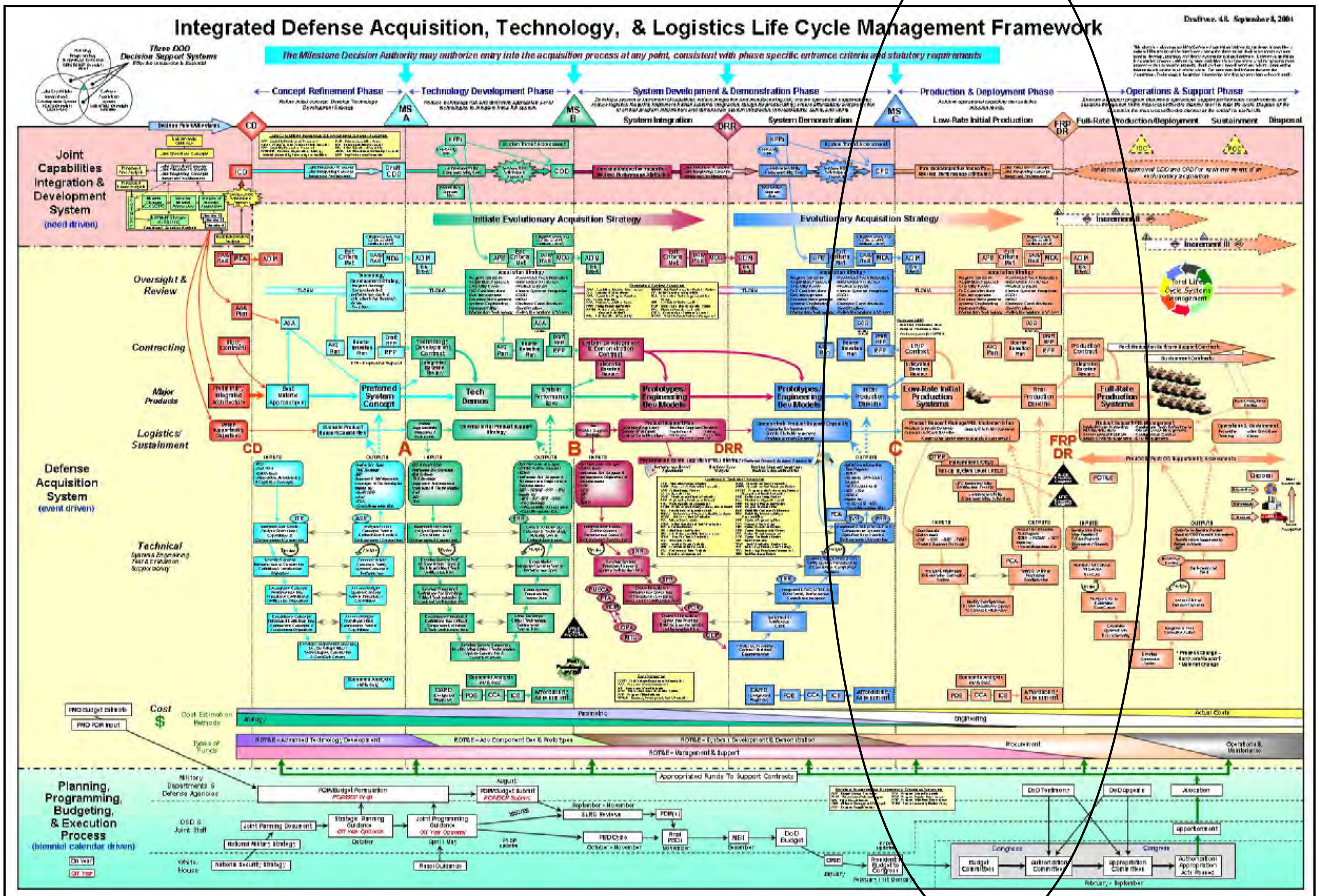


System Safety in SE Process System Development and Demonstration Phase

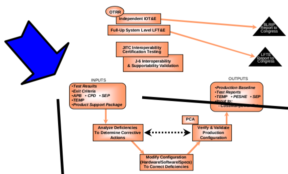


Inputs	System Safety Should:
System Performance Specification	1. Include the Safety Requirements/Criteria Requirements Analysis (SRCA) data 2. Include applicable specifications (e.g., MIL-STD-2105C, MIL-STD-1316, MIL-STD-331, MIL-STD-1901, MIL-STD-464, IEEE/EIA 12207, HAZMAT list to avoid, 29CFR1910)
Exit Criteria	1. Document risk disposition of identified hazards, e.g., Safety Assessment Report (SAR) 2. Obtain concurrence/approval of appropriate safety boards 3. Update Programmatic Environment, Safety, and Occupational Health Evaluation
Validated System Support and Maintenance Objectives & Req.	Identify operating, maintenance, and support hazards
Acquisition Program Baseline	Provide inputs as requested
Capability Development Document (CDD)	1. Identify hazard mitigation requirements 2. Identify insensitive munitions requirements 3. Identify mishap reduction requirements
Systems Engineering Plan (SEP)	1. Update strategy for integrating ESOH risk management into SE (e.g., Integrated Product Team (IPT) Process, technical reviews, etc.) 2. Identify applicable safety boards and process for concurrence/approval
Integrated Support Plan (ISP)	Provide guidance on performance feedback and hazard communication
Test and Evaluation Master Plan (TEMP)	1. Identify specific test requirements (e.g., MIL-STD-2105C, MIL-STD-1316, MIL-STD-331, MIL-STD-1901, IEEE/EIA 12207, 29CFR1910) 2. Identify requirements for verification of risk mitigation controls (based upon system safety analyses) 3. Identify safety release requirements, e.g., SAR

SE in the System Life Cycle
“The Wall Chart”

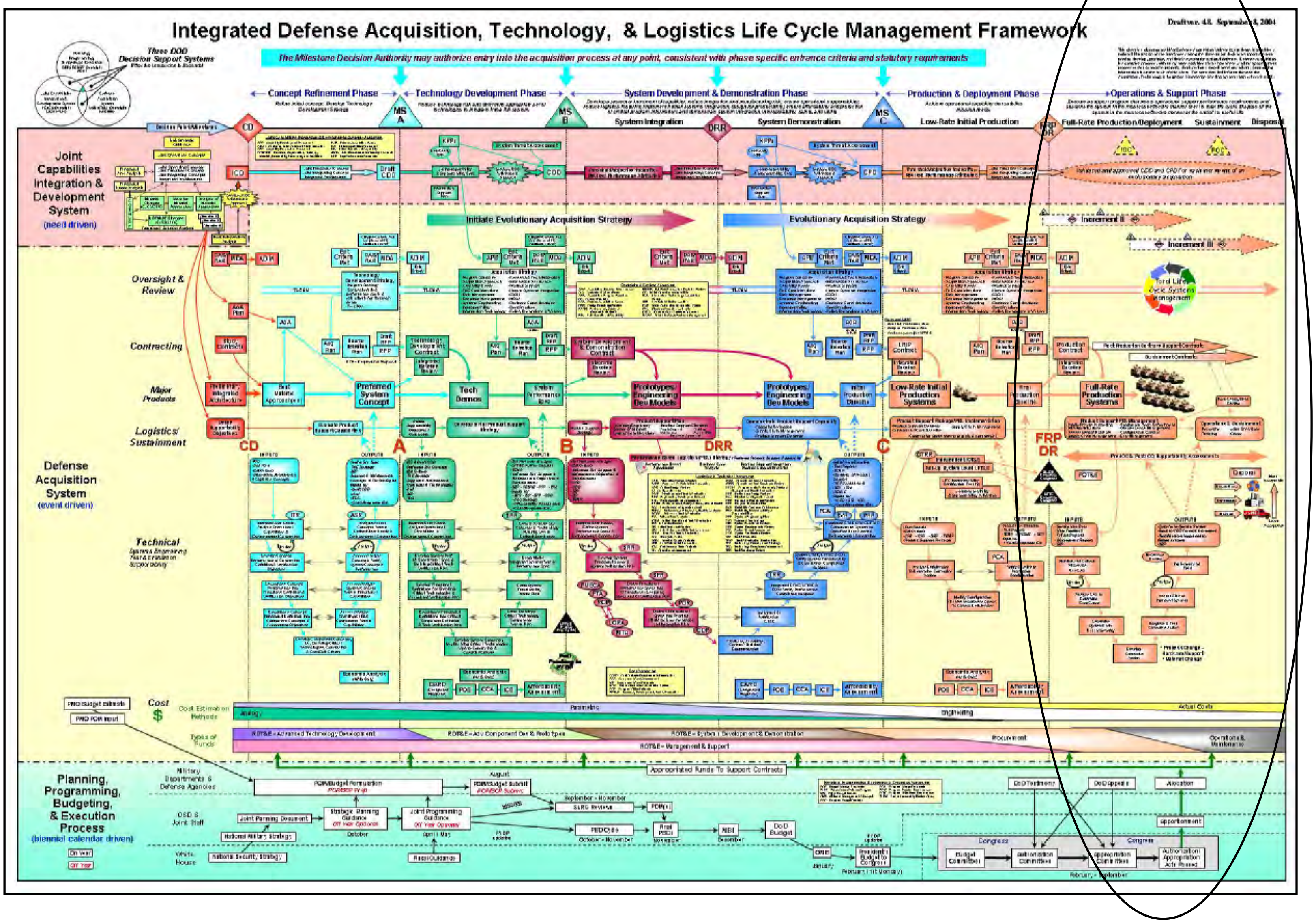


System Safety in SE Process
Production and Deployment Phase

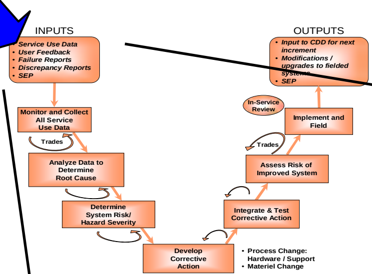


Inputs	System Safety Should:
Test Results	1. Review Initial Operational Test & Evaluation (IOT&E) results for the effectiveness of risk mitigation controls 2. Analyze anomalies, incidents, and mishaps
Exit Criteria	1. Document formal risk disposition of identified hazards, e.g., Safety Assessment Report 2. Obtain concurrence/approval of appropriate safety boards 3. Update Programmatic Environment, Safety, and Occupational Health Evaluation 4. Provide updated inputs for demilitarization/disposal plan
Acquisition Program Baseline	Provide inputs as requested
Capability Production Document (CPD)	1. Update hazard mitigation requirements as necessary 2. Update insensitive munitions requirements as necessary 3. Identify mishap reduction requirements as necessary
Systems Engineering Plan (SEP)	1. Update strategy for integrating ESOH risk management into SE 2. Identify applicable safety boards and process for concurrence/approval
Test and Evaluation Master Plan (TEMP)	1. Update specific test requirements (e.g., MIL-STD-2105C, MIL-STD-1316, MIL-STD-331, MIL-STD-1901, IEEE/EIA 12207, 29CFR1910.95) 2. Update requirements for verification of risk mitigation controls (based upon system safety analyses) 3. Update safety release requirements, e.g., SAR
Product Support Package	Include O&SHA results

SE in the System Life Cycle
“The Wall Chart”



System Safety in SE Process Operations and Sustainment Phase



Inputs	System Safety Should:
Service Use Data	Review for system safety implications
User Feedback	Review for system safety implications
Failure Reports	1. Review Follow-On Operational Test & Evaluation (FOT&E) results for system safety implications 2. Review failure/mishap reports for causal factors or mitigation failures and recommend alternative mitigation measures 3. Assist in mishap investigations as requested
Discrepancy Reports	Review discrepancy reports for system safety implications
Systems Engineering Plan (SEP)	1. Update strategy for integrating ESOH risk management into SE 2. Identify applicable safety boards and process for concurrence/approval

Program Support Reviews System Safety Metrics

- Developing evaluation criteria for System Safety
  - Emphasizing effective integration into Systems Engineering
  - Focused on assessing performance of System Safety
    - Identifying environment, safety, and occupational health hazards
    - Influencing design development to eliminate or mitigate hazards
- Integrating System Safety into Defense Acquisition Executive Summary (DAES) quarterly reporting
  - Piloting with DAES-Sustainment
  - Four System Safety Metrics for Sustainment phase
    - Hazard with highest risk category
    - Class A, B, and C mishap rate trends
    - Open Safety or Hazardous Material technical data change requests
    - System Safety level-of-effort

Summary

- OSD's fundamental role is to set policy, provide relevant and effective education and training, and foster communication throughout the community
- OSD cannot do everything…NOR should we
- Challenges Remain
  - Refocusing Acquirer and Supplier on technical management of programs throughout the life cycle
  - Getting System Safety fully and effectively integrated into the Systems Engineering process to reduce Environment, Safety, and Occupational Health risks & costs

Systems Engineering for Software Assurance

Kristen Baldwin
Office of the Under Secretary of Defense
Acquisition, Technology and Logistics
Systems Engineering

Software Assurance

- ***Scope***: Software is fundamental to the GIG and critical to all weapons, business and support systems
- ***Threat agents***: Nation-state, terrorist, criminal, rogue developer who:
  - » Gain control of IT/NSS through supply chain opportunities
  - » Exploit vulnerabilities remotely
- ***Vulnerabilities***: All IT/NSS (incl. systems, networks, applications)
  - » Intentionally implanted logic (e.g., back doors, logic bombs, spyware)
  - » Unintentional vulnerabilities maliciously exploited (e.g., poor quality or fragile code)
- ***Consequences***: The enemy may steal or alter mission critical data; corrupt or deny the function of mission critical platforms

Software assurance (SwA) relates to the level of confidence that software functions as intended and is free of vulnerabilities, either intentionally or unintentionally designed or inserted as part of the software.

Background

- In July 2003, the Assistant Secretary of Defense for Networks and Information Integration [ASD(NII)] established the Software Assurance Initiative to examine software assurance issues
- On 23 Dec 04, Undersecretary of Defense for Acquisitions, Technology and Logistics [USD(AT&L)] and ASD(NII) established a Software Assurance (SwA) Tiger Team to:
  - Develop a holistic strategy to reduce SwA risks within 90 days
  - Provide a comprehensive briefing of findings, strategy and plan
- On 28 Mar 05, Tiger Team presented its strategy to USD(AT&L) and ASD(NII) and was subsequently tasked to proceed with 180 day Implementation Phase

Guiding Principles for DoD SwA Strategy

- Understand problem from a systems perspective
- Response should be commensurate with risk
- Sensitive to potential negative impacts
  - » Degradation of our ability to use commercial software
  - » Decreased responsiveness/ increased time to deploy technology
  - » Loss of industry incentive to do business with the Department
  - » Minimize burden on acquisition programs
- Exploit and extend relationships with:
  - » National, international, and industry partners
  - » DoD initiatives, e.g., trusted integrated circuits and Information Assurance

DoD SwA Strategy – Primary Elements

- Partner with Industry to focus science and technology on research and development of technologies
  - Improve assured software development tools and techniques
  - Strengthen standards for software partitioning and modularity
  - Enhance vulnerability discovery
- Employ repeatable Systems Engineering (SE) and test processes to identify, assess, and isolate critical components, and mitigate software vulnerabilities
- Leverage and coordinate with industry, academia and national and international partners to address shared elements of the problem

Industry Outreach

Goal: Partner with industry to create a competitive market that is building demonstrably vulnerability-free software

- USD(AT&L)/ASD(NII) memo to Industry
  - » Requested participation in an Executive Roundtable

- Tiger Team held initial meetings with directors:
  - » National Defense Industrial Association (NDIA)
  - » Government Electronics & Information Technology Association (GEIA)
  - » Aerospace Industries Association (AIA)
  - » Object Management Group (OMG)

- Identified areas of interest for SwA white papers
  - » OMG will leverage ongoing standards activities
  - » NDIA hosting SwA Summit; will consider SE, C4ISR, IT implications
  - » GEIA will share lessons and collaborate to develop new processes
  - » AIA will help integrate SwA processes into mainstream integration activities

NDIA Software Assurance Summit, 7-8 Sep 05

Summit Purpose

- **Explore the range of opportunities for a long term solution to the issue of software assurance to consider how we can force the desired capability.**
- **Bring together Government and Industry in partnership to consider the way forward, such as**
  - » **Focus on science and technology**
  - » **Improve software development tools and techniques**
  - » **Strengthen standards**
  - » **Enhance vulnerability discovery**
  - » **Use Systems Engineering and test processes to identify assess, and isolate critical components and mitigate vulnerabilities**
  - » **Leverage and coordinate with industry, academia and national and international partners in achieving the desired goals**
  - » **Apply techniques used in other industries for certification and mission assurance**

SwA Summit Activities

- Plenary panel discussions/briefings from DoD, Department of Homeland Security and Industry
- Conducted Four Breakout Sessions:
  - » Standards, Metrics, Models
  - » Industry Best Practices
  - » Engineering Processes
  - » Science and Technology
- Attendance
  - » 40 in attendance
    - 17 Industry
    - 5 Academia
    - 18 Government/FFRDC
- Proceedings posted on NDIA website

Systems Engineering for SwA - Many Alternatives to Consider

- Design around the problem
  - » Added emphasis on DoD systems engineering practices to mitigate COTS-based risks
- Build better products
  - » Vector commercial products to enhance bounding and controllability
- Better understanding of what's in the product
  - » Enhance transparency, testability and understandability of product software code
- Use High Assurance products selectively where needed
  - » Use DoD security components in critical functions and at key architecture junctures
- Many more possible avenues…

Potential SE Support for SwA

- Top level definition:
  - » Focus SE on the issues of SwA
  - » Design SwA into the product instead of adding it on
- Top level approach:
  - » Work with industry to define SE enhancements
- Derive reasonable and cost effective enhancements
  - » Insert agreed enhancements into DoD acquisition policies & guidance

SE Processes (Defense Acquisition Guidebook)

Technical Mgt Processes	Technical Processes
Decision Analysis (5) (3)	Requirements Development (1)
Technical Planning	Logical Analysis
Technical Assessment (8)	Design Solution (2)
Requirements Mgt	Implementation
Risk Mgt (7)	Integration
Configuration Mgt (9)	Verification (4)
Technical Data Mgt	Validation (6)
Interface Mgt	Transition
	(Overarching:) (10) (11) (12)

What Key SE processes can we enhance to achieve the best effects?

(#) = potential EID SE process intersects

Notional SE Support Mechanisms (1 of 2)

1. **Develop a common core set of tailorable SwA requirements & metrics**
2. **Develop an approach for performing operational SwA sensitivity analysis**
3. **Develop an approach for identifying SwA driven scenarios for use in Analyses of Alternatives (AOA) and hazard analyses**
4. **Develop candidate SwA test metrics for inputs to Test and Evaluation Master Plan (TEMP) SwA Annexes, to include applicable:**
5. **Define an approach for SwA applicable Modeling and Simulation (M&S)**
6. **Define a mechanism for selective technical “red-team” reviews of key software**

Notional SE Support Mechanisms (2 of 2)

7. **Develop a common core set of SwA threats and vulnerabilities with probability and consequence metrics**
8. **Develop top-level Software and SwA Entry/Exit Criteria for SE Technical review(s)**
9. **Develop an enhanced SwA informed CM process to ensure full life cycle protection**
10. **Examine strategies for providing enhanced DoD SwA Standards leadership and management**
11. **Develop and implement education, training and certification avenues for acquisition participants**
12. **Define a continuous process improvement approach based upon evolving threat assessments through an engineering community sensitized to SwA**

Way Ahead

We must create a competitive market that is building demonstrably vulnerability-free software

Revitalization of Systems Engineering: Past, Present and Future

Karen B. Bausman
NDIA 25 October 2005
Air Force Center for Systems Engineering
937-255-3355 ext 3331
DSN 785-3355 ext 3331
Karen.bausman@afit.edu

Overview

- OSS&E
- Background
- AFMC Revitalization Plan
- SAF SE Activities
- DoD SE Activities
- Current Initiatives and Products
- Conclusions

Why do we care?

"Increasingly, I'm convinced that the systemic problem is in the field of systems engineering."

– Air Force Times, 24 Jun 02

AFMC SE Revitalization Plan

AETC

ENGINEERING & TECHNICAL MGT

S E Revitalization Plan

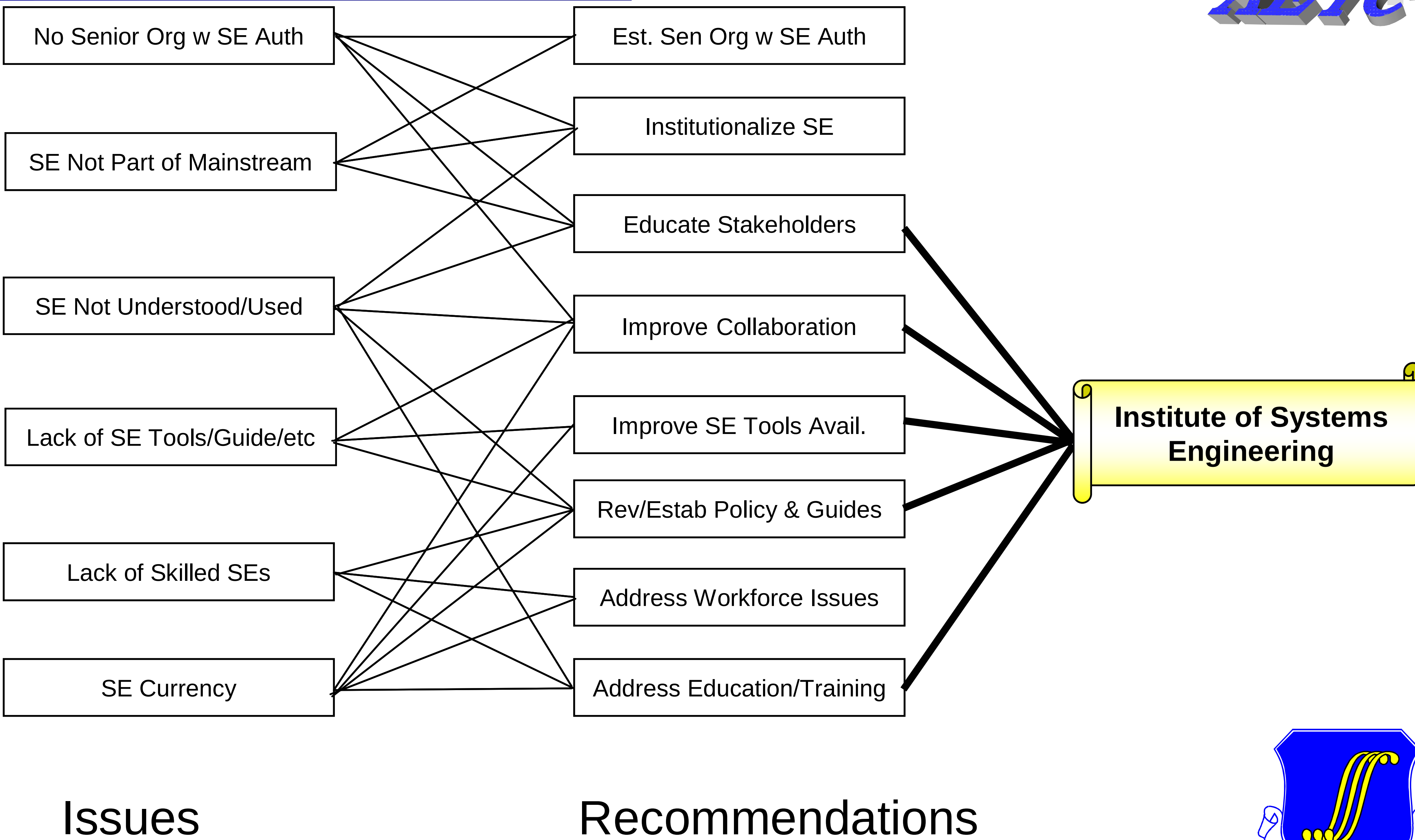
1. Senior Level Champion and Support
2. Evaluating at all existing policies/instructions for currency/connectivity between "Lust to Dust"
3. Developing a USAF guide/pocketbook for Systems Engineering Management
4. Increase interaction with industry to ensure improved implementation on Acquisition and Sustainment Programs
5. Reviewing education/training requirements
6. Developing civilian career path and military field for Systems Engineering Management Professionals*
7. Establishing Institute for Systems Engineering – Later changed to Air Force Center for Systems Engineering (CSE)

* Remember Systems Engineering Management is not just for Engineers

AF SE Focus Forum

- Questions to be addressed:
  - What are the Gaps in existing Systems Engineers knowledge and performance?
  - How should the ISE fill those Gaps?
  - What organizational structure should ISE have (i.e. reporting chain)?
  - How do we know when the ISE is successful?
  - How do we plan for expansion from just AFMC/AFIT ISE to DoD National ISE?
- Invited Participants
  - AFMC/EN, ASC/EN, SMC/AX, WR/ALC
  - MITRE, Aerospace, RAND, Navy, Army
  - AFIT, USC, George Mason
  - Boeing, Raytheon, Northrop Grumman, NDIA, INCOSE

SE Focus Forum Results



Air Force CSE

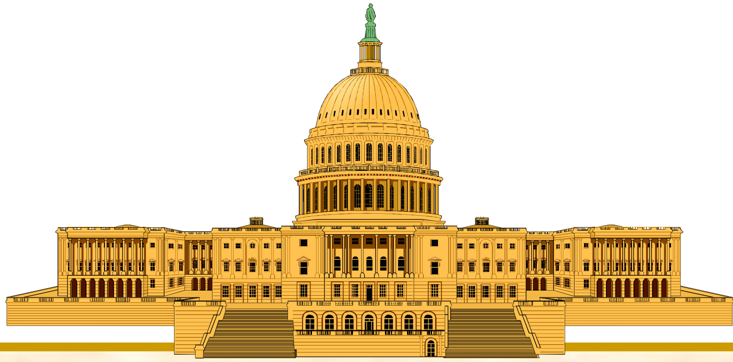
- Purpose:
  - Collaborate the education and training of engineers and managers in basic systems engineering/management processes and principles, best practices, tools, industry standards, lessons learned giving them the right questions to ask
  - Provide consultative services through the establishment of a senior level group of industry, government, and academia experts
  - Advocate and maintain systems engineering/ management process and tools in order to sustain a robust disciplined process into the future

Systems engineering is not learned entirely in the classroom, it is also learned with hands-on experience working on real systems

SAF SE Activities

Congressional Testimony

AETC



"We need to instill an adequate systems engineering foundation within the acquisition process. Systems engineering is one of the bedrocks of sound management for acquisition programs as it ensures that contractor-proposed solutions are consistent with sound engineering principles. Decisions based on a solid systems engineering approach will ensure our program managers will be better prepared to assess their programs' health and will help to keep programs on budget and schedule. As such, I am implementing a process by which *all future Milestone Decision Authorities will not sign out any future Acquisition Strategy Plans that lack the necessary attention to systems engineering.* Additionally, I am demanding *systems engineering performance be linked to the contract award fee or incentive fee structures*. This link will help ensure the industry will also follow a sound systems engineering approach."

-- 2 Apr 03

Policy History

Policy Memo 03A-001, 6 Jan 03, "Incentivizing Contractors for Better Systems Engineering"

- Directed action on current programs within 90 days
- Provided direction for future acquisitions
- Provided examples of incentive/award fee plan provisions and SE tools

Policy Memo 03A-003, 15 Jan 03

- Clarified importance of AFMC, AFSPC, ACE and engineering organizations as conduit for expertise

Policy Memo 03A-005, 09 Apr 03

- Consolidated 03A-001 and 03A-003
- Directed action on current programs by 30 Apr 03
- Directed Re-invigorating Basics of Sound SE Disciplines

Policy site: http://www.safaq.hq.af.mil/acq_pol/afpolicies.shtml

Critical Steps for Front Ends

- Risk Assessment to Identify, Classify and Measure all Performance, Cost and Schedule Issues
- Technical Strategies that Evolve from Risk Assessment and are Integrated with Business and Sustainment Strategies
- Develop Program IMP and Share with Bidders
- Evaluation Criteria that Clearly Define Levels of Acceptability for:
  - All Product Performance, Cost and Schedule Issues and Risks
  - All Proposal Performance (Process and Practice) Issues and Risks
  - Contractor Past Performance in Critical Areas and Risk
  - Potential Show Stoppers
- Statement of Objective that Focuses on solid SE Approach
- RFP that overlays an organized structure based on Risk and Strategies
- A Systems Thinking Team that works together to cross the t's, dot the i's, ensures legality and covers bases

SAF SE Focus Areas

People Processes Policy Programs

Good SE Processes

- Structured Requirements Development for Performance and Verification with Feedbacks
- Risk Management Program Integrated with Other Processes
- Baseline Management Flexible enough to Support Program
  - Allocation to Subs and Vendor levels
  - Traceability for Subs and Vendors
  - Control for all Levels
  - Integrated Baseline/Change Reviews that look at performance, cost and schedule
- Process Checklists
- Event Based Schedules with Measurable Completion Criteria

If Its Not Documented It ISN"T Repeatable or Improvable!

How to Measure SE Processes

- Focus on IMP Completion Criteria for Measuring Progress & Maturation
  - Tie to Progress Payments
- Interact with Quality Department (Contractor and Government) to Track Process and Practice Implementation
- Initiate Technical Performance Measures for Critical Technical Parameters
- Co-Chair Contractors CCB
- Participate in Contractors Risk Assessments and Updates
- Participate in Contractors Reviews with Subcontractors and Major Vendors
- Use Measurable Criteria that reflect Systems Engineering
  - Use leading indicators, hold periodic award fee reviews, periodic plan changes, and board meetings as opportunity for appropriate refocus

Remember – We Measure To Improve!!!!!

DoD SE Activities

Top Five S E Issues*

- Lack of awareness of the importance, value, timing, accountability, and organizational structure of SE on programs
- Adequate, qualified resources are generally not available within government and industry for allocation on major programs
- Insufficient SE tools and environments to effectively execute SE on programs
- Poor initial program formulation
- Requirements definition, development, and management is not applied consistently and effectively

* Based on an NDIA Study in January 2003

DoD S E Shortfalls*

- Root cause of failures on acquisition programs include:

  – Inadequate understanding of requirements
  – Lack of systems engineering discipline, authority, and resources
  – Lack of technical planning and oversight
  – Stovepipe developments with late integration
  – Lack of subject matter expertise at the integration level
  – Availability of systems integration facilities
  – Incomplete, obsolete, or inflexible architectures
  – Low visibility of software risk
  – Technology maturity overestimated

  • DoD-directed Studies/Reviews

Major contributors to poor program performance

DoD Revitalization of S E

- Issued systems engineering (SE) policy
- Issued guidance on SE and test and evaluation (T&E)
- Established SE Forum—senior-level focus within DoD
- Instituted system-level assessments in support of OSD major acquisition program oversight role
- Working with Defense Acquisition University to revise SE, T&E, and enabling career fields curricula
- Integrating Developmental T&E with SE policy and assessment functions—focused on effective, early engagement of both
- Leveraging close working relationships with industry and academia

DoD Response Policy

- 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)

Driving systems engineering back into programs

DoD Response
Guidance and Tools

- Defense Acquisition Guidebook:
  - –SE in DoD Acquisition–SE Processes
  - –SE Implementation in the System Life Cycle
  - –SE Tools and Techniques, and SE Resources
  - –Test & Evaluation

- Systems Engineering Plan:
  - –Interim guidance
  - –Preparation Guide
  - –Twenty-five focus areas to address in technical planning
    - •One each, tailored for Pre-SDD, SDD, and Sustainment

DoD Response
Guidance and Tools

- SE in the Integrated Defense AT&L Life Cycle Management Framework Chart (v5.1)
- Guides (in development):
  - Reliability, Availability, and Maintainability
  - Risk Management
  - Integrated Master Plan/Integrated Master Schedule
  - Contracting for SE
- Tools:
  - Defense Acquisition Program Support
  - Initial Operational T&E (IOT&E) Readiness
  - Capability Maturity Model Integrated Acquisition Module (CMMI-AM)

http://www.acq.osd.mil/ds/se

Current SE Initiatives/Products

- Senior Level Champion and Support
  - SAF/AQR Technical Leaders Roundtable
  - DoD SE Senior Level Forum

- Evaluating at all existing policies/instructions
  - - SE AFI 63-XXX In Coordination

- Developing a USAF guide/pocketbook for Systems Engineering Management
  - Defense Acquisition Guide, DoD SEP Guide
  - CSE SE Handbook, CSE SEP Guide

- Increase interaction with industry to ensure improved implementation on Acquisition and Sustainment Programs

  - NDIA, INCOSE, GEIA, AIAA, AIA, IEEE, et al

Current SE Initiatives/Products

- Reviewing education/training requirements
  - Revamped SE Masters Program at AFIT
  - Created SE Certificate Program at AFIT
  - Established SE PhD Program at AFIT
  - Established Distance Learning Methods at AFIT
  - Established Academic Agreements through Outreach

- Developing civilian career path and military field for Systems Engineering Management Professionals*
  - AFMC Established Engineering Focal Points and Home offices at each Center
  - AFMC Defining SE Core Competancies

- Establishing Institute for Systems Engineering – Later changed to Air Force Center for Systems Engineering (CSE)

Current SE Initiatives/Products

- Influence and institutionalize systems engineering process
  - Policy, process, practices, tools
    - Collaboration with government, industry & academia
  - Advocacy / consultation
  - Rotational program

App/Dev

- Educate the workforce
  - Academic programs
    - Graduate programs – MS, PhD & certificate
    - Intermediate Developmental Education Program
    - Seminars, workshops, short courses
    - Outreach--provide accessibility at key locations
  - Case studies

Education

Critical Behaviors

- Systems Thinking
  - All Functionals Learn Technical Basics of System
  - All Functionals Participate in Risk Assessments
  - All Functionals Bring Their Strategies to Table to Develop Overall Program Acquisition Strategy
- Integrating the Total System
  - Institute a Flexible Baseline Management System for Government Documentation Prior to Contract Award
    - Risk Assessment and Measures, Functional Strategies, SAMP, ASP, RFP, SSP
  - All Functionals Identify and Share Information That Impacts Change to Program Baselines
- Discipline, Discipline, Discipline…
  - Ensure Flexible Baseline Management System Proposed for Systems/Subsystems/Major Vendor Levels and IS IMPLEMENTED

Attitude Is Everything!!!!

Conclusions

- Making Progress with Current Innovations and Products
- ALL ORGANIZATIONS Need to Work Closer Together
- Need Serious Involvement with Sustaining Organizations
- Need to Establish Measurement Guides for Effectiveness
- Would Like to Engage Industry
  - Presence at CSE
  - Help in Defining “Better Way to do Business”

The Management of Logistics in Large Scale Inventory Systems to Support Weapon System Maintenance

Eugene A. Beardslee, SAIC
and
Dr. Hank Grant
Department of Industrial Engineering,
University of Oklahoma

Briefing Overview

- Problem Definition and Scope
- Background
- Challenges
- Solving the problem

Problem Definition

- Classic inventory problems
  - How much to stock?
  - When to order?
  - How much to order?
- Difficult problem without demand data
  - When will the stock location run out of inventory?
- Multiple Consumers, Multiple interrelated maintenance tasks
- No access to planning and production data
- Multiple-criteria optimization problem

Minimize Inventory Management Cost

- Holding Cost
  - Parts
  - Physical Space
  - Stocking Labor
- Penalty Cost
  - Idle workers
  - Delayed tasks
- Order Cost
  - Inventory Review
  - Shipping
  - Receiving
  - Forward Locating

Maximize Performance

- Inventory Bin Fill Rate
- Service Rate
- Inverse Waiting time

Background

- Bench stock inventory
- More than 400,000 stock locations
- More than 100,000 inventory items
- Over 1.8 million transactions over three years
- Multiple weapon systems:F-15, F-16, C-130, C-141, C-5, KC-135, B-1B, B-52, B-2, E-3, E-6A, FA-18, P-3, H-60, AV-8, and others.
- Multiple Sites: OCALC, OOALC, WRALC, JXNADEP, NINADEP, CPNADEP

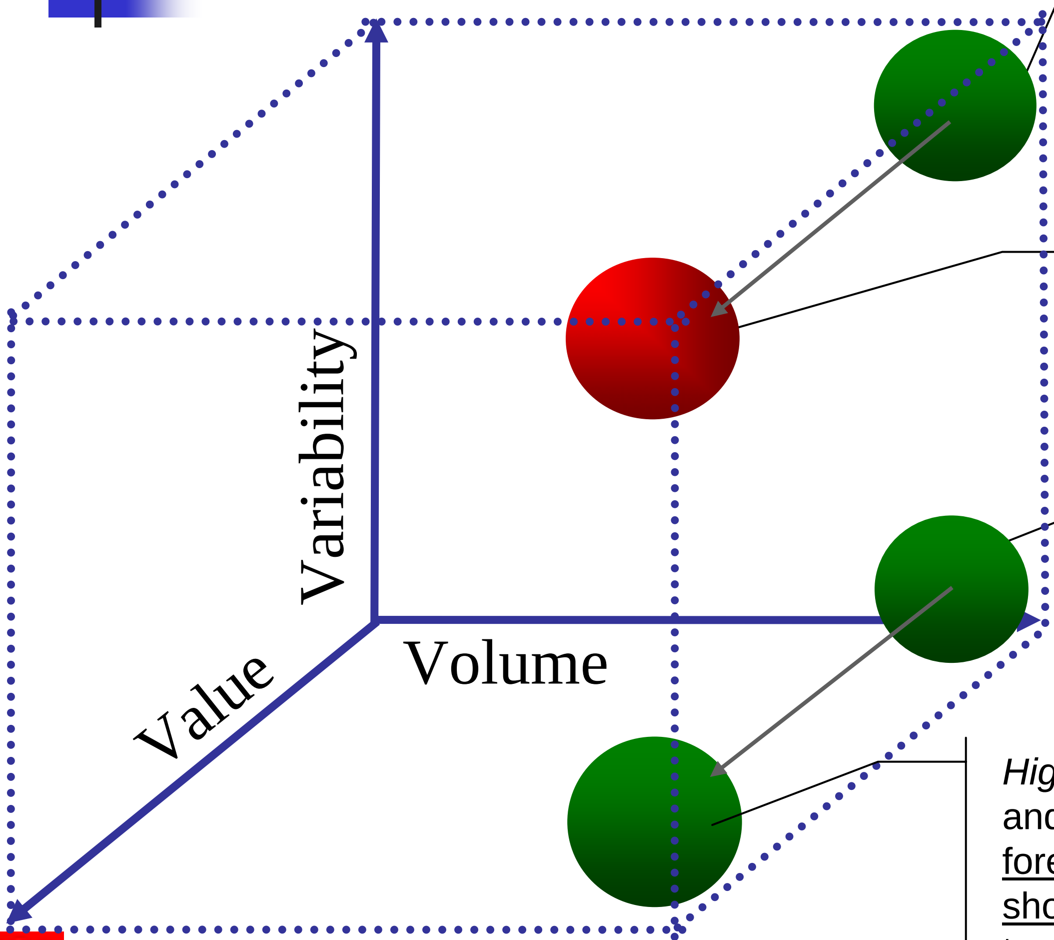
Challenges

- Detecting stock-out conditions
- Forecasting demand
- Identifying inventory policy errors
- Compensating for variability of the maintenance environment
- No access to planning and production data

More Challenges

- Exact item count in inventory location is unknown
- Accurate inventory review is not economically feasible
- Reorder level is an estimate
- Reorder quantity is fixed
- Items removed from the stock locations for direct use

Insights: Inventory Segmentation



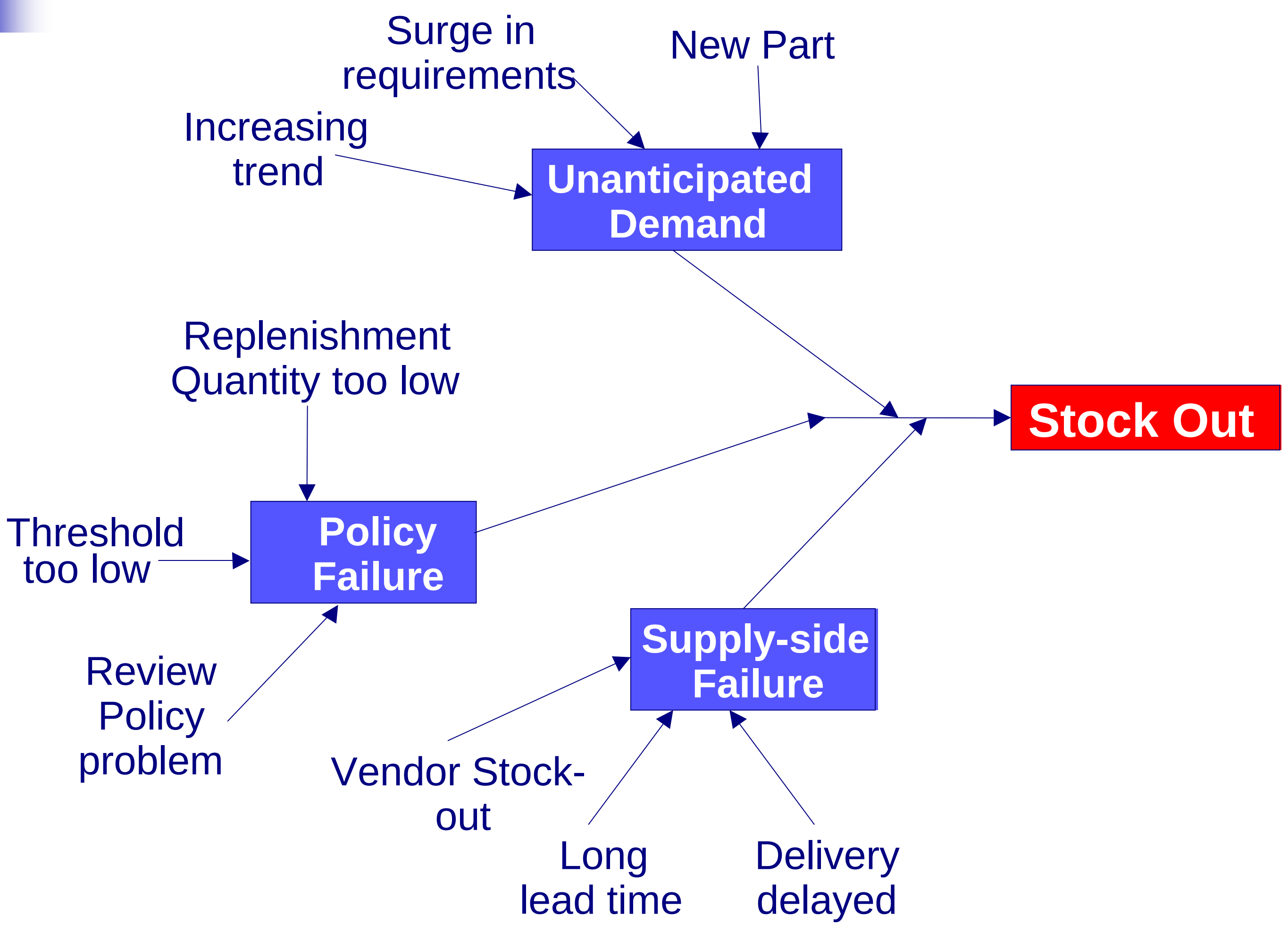
Low value parts with *highly variable* and *high volume* demand can have high reorder thresholds (safety stock) to avoid stockouts without incurring excessive inventory costs.

High value parts with *highly variable* and *high volume* demand would benefit from demand forecasts based on anticipated needs to minimize the value of stock on hand.

Low value parts with *low variability* and *high volume* demand could be "auto-replenished" based on historical demand patterns – lowering inventory review costs.

High value parts with *low variability* and *high volume* demand could be forecasted to assist suppliers, but should be reviewed more frequently to minimize overstock conditions.

Stock Out Triggers

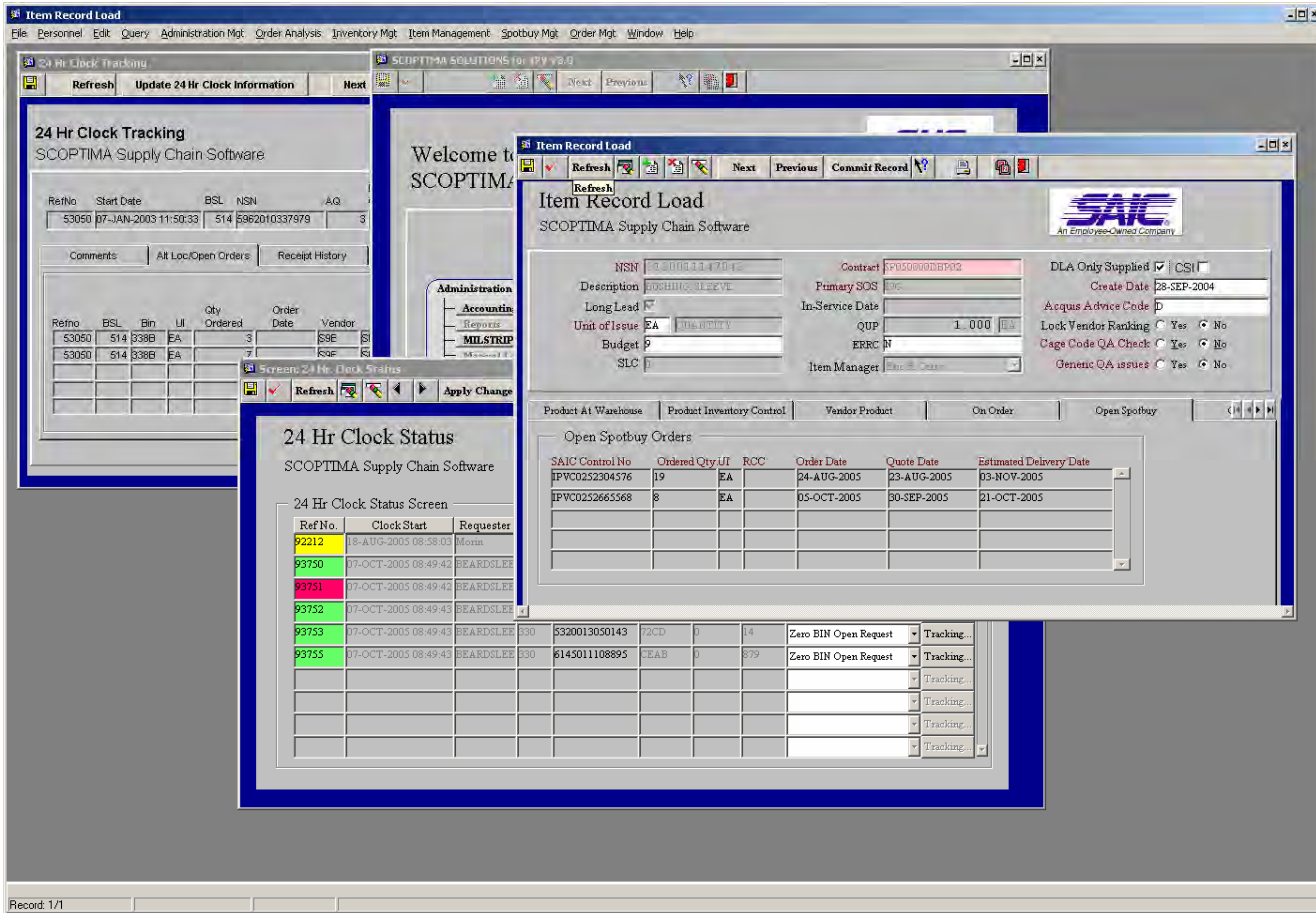


Solving the problem: Daily

- Unmanned Bench Stock Location
  - Material is placed in a bin and mechanic takes what he needs
  - If a bin is empty, inventory manager is notified and generates an emergency PR to Vendor
  - Conduct physical review of each bench stock location twice per week to create routine replenishment
- Emergency Requirements Management
  - Each emergency requirement is tracked from birth to death
- Stock outage Management
  - Intensive management to ensure parts are in the bin
  - Focuses manager on potential problems
- Web based asset visibility
- EDI Ordering and Invoicing

Enterprise Supply Chain System: SCOPTIMA™

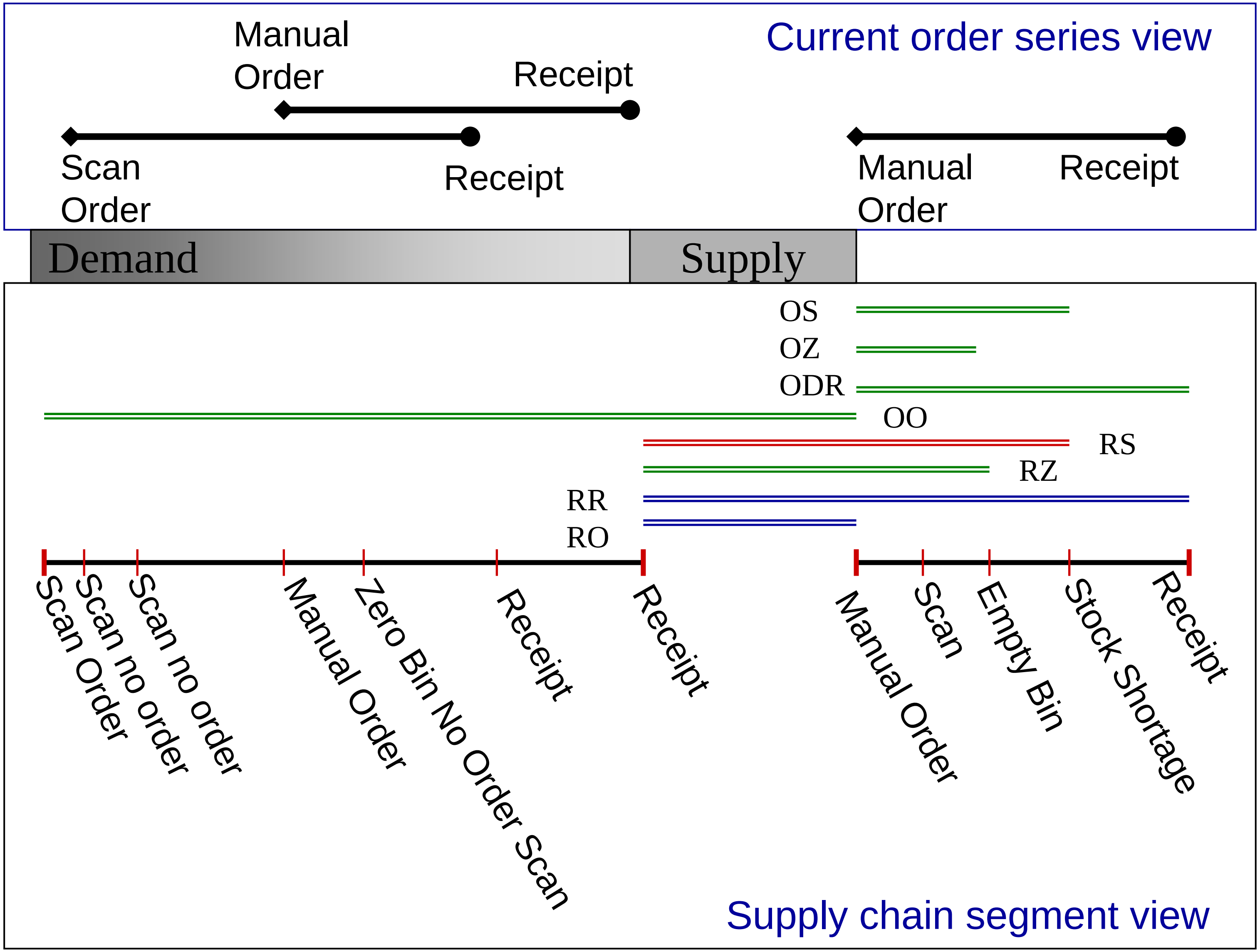
- Oracle DBMS with custom user and system interfaces
- User-friendly interface for management queries
- Maintains record of supply chain events
  - Bin scan to generate potential order (hand-held device)
  - Order generation based on rule set (automated)
  - EDI order placement to vendor(s)
  - Order receipt and replenishment (physical inspection and confirmation)
  - EDI invoicing
- Supports analysis to identify historical demand patterns and relationships through simulation and data mining


Item Record Load
File Personnel Edit Query Administration Mgt Order Analysis Inventory Mgt Item Management Spotbuy Mgt Order Mgt Window Help
24 Hr Clock Tracking
Refresh
Update 24 Hr Clock Information
Next
24 Hr Clock Tracking
SCOPTIMA Supply Chain Software
RefNo Start Date BSL NSN AQ
53050 07-JAN-2003 11:50:33 514 5962010337979 3
Comments
Alt Loc/Open Orders
Receipt History
Refno BSL Bin UI Qty Ordered Order Date Vendor
53050 514 338B EA 3 S9E
53050 514 338B EA 7 S9E
Next
Previous
Welcome t
SCOPTIMA
Administration
Accounting
Reports
MILSTRIP
Screen: 24 Hr. Clock Status
Refresh
Apply Change
24 Hr Clock Status
SCOPTIMA Supply Chain Software
24 Hr Clock Status Screen
Ref No. Clock Start Requester
92212 18-AUG-2005 08:58:03 Morin
93750 07-OCT-2005 08:49:42 BEARDSLEE
93751 07-OCT-2005 08:49:42 BEARDSLEE
93752 07-OCT-2005 08:49:43 BEARDSLEE
93753 07-OCT-2005 08:49:43 BEARDSLEE 330 5320013050143 72CD 0 14 Zero BIN Open Request Tracking...
93755 07-OCT-2005 08:49:43 BEARDSLEE 330 6145011108895 CEAB 0 879 Zero BIN Open Request Tracking...
Tracking...
Item Record Load
Refresh
Next
Previous
Commit Record
Item Record Load
SCOPTIMA Supply Chain Software
SAIC
An Employee-Owned Company
NSN
Description
Long Lead
Unit of Issue EA
Budget 9
SLC
Contract
Primary SOS
In-Service Date
QUP 1.000
ERRC N
Item Manager
DLA Only Supplied
CSI
Create Date 28-SEP-2004
Acquis Advice Code D
Lock Vendor Ranking Yes No
Cage Code QA Check Yes No
Generic QA issues Yes No
Product At Warehouse
Product Inventory Control
Vendor Product
On Order
Open Spotbuy
Open Spotbuy Orders
SAIC Control No Ordered Qty UI RCC Order Date Quote Date Estimated Delivery Date
IPVC0252304576 19 EA 24-AUG-2005 23-AUG-2005 03-NOV-2005
IPVC0252665568 8 EA 05-OCT-2005 30-SEP-2005 21-OCT-2005
Record: 1/1

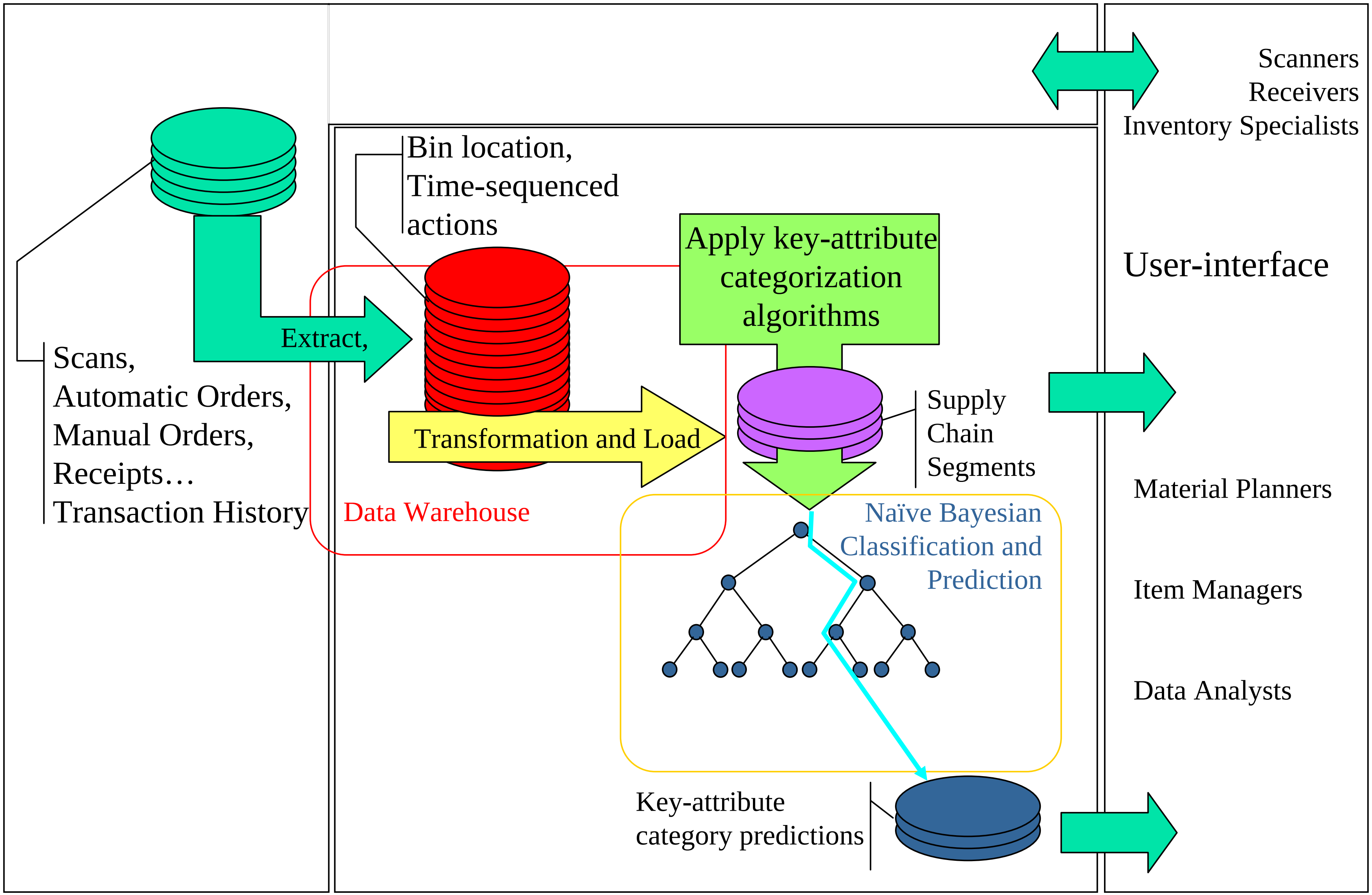
Applying Technology

- Data Warehousing
- Data Mining
- Simulation
- Time-series Forecast modeling
- Dynamic data display

Key Transaction Events



SCOPTIMA™ Data Mining



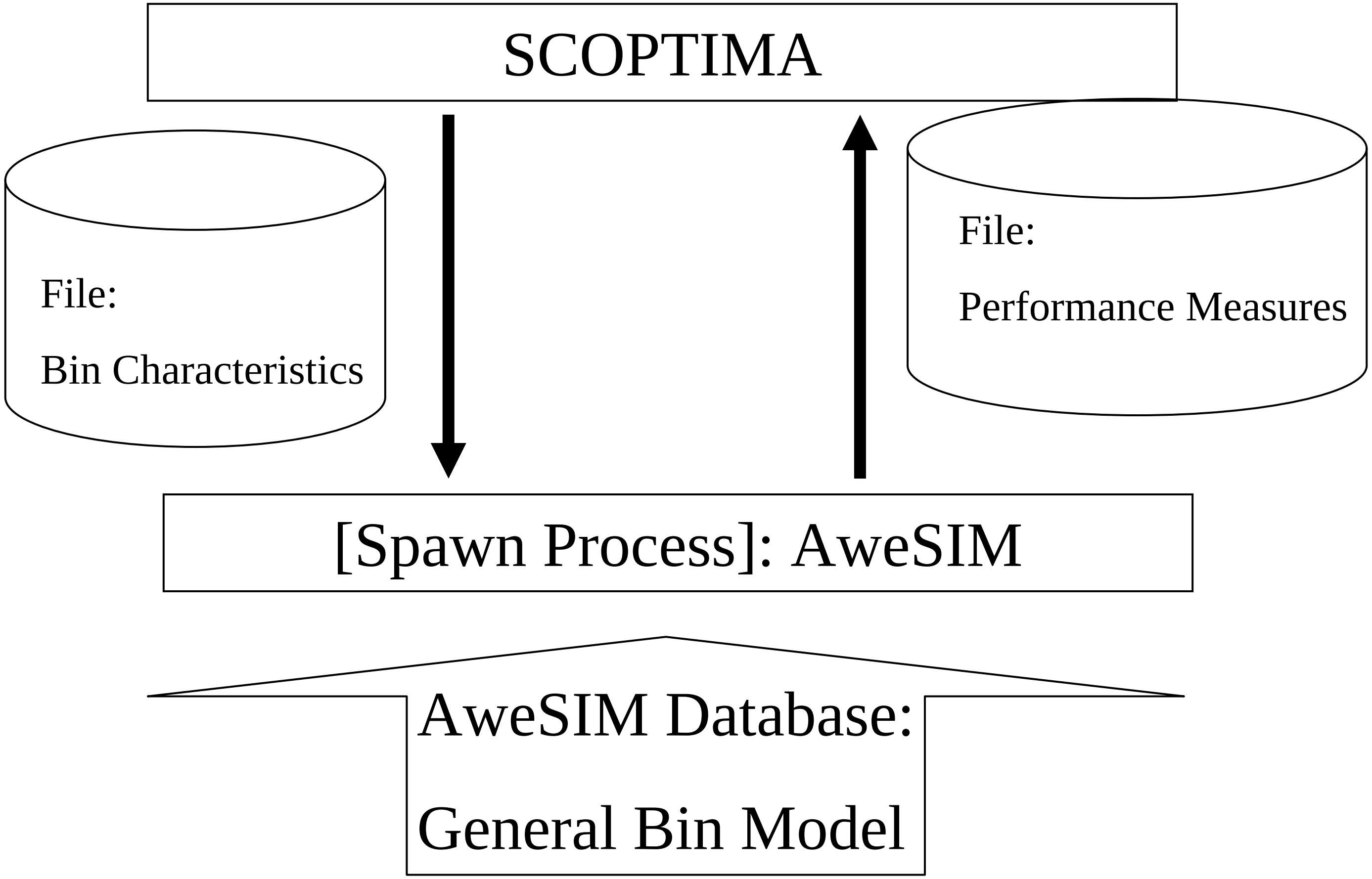
Integration of SLAM and SCOPTIMA™

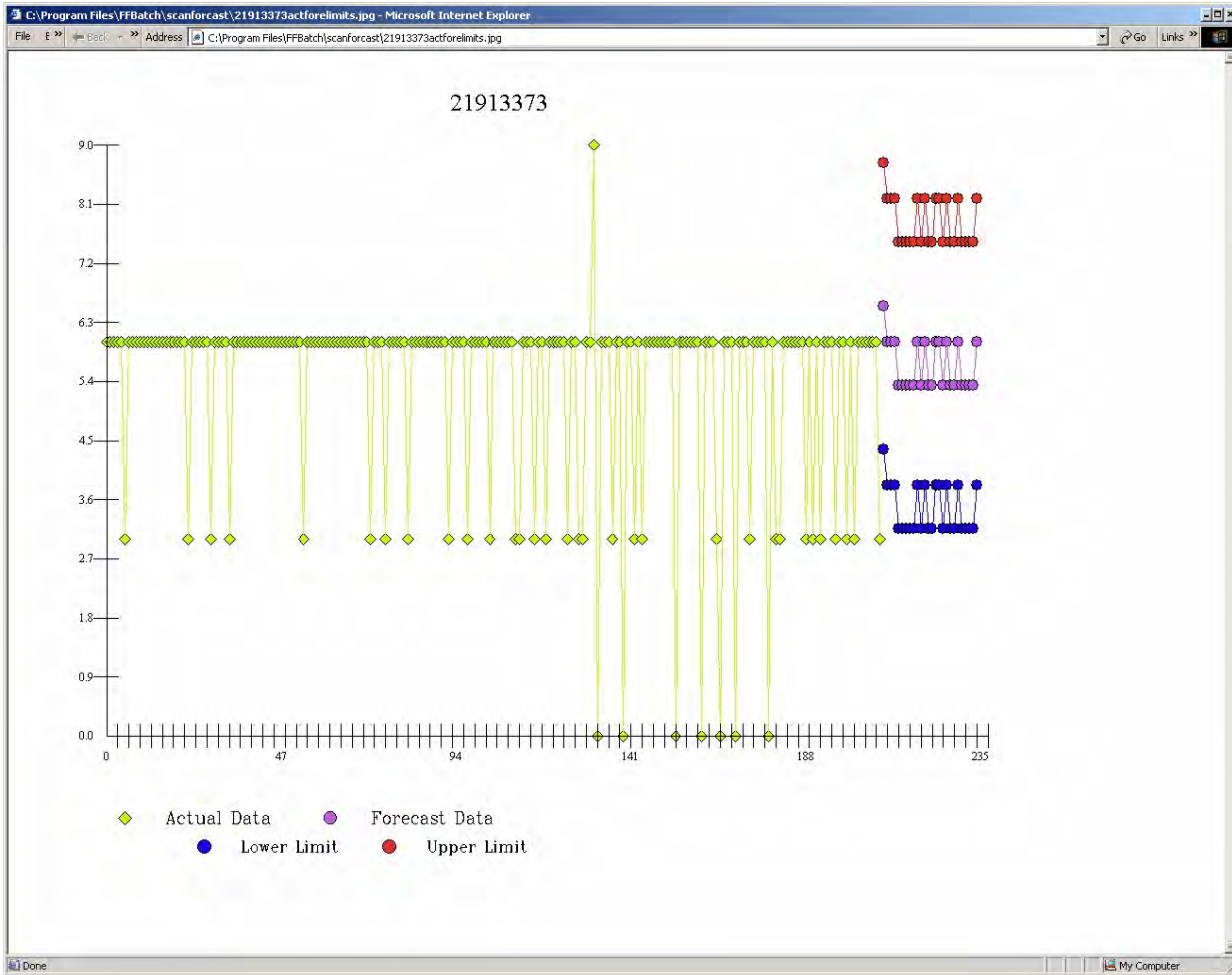
- Automatically run simulation of Bin Q,r strategy to verify results
- Support SCOPTIMA decision making using simulation
  - Verification of Q,r changes when bin agent determines need for change
- “Agent” based approach
- Automated

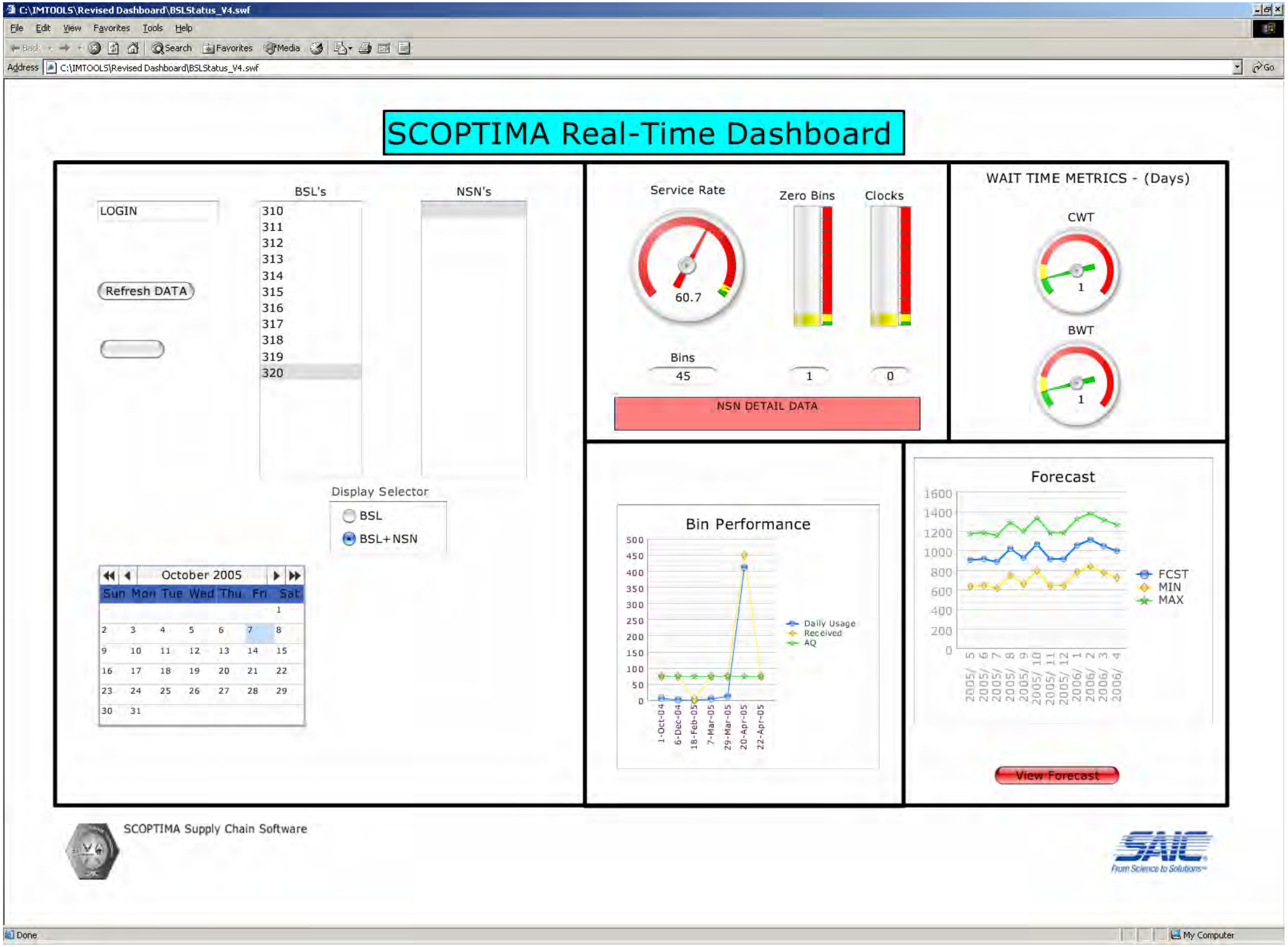
Integration

- Spawn process from SCOPTIMA to invoke AweSIM model
- Interface via Data Files or Database
- Results returned to SCOPTIMA via Data Files or Database

Architecture




C:\Program Files\FFBatch\scanforcast\21913373actforelimits.jpg - Microsoft Internet Explorer
File
Back
Address
C:\Program Files\FFBatch\scanforcast\21913373actforelimits.jpg
Go
Links
21913373
9.0
8.1
7.2
6.3
5.4
4.5
3.6
2.7
1.8
0.9
0.0
0
47
94
141
188
235
Actual Data
Forecast Data
Lower Limit
Upper Limit
Done
My Computer


C:\IMTOOLS\Revised Dashboard\BSLStatus_V4.swf
File Edit View Favorites Tools Help
Address C:\IMTOOLS\Revised Dashboard\BSLStatus_V4.swf
SCOPTIMA Real-Time Dashboard
LOGIN
Refresh DATA
BSL's
310
311
312
313
314
315
316
317
318
319
320
NSN's
Display Selector
BSL
BSL+NSN
October 2005
Sun Mon Tue Wed Thu Fri Sat
Service Rate
60.7
Zero Bins
Clocks
Bins
45
1
0
NSN DETAIL DATA
WAIT TIME METRICS - (Days)
CWT
1
BWT
1
Bin Performance
Daily Usage
Received
AQ
1-Oct-04
6-Dec-04
18-Feb-05
7-Mar-05
29-Mar-05
20-Apr-05
22-Apr-05
Forecast
FCST
MIN
MAX
View Forecast
SCOPTIMA Supply Chain Software
SAIC
From Science to Solutions
Done
My Computer

Conclusion

- Challenging Supply Chain Problems
- Complex inventory model
- Integrated Enterprise System
- Advanced technology solutions

Dr. Hank Grant

Dr. Grant joined the faculty at the University of Oklahoma in December of 1993 as Director of the School of Industrial Engineering and Southwestern Bell Professor. He is currently Director of the Center for the Study of Wireless Electromagnetic Compatibility and Dugan Professor of Industrial Engineering. Prior to joining the University of Oklahoma, he was with the National Science Foundation in Washington, DC, where he directed programs in Production Systems, Engineering Design, and Operations Research. Dr. Grant was instrumental in the startup and development of two Industrial Engineering software companies: Pritsker Corporation and FACTROL. Dr. Grant is a Fellow of the Institute of Industrial Engineers and is a member of the following societies: INFORMS, Tau Beta Pi and The Institute of American Entrepreneurs. Dr. Grant received his Ph.D. from Purdue University in Industrial Engineering in 1980.

Eugene Beardslee

Eugene Beardslee is the software system architect of the Industrial Prime Vendor (IPV) project's enterprise system: SCOPTIMA Supply Chain Software. For the past five years, Mr. Beardslee has managed and directed the design, development, implementation and maintenance of all aspects of this logistics support software. Recipient of the 2003 SAIC Achievement Award for Excellence in Program Performance: Technology Development and Analysis, he has guided three successful Manufacturing Production and Engineering research projects focused on improved inventory and replenishment process performance. Mr. Beardslee has over 18 years experience in the production of software systems with over 12 years designing Oracle software systems. He is a member of the IEEE Computer Society, the Association for Computing Machinery and the Institute of Industrial Engineers. Mr. Beardslee received his Bachelor of Science degree in Computer Science in 1988, and his Master of Arts in Computer Resources and Information Management in 1997.

Transforming Logistics

Achieving Knowledge-Enabled Logistics

2005 NDIA Systems Engineering Conference

Jerry Beck OADUSD(LPP)

25 October 2005

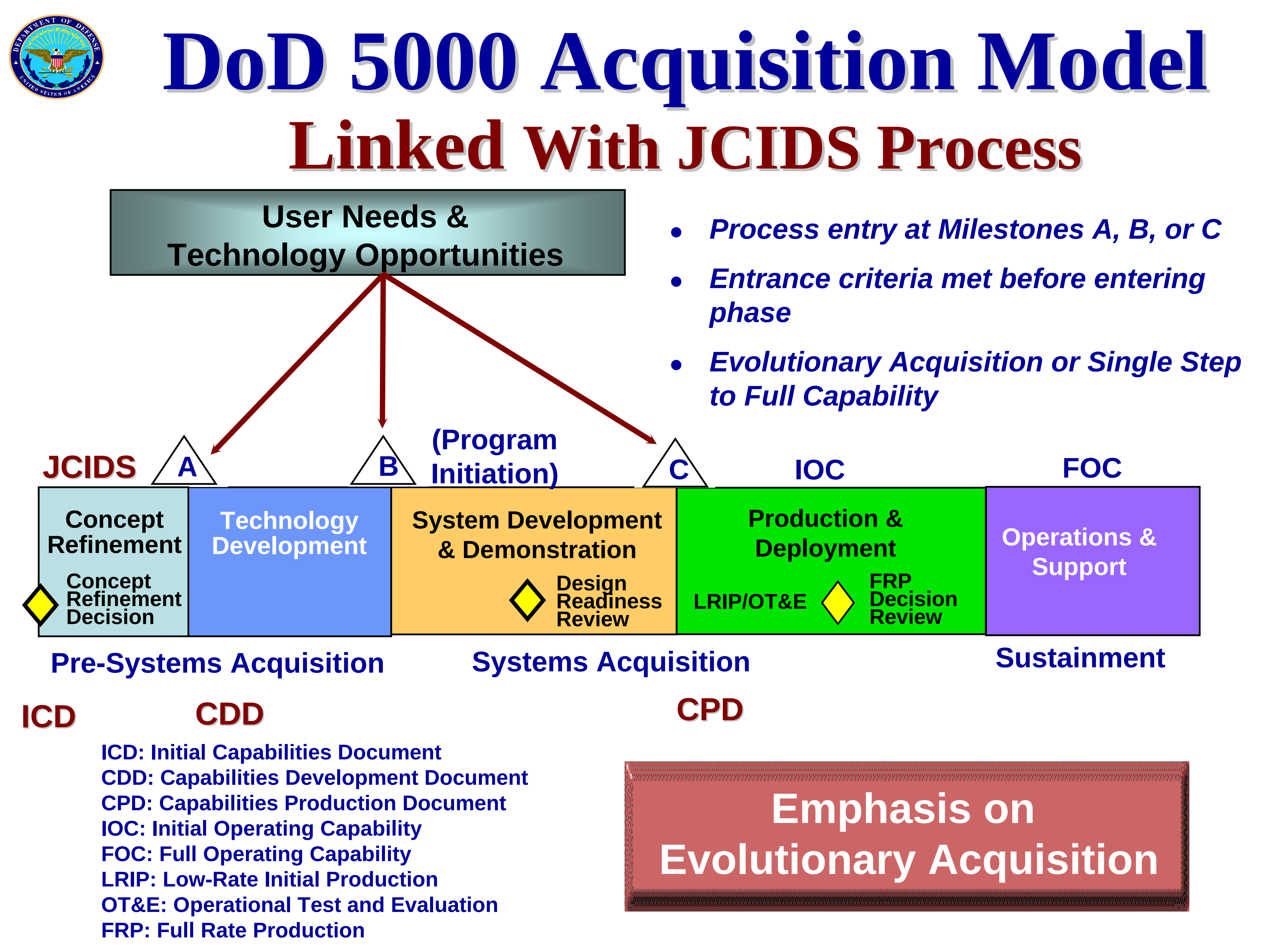
QDR Direction
(2001)

- **Project and sustain the force with minimal footprint**
- **Implement performance-based logistics to improve readiness for major weapon systems and availability of commodities**
- **Reduce cycle times to industry standards**

DoD 5000 Policy

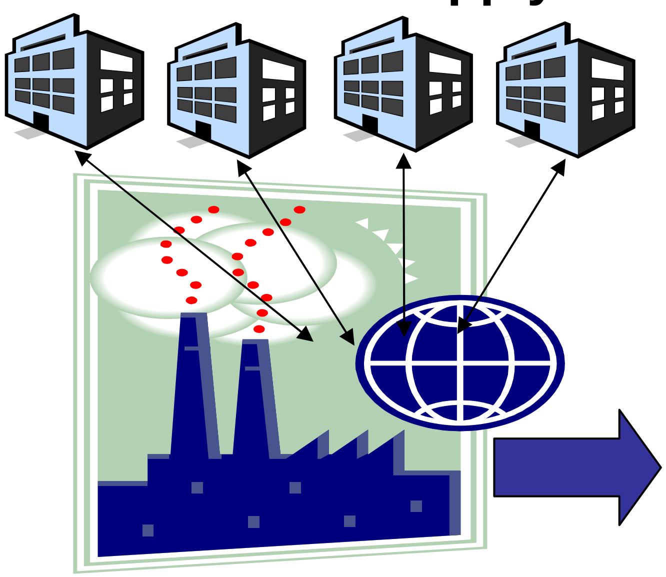
Total Systems Approach. The PM shall be the single point of accountability for accomplishment of program objectives for total life cycle systems management, *including sustainment*.

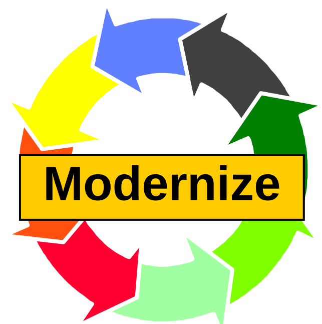
Performance-Based Logistics. PMs shall develop and implement performance-based logistics strategies that optimize total system availability while minimizing cost and logistics footprint. Sustainment strategies shall include the best use of public and private sector capabilities through government/industry partnering initiatives, in accordance with statutory requirements.


DoD 5000 Acquisition Model
Linked With JCIDS Process
User Needs & Technology Opportunities
Process entry at Milestones A, B, or C
Entrance criteria met before entering phase
Evolutionary Acquisition or Single Step to Full Capability
JCIDS
A
B
(Program Initiation)
C
IOC
FOC
Concept Refinement
Concept Refinement Decision
Technology Development
System Development & Demonstration
Design Readiness Review
Production & Deployment
LRIP/OT&E
FRP Decision Review
Operations & Support
Pre-Systems Acquisition
Systems Acquisition
Sustainment
ICD
CDD
CPD
ICD: Initial Capabilities Document
CDD: Capabilities Development Document
CPD: Capabilities Production Document
IOC: Initial Operating Capability
FOC: Full Operating Capability
LRIP: Low-Rate Initial Production
OT&E: Operational Test and Evaluation
FRP: Full Rate Production
Emphasis on Evolutionary Acquisition

Acquisition 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
- Supply Chain Agility

Performance-Based Logistics (PBL)

- **Buy weapons system support as an integrated, affordable, performance package designed to optimize system readiness**
- **Defined performance goals with clear lines of authority**
- **Support structure based on long-term performance agreements**
- **Supplier accountable for continuously meeting the users needs**
- **Compensation based on outcomes, not activities**

Buying performance as a package and a capability.

Structure, Strategy, and Process

STRUCTURE

Designate a Single Point of Accountability for the Weapon System from Cradle to Grave

Total Life Cycle Systems Management

TLCSM

STRATEGY

Buy Weapon System Support As an Integrated Package, vice Segmented Functions

Performance Based Logistics

PBL

PROCESS

Incorporate best practice elements (LEAN, SIX SIGMA, TOC)

Continuous Process Improvement

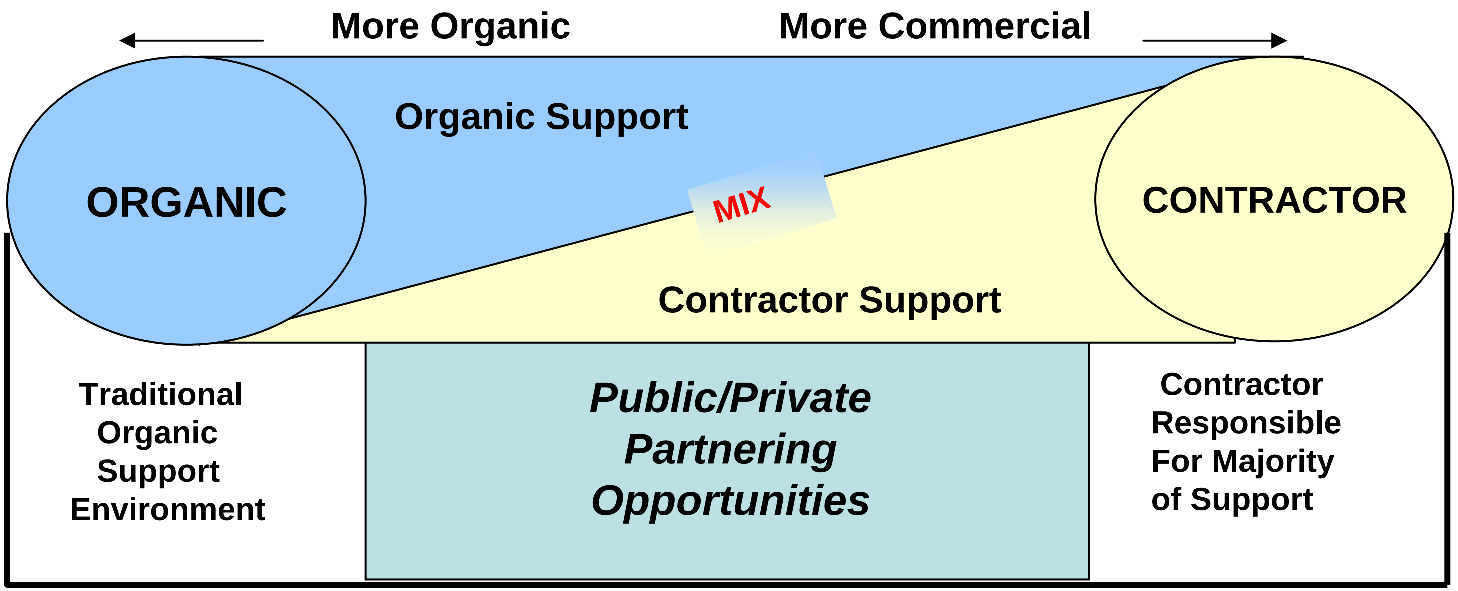
CPI

PBL is Performance -Based Life Cycle Product Support

PBL Guidance: A strategy for weapon system product support that employs the purchase of support as an integrated, affordable, performance package designed to optimize system readiness. It establishes performance goals for a weapon system through a support structure based on long-term performance agreements with clear lines of authority and responsibility to continuously meet the users needs.

- ***Functions That May Be the Life Cycle Responsibility of the Provider:***
- DMSMS/Obsolescence Management
- Requirements Determination
- Engineering and Technical Services
- Configuration Management/Control
- Technology Insertion
- Transportation & Warehousing
- Technical Data Management
- Retrograde Management
- FMS Support (If Applicable)
- Public/Private Partnerships or Teaming

Spectrum of PBL Strategies



PBL strategies will vary along this spectrum depending on:

- Age of System (Phase in Life Cycle)
- Existing Support Infrastructure
- Organic & Commercial Capabilities
- Legislative and Regulatory Constraints

One Size Does Not Fit All

PBL is *NOT* CLS

Examples:

- Total System Support Partnership (TSSP)
- Industry Partnering
- Service Level Agreements
- Performance-based Agile Logistics Support (PALS)
- Prime Vendor Support (PVS)
- Contractor Delivery System (CDS)
- Performance Plans
- MOU with Warfighter

PBL Weapon System Support

Real-Time System Status

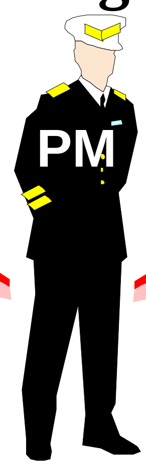
Industry/Government

Partnerships

Buys Performance As a Package
(Including Surge/Flexibility)

Weapon System Management

Force Provider



PBA

PBA

Ensure system is sustained at optimum level per PBA

Provide continuous, reliable, affordable support per PBA

Acquisition

Sustainment

Disposal

Visibility into cost/risk decisions across life cycle

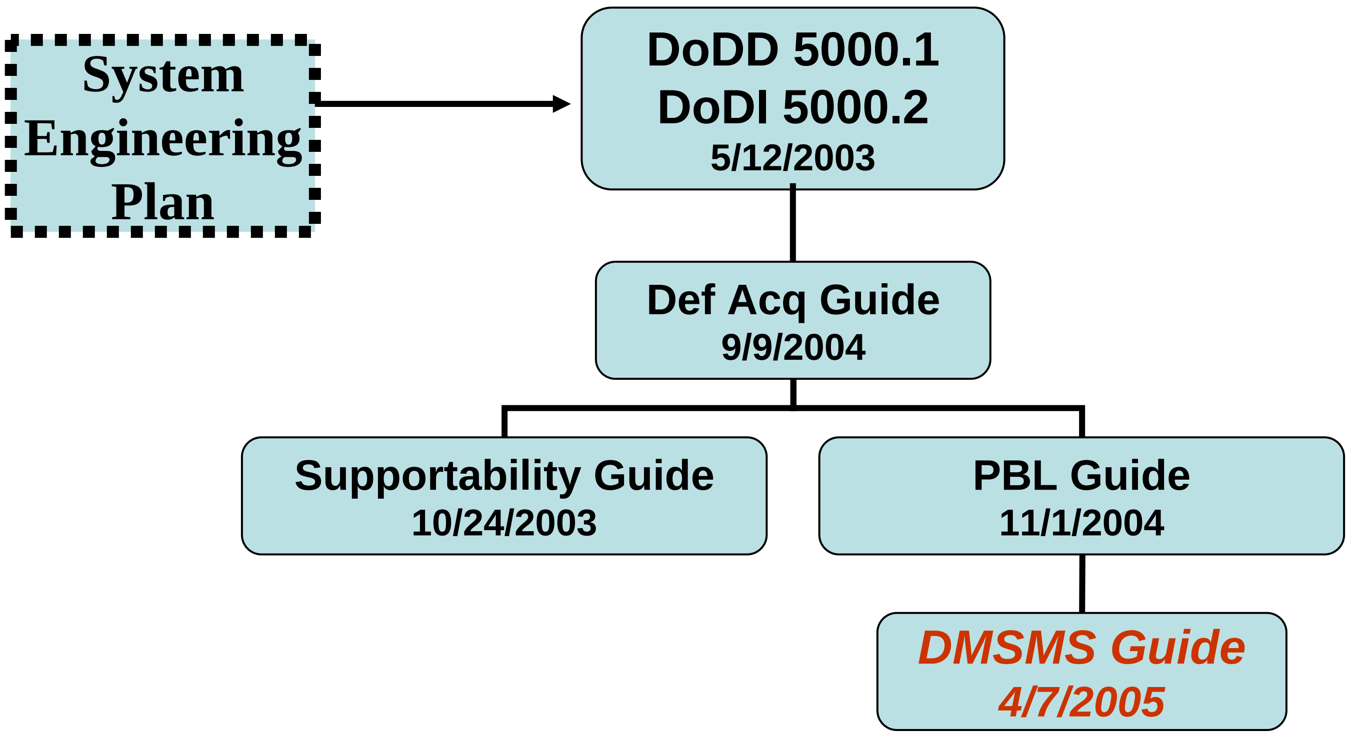
Developed Output Metrics

Questions Answered

- **Operational Availability** — **Are we ready?**
- **Mission Reliability** — **Will we be effective?**
- **Cost per Unit Usage** — **What is the cost?**
- **Footprint** — **How much real estate do we need?**
- **Logistics Response Time** — **Are we sustainable?**

AT&L memo of 16 August 2004 Performance Based Logistics; using Performance Based Criteria

Hierarchy of Key Documents



Total Life Cycle Systems Management (TLCSM)

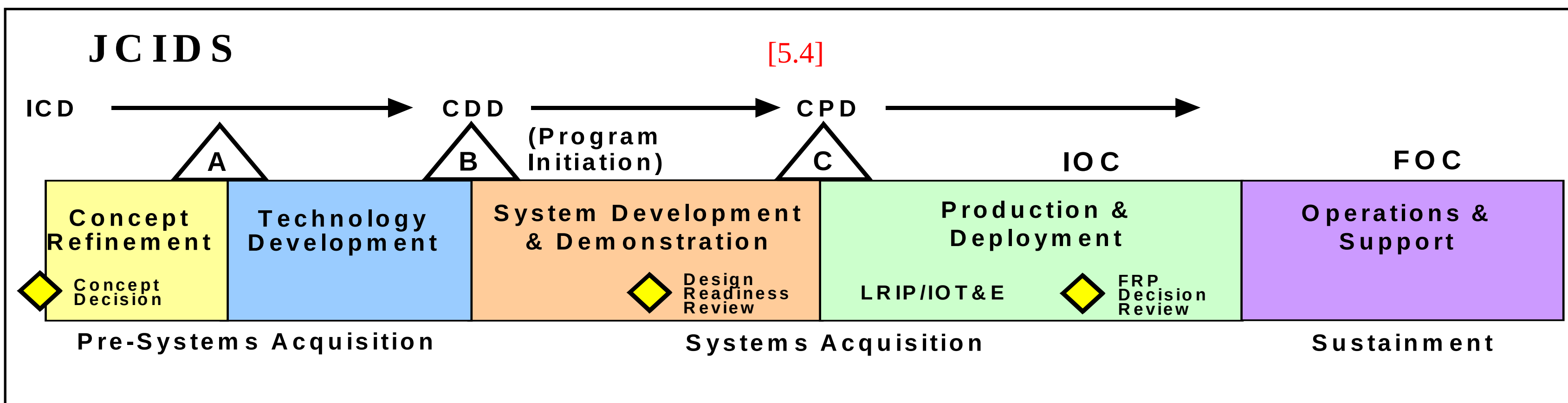
[5.1.1]

Life Cycle Logistics (LCL)

[5.1.2]

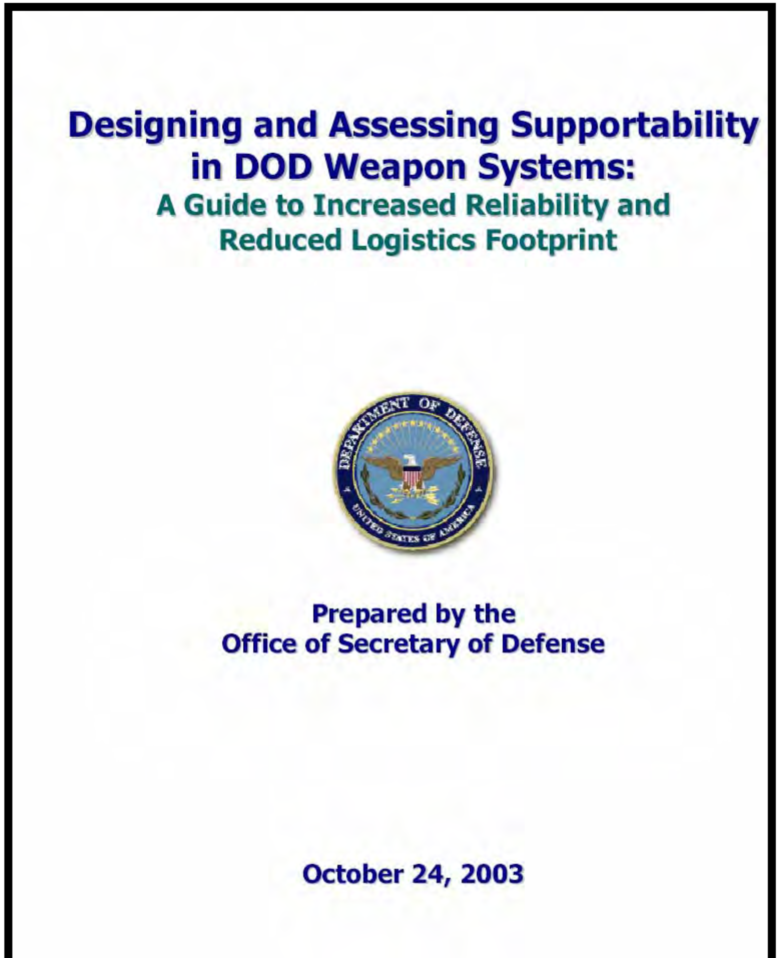
LCL in Systems Engineering (SE) [5.2]

Performance Based Logistics (PBL) [5.3]



Under TLCSM the PM is responsible for Life Cycle Logistics (LCL), emphasizing LCL in systems engineering and implementing product support through Performance Based Logistics (PBL).

Established Supportability Design and Assessment Criteria



Designing and Assessing Supportability in DOD Weapon Systems:

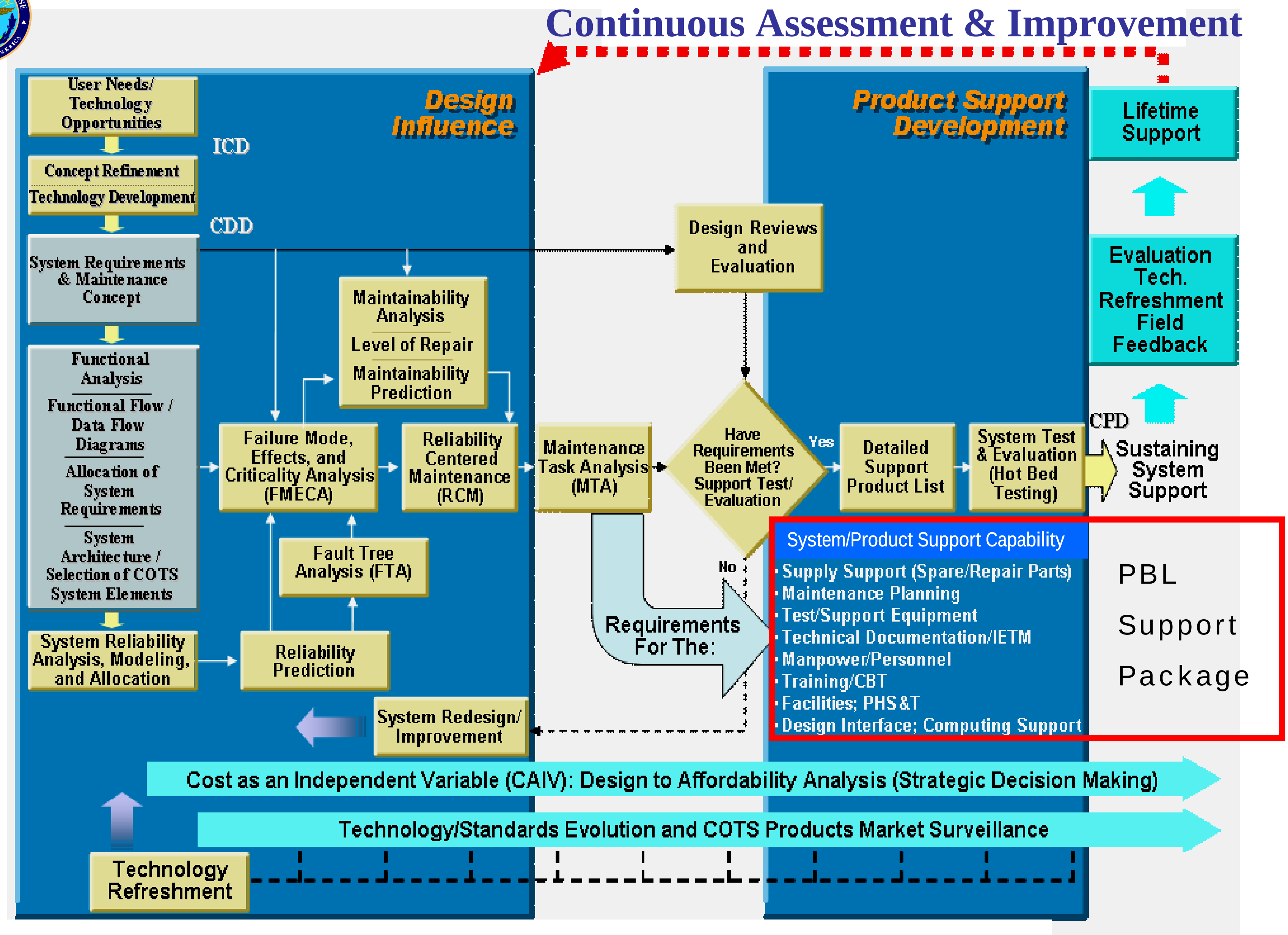
A Guide to Increased Reliability and Reduced Logistics Footprint

Prepared by the Office of Secretary of Defense

October 24, 2003

Under Secretary of Defense Memo of 24 Oct 03

- **Technical guidance to assist the PM to effectively implement TLCSM and PBL**
- **Incorporates Design for Operational Effectiveness (DOE) criteria into the systems engineering process to:**
  - **Increase Reliability**
  - **Reduce Logistics Footprint**
- **Evaluation Criteria for all Milestones**
- **Establishes IOC and Post IOC Reviews**
- **Provides template for PM & Team to use in defining and assessing program life cycle supportability requirements**



FRAMEWORK: System Design for Operational Effectiveness

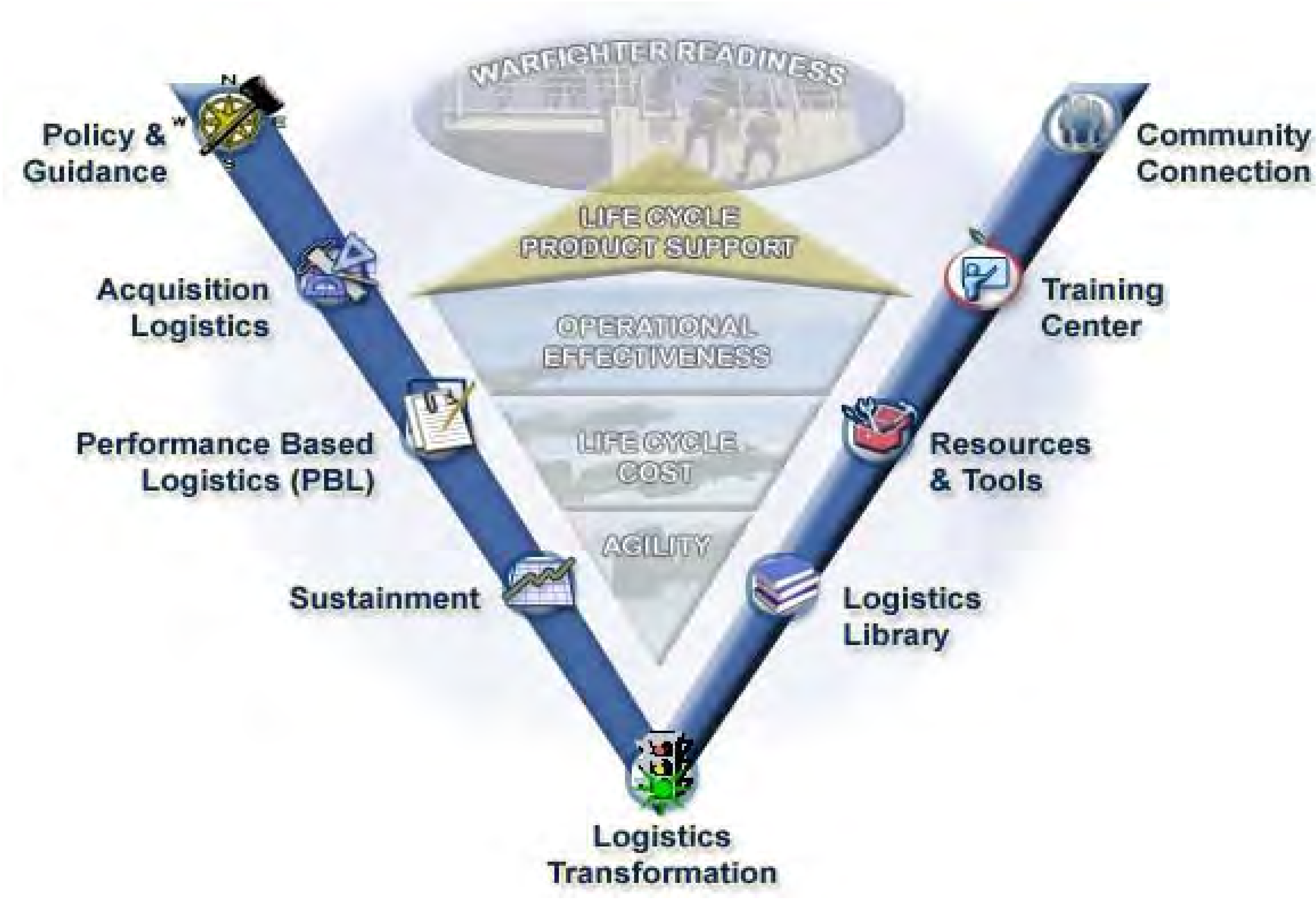
DAU Website

- **LOG CoP provides logisticians with direct access to references, guides, and tools for job support and was recently enhanced to add new resources – like the PBL Toolkit and logistics library. LOG CoP is accessible on the internet at <https://acc.dau.mil/log>**
-
- **The Performance Based Logistics (PBL) Toolkit is now accessible via LOG CoP. The Toolkit assists Program and Logistics Managers in the design and management of PBL strategies for buying weapon system capability. It is based on a 12-step process model that guides users through each step of developing a PBL strategy, and provides ready access to policy, references, examples, and other useful information. The direct link is https://acc.dau.mil/pbltoolkit**

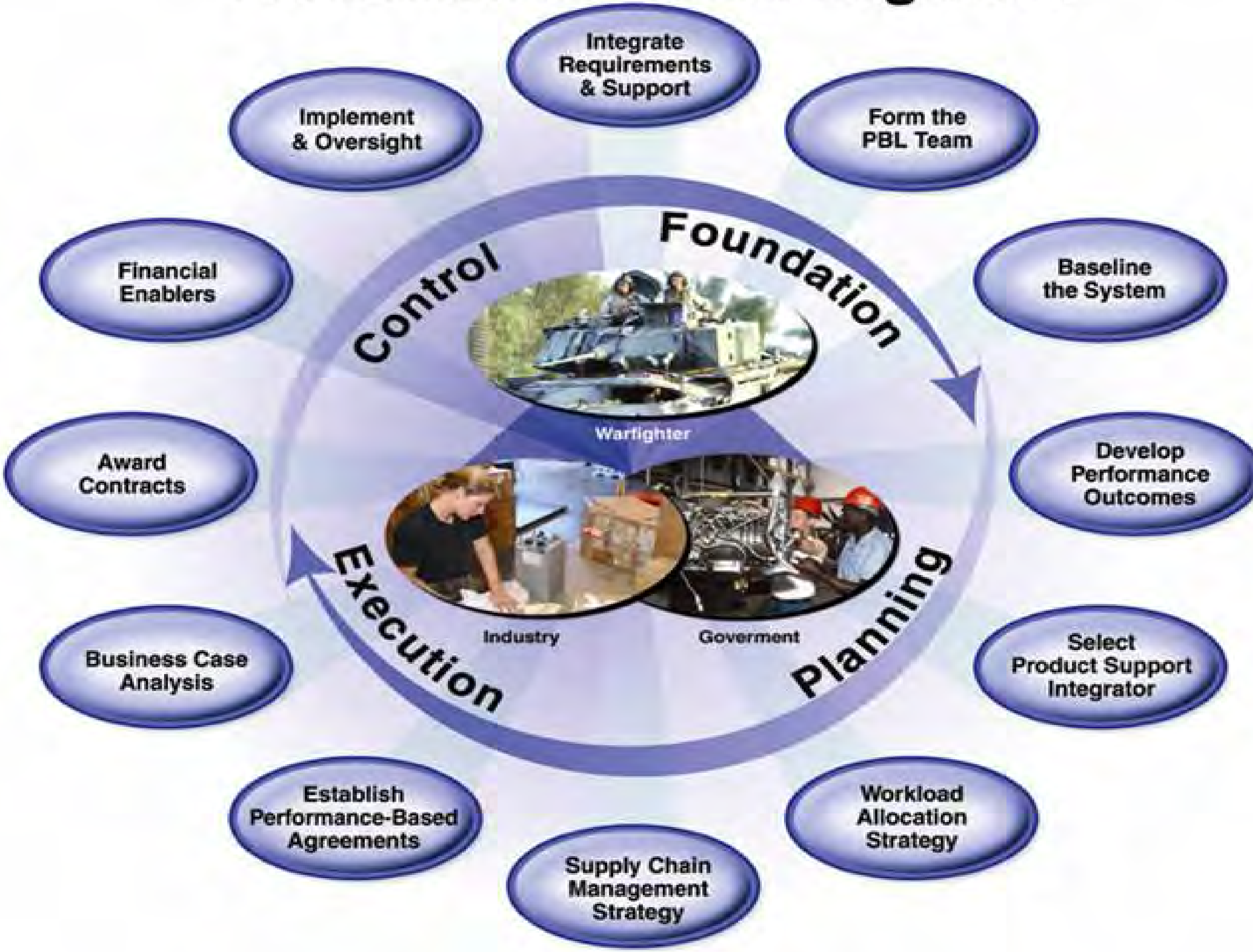
- **Link to: Integrated Framework Chart Main System View**
  http://akss.dau.mil/ifc/

- **Direct any questions to Jill Garcia at jill.garcia@dau.mil**

Logistics Management (DAU website)

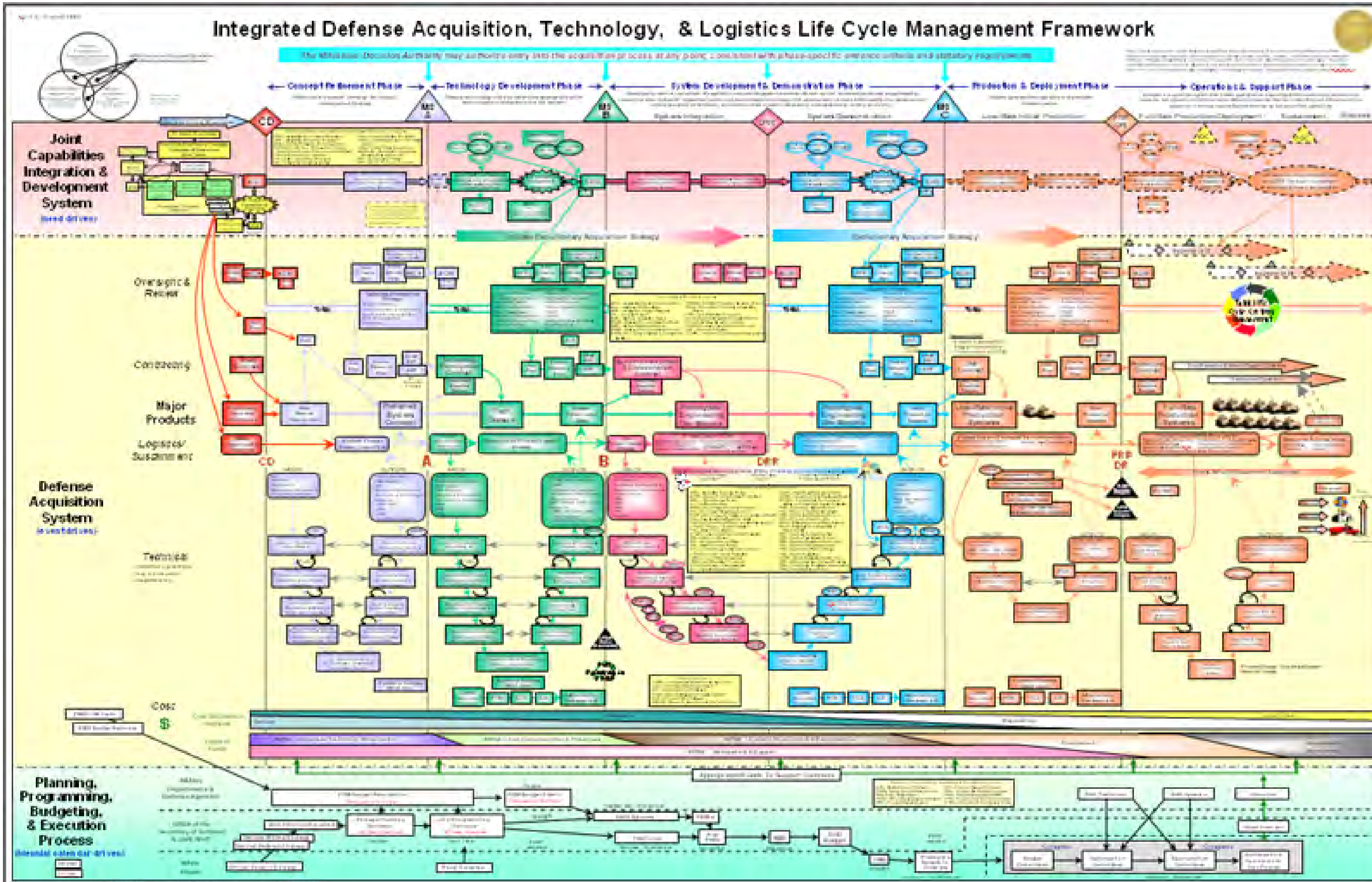


Performance-Based Logistics

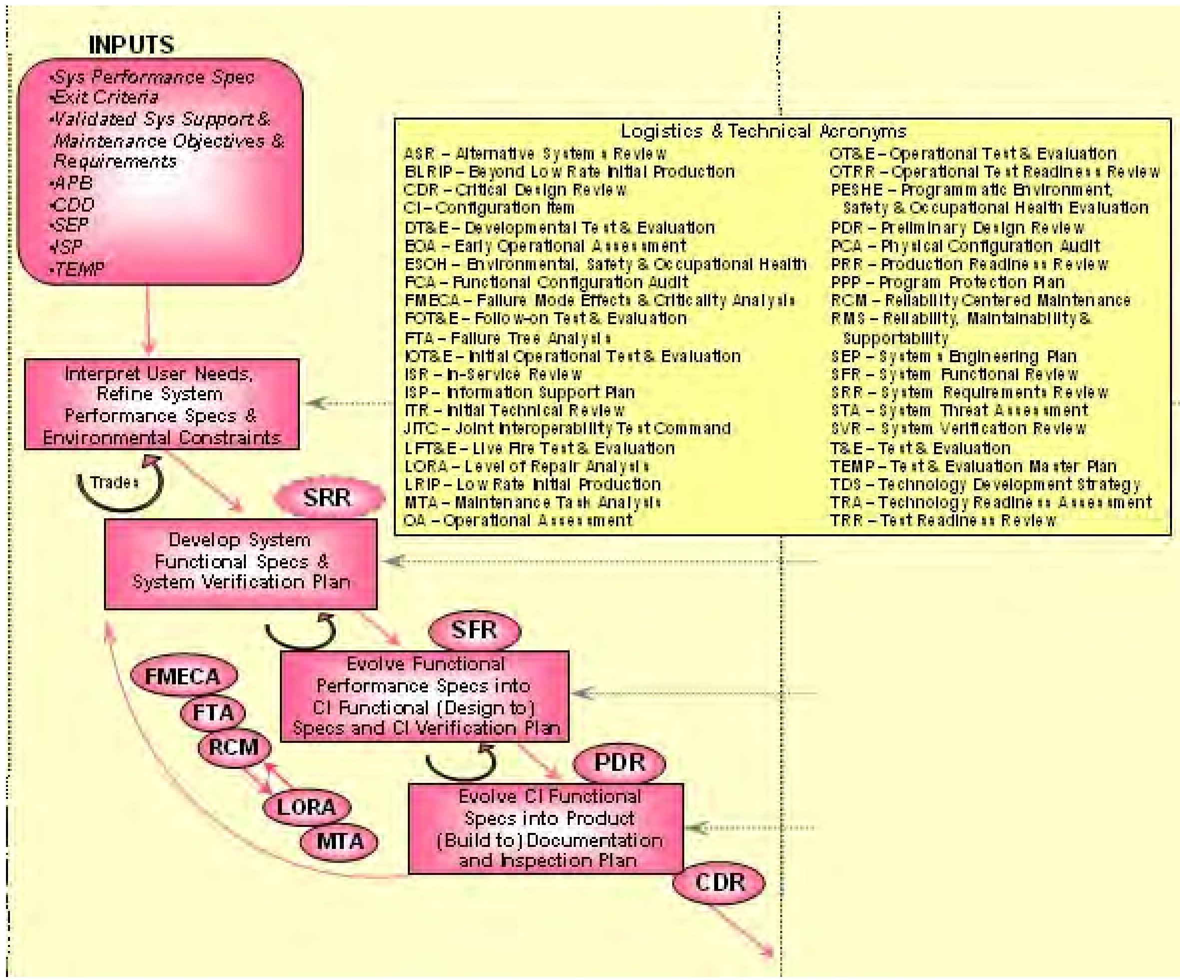


Integrated Framework Chart - System View

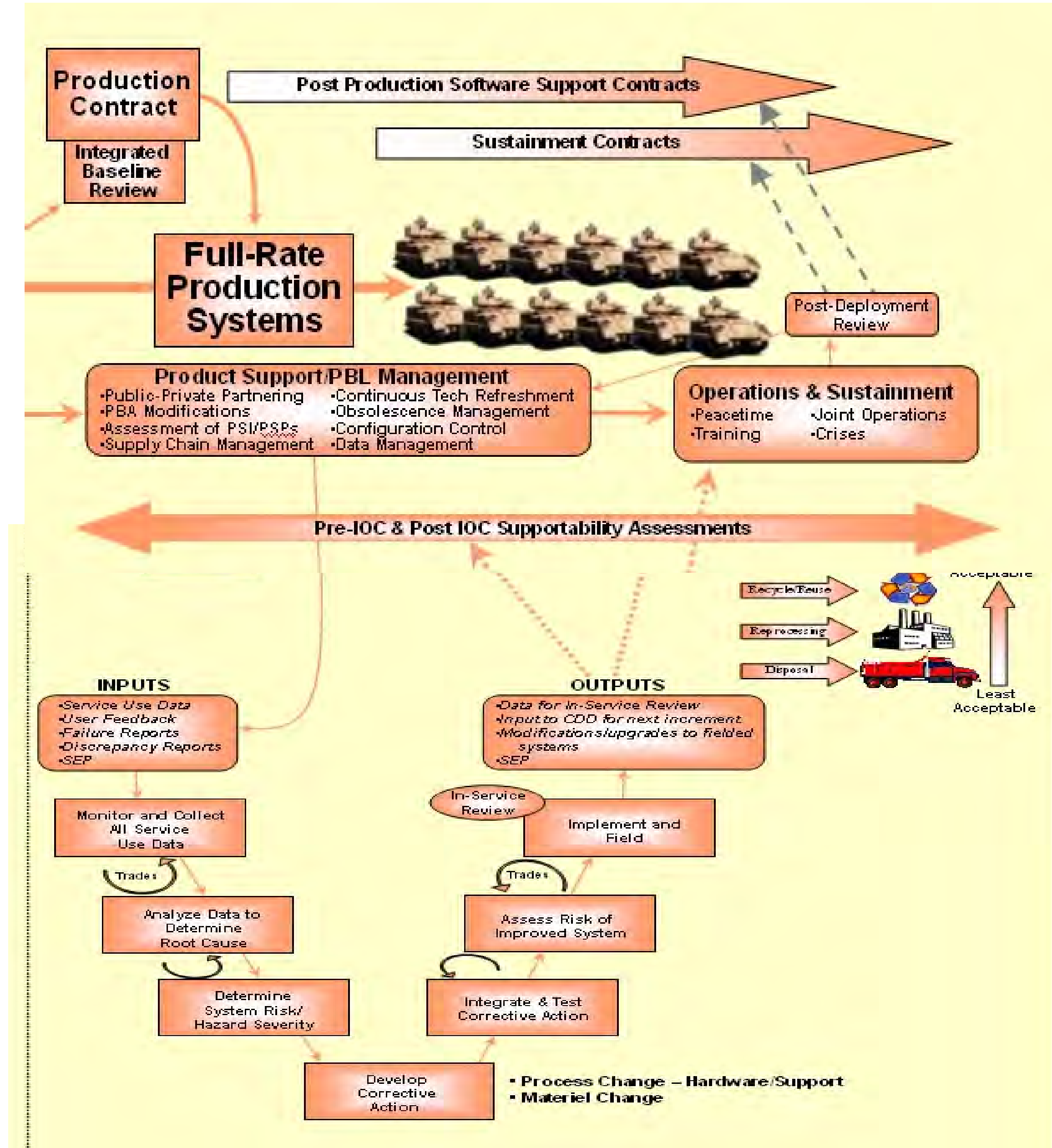
http://akss.dau.mil/ifc/



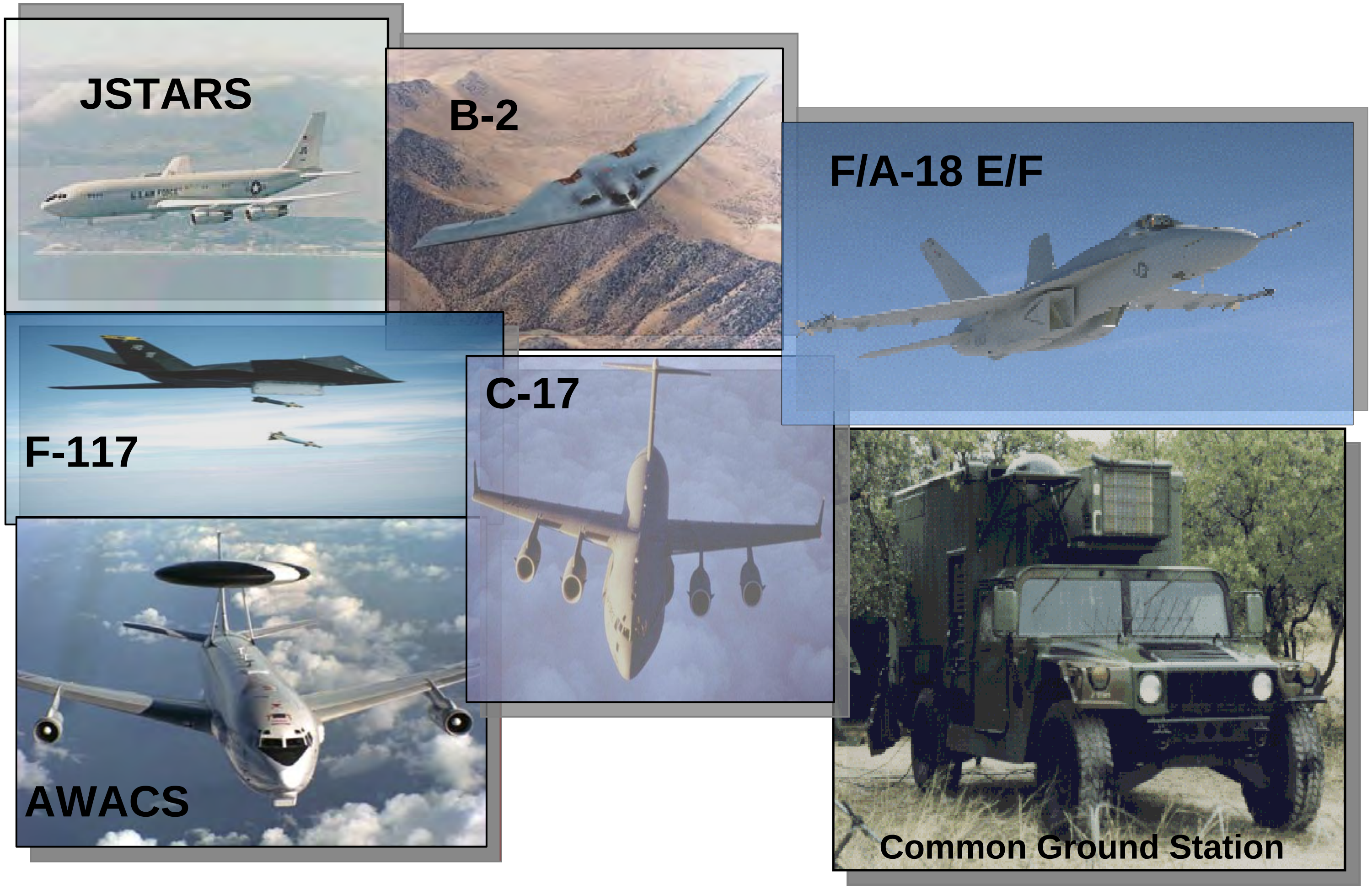
SDD "Design for Support"



Sustainment "Support the Design"

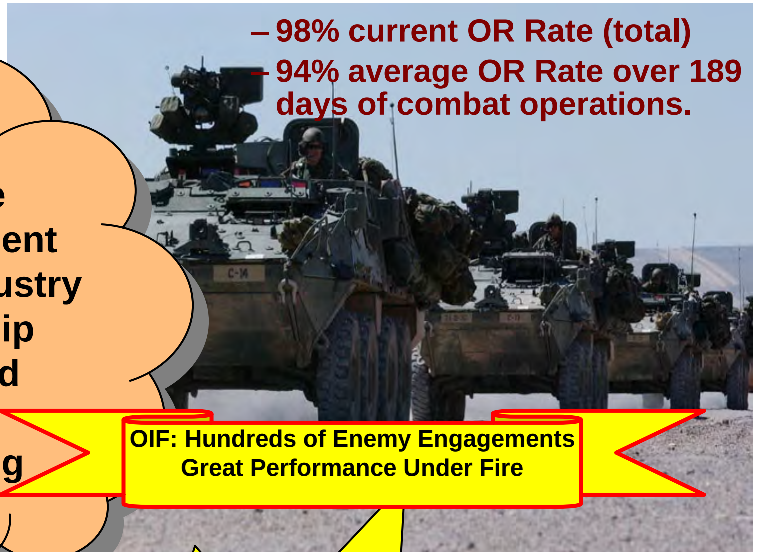


PBL Demonstrated in OEF/OIF



Delivering Capability NOW!

Performance-Based Logistics



- 98% current OR Rate (total)
- 94% average OR Rate over 189 days of combat operations.

- Life Cycle Management
- Gov't/Industry partnership
- Embedded health monitoring

OIF: Hundreds of Enemy Engagements
Great Performance Under Fire

Navy Program	Pre-PBL	Post-PBL
 F-14 LANTERN	56.9 Days	5 Days
 ARC-210	22.8 Days	5 Days
 H-60 Avionics	52.7 Days	8 Days
 F/A-18 Stores Mgmt System (SMS)	42.6 Days	2 Days CONUS 7 Days OCONUS
 Tires	28.9 Days	2 Days CONUS 4 Days OCONUS
 APU	35 Days	5 Days

Decreased Response Time 70%-80%

- Focused on warfighter needs
- Buying outcomes (not inventory)
- Aligning incentives to outcomes

C-17 Globemaster Sustainment Partnership

- Performance-based contract/partnership between AF & Boeing -- requires the contractor to provide sustainment support at continuously raised benchmarked levels
- Includes parts, item management and depot-level repair of airframe and sub-components
- $4.9B FY04 through FY08
- Follow-on PBL relationships
  - Wheels and brakes workload
  - Triumph Air Repair for APU touch labor
  - Parker-Hannifin and ALCS in planning phase

Stryker

"I just did a year in Iraq…. If we did not have [Stryker], there would have been a lot of dead Joes."

"Stryker is an urban pacification vehicle. I love it."

"I personally would rather get out of the Army than go somewhere that doesn't have the Stryker."

-Sgt. John Hedrington*

"The Stryker Isn't a poster child gone bad. It has saved the lives of many of my fellow soldiers."

"One of my sister platoon's Strykers was hit by five rocket-propelled grenades and everyone on that crew is still walking."

"Our weapons were plenty for the missions we were placed in."

"The tires lasted longer than track pads."

-Staff Sgt. Johnathan Vines*

*Quoted in *Defense News* 1/17/2005

PBL Partnership Vs. Routine Organic Repair

PBL Partnership (GE & JAX)

- Parts Cost: $300,000
- Labor & Admin Costs: $34,000
- Total Cost: $334,000
- Average Life: 2,000 hours
- ***Cost per hour: $167***

Previous Organic Repair

- Used Parts: $120,000
- Labor & Admin Costs: $34,000
- Total Cost: $154,000
- Average Life: 375 hours
- ***Cost per hour: $411***

PBL Process +
- Lean
- Six Sigma
- TOC

>90% Availability

Notional Construct

F404 PBL (F/A-18A-D) Status

- **Four and 1/2 Year Firm-Fixed Price Contract Base Period; Five One Year options**
- **Largest Aviation Fixed Price PBL Contract…BCA Projects $79M Cost Avoidances**
- **Includes 36 F404 Major Sub-Assemblies Covering 1895 Engines**
- **Covers the Overhaul of the Major Sub-assemblies Regardless of Quantity Repaired/Replaced**
- **Provides Flying Hour and War Time Surge Flexibility**

- **Measurable Performance Metrics (LRT, SMA and Durability)**
  - ✓ **85% Availability; Disincentives for Lower Than 75%, Incentives Up to 3% for 90% Availability**
- **Public Private Partnership With NADEP Jacksonville- Leverages OEM "Best Practices" Efficiencies (i.e. Six Sigma, Lean, TOC)**

Exceeding Expectations!

- ***100% Total Backorder Reduction Contract-to-Date***
- ***Availability 95% (Historical, 43%)***
- ***TAT Reduced by 25%; Backlog Reduced 50%***

Improving F404 Availability While Reducing $/EFH Cost

TOW IMPROVED TARGET ACQUISITION SYSTEM (ITAS)

TOW/ITAS PBL Concept

Field Repair

- **Soldier Maintainer at Organizational and Direct Support Levels**
  - **BIT/BITE to Line Replaceable Unit (LRU)**
  - **Repair by Replacement**
- **Contractor Forward Repair Activity (FRA)**
  - **Limited Depot Level Repair and Test Equipment**
  - **Co-located With Army Main Support Battalion at Selected Units**
  - **FRA (Personnel and Equipment) Deployable, Commander's Call**
    - **On Unit's Load Plan**
    - **2 Hour Recall - Has Shots, Wills, Personal Equipment**

Depot Repair - Raytheon, McKinney, TX

97-100% Availability to Warfighter since Feb 01

Blackhawk Health Monitoring

Successful application to a fielded system

Description:

- On-board diagnostics and prognostics.
- Crash survivable cockpit voice and data recorder.
- Obtains real time vibration, rotor smoothing and aircraft health usage info.

Benefits:

- Obtains real time vibration, rotor smoothing and aircraft health usage info.
- Supports predictive methods to allow replacement of parts prior to catastrophic failure.
- Reduces O&S costs.
- Improves readiness.

Health and Usage Monitoring System (HUMS)

Fleet Management Recorder (FMR)

Incident Investigation Direct Download through Ethernet

Dramatic improvement in Aircraft Turn Rate on the Desert Deck!

- ***89% reduction in manhours for Main Rotor Track and Balance***
- ***95% reduction in manhours for Tail Rotor Balance***
- ***87% reduction in manhours for Vibration Chuck***

TASKING

- **Missions**
  - RWCAS
  - Convoy Escort
  - Utility Support
  - Armed Recce
  - CASEVAC
  - Airfield QRF

- **24 / 7 Sustained operations**

- **Average % Day/Night**
  - AH: 58.6 / 41.4
  - UH: 60.6 / 39.4

- **FMC / MC (%)**
  - AH: 61.0 / 70.7
  - UH: 55.0 / 60.0

“These old aircraft are surviving and succeeding on the backs of our maintenance Marines and at the risk of our aircrews lives.”

Our Challenge

Ubiquitous, cost-effective capability to project and sustain power.

Logistics Transformation

Mass-Based

- More is better
- Mountains of stuff measured in days of supply
- Uses massive inventory to hedge against uncertainty in demand and supply
- Mass begets mass and slows everything down

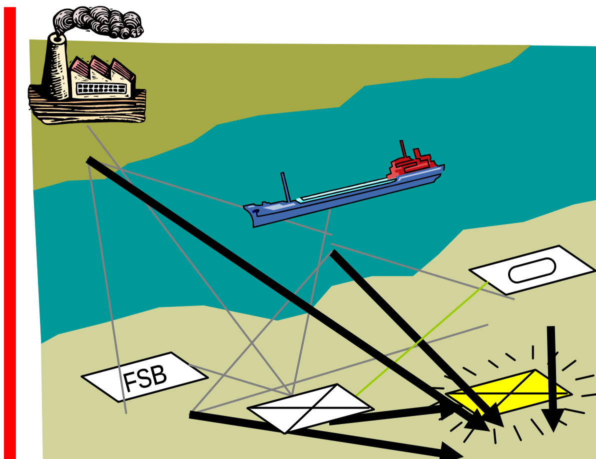
Prime Metric: Days of supply

Just-in-Time

- Precision is better
- Reduce Inventory to a minimum and keep moving
- Use precise demand prediction and optimization to reduce uncertainty
- Works great, except when it doesn’t

Prime Metric: Flow Time

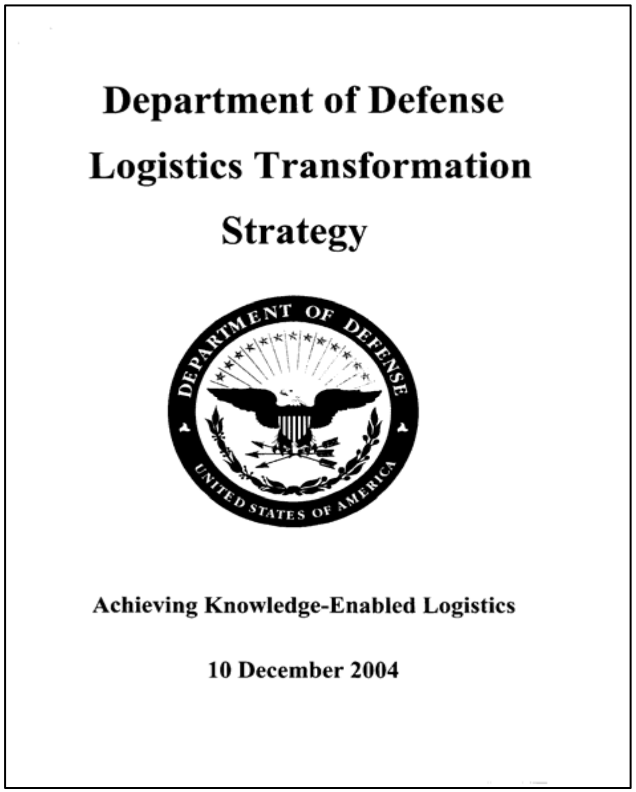
Sense and Respond



- Agile is better
- Dynamically positioned Inventory throughout
- Use transportation flexibility and robust IT to handle uncertainty
- Supports adaptive operations

Prime Metric: Effects

Logistics Transformation Strategy


Department of Defense

Logistics Transformation

Strategy

Achieving Knowledge-Enabled Logistics

10 December 2004

- Recognized Focused Logistics as JROC-Approved Concept
- Incorporated Sense and Respond Tenets
- Subsumed Force-Centric Logistics Enterprise initiative
- Recognized emerging transformation concepts

Fulfillment of DoD transformation strategy requires an integrated enterprise across Government and Industry.

Where We Need To Be

- Readiness objectives based upon national security strategy
- Supply Chains structured to be performance-based
  - Clear accountability for performance, outcomes, and resources
- Optimize materiel, maintenance, and fuel demands
  - System reliability driven by operational requirements
- Global end-to-end distribution capability focused on customer needs; enabled by comprehensive asset visibility
- Embedded culture of continuous improvement in performance and cost

Requires significant change in strategy, processes and systems

Why?

- **DoD Logistics cost ≈ $90B**
- **Secondary item inventory ≈ $77B**
- **Customer Wait Time ≈ 24 days**
- **Materiel Readiness ≈ 70-90%**

PBD-753

…and we are a nation at war!

Key Questions

- **What is military utility of high reliability?**
  - Increased use of capital assets; longer periods free of maintenance; improved safety
  - Decreased demand throughout the supply chain
  - Reduced footprint
- **What can be done to achieve high reliability in defense systems?**
  - Early, continuous R, M, & S engineering
  - Increased application of health monitoring, diagnostics, and prognostics
- **What changes would incentivize greater focus on supportability in design?**
  - PBL; sharing product supportability risk with key stakeholders

Innovation from the R, M, & S community is essential!

Performance-Based Weapon System Support

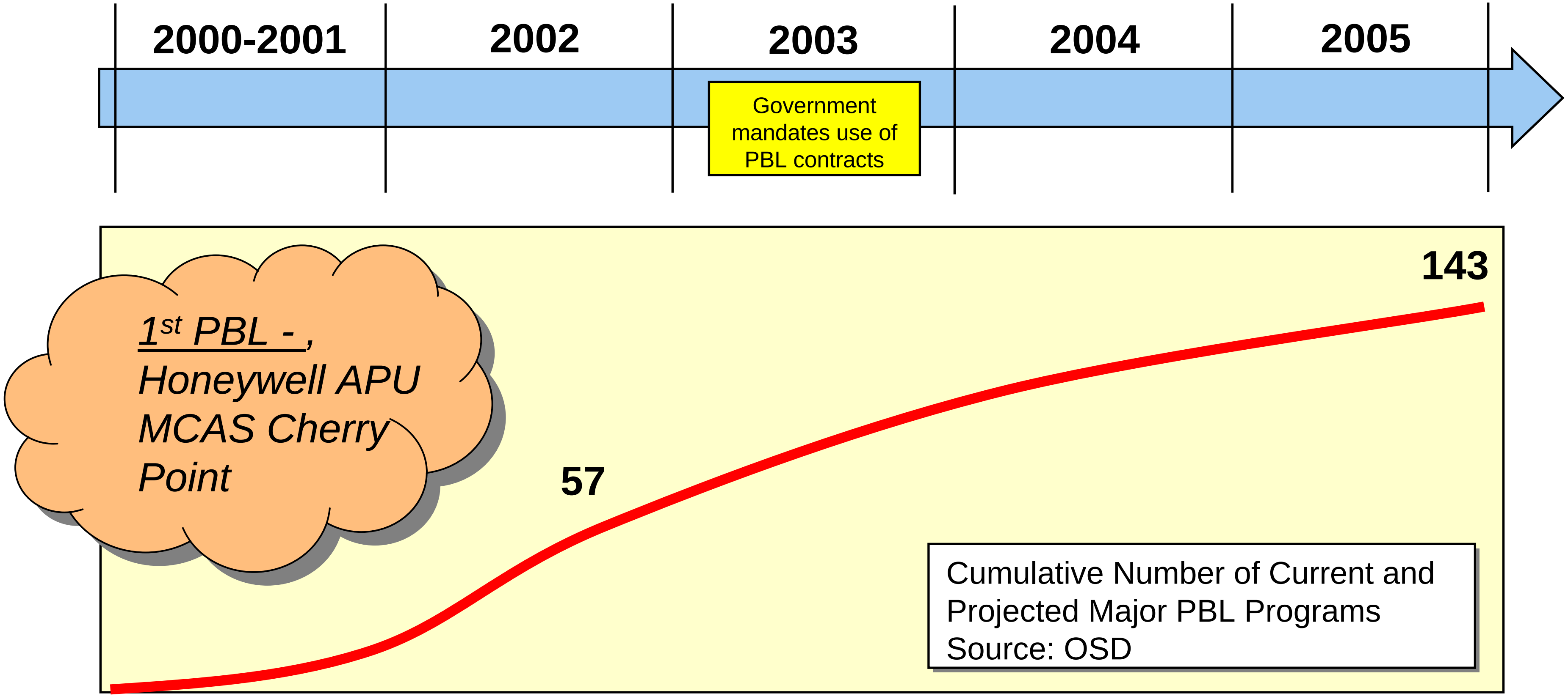
PM is life cycle manager

- <u>**Performance Based Logistics (PBL)**</u>**:** **A strategy for weapon system life cycle support that employs *purchase of performance as a package***
  - **Delineates outcome performance goals**
  - **Provides incentives for attaining goals**
  - **Facilitates overall lifecycle management of system reliability, readiness, supportability and total ownership costs**

- **PBL…Key pillar of DoD's Logistics Transformation**
  - **Goal…improve near-term readiness of critical platforms while moving toward an end-to-end weapon system sustainment framework**
  - **Directed in Strategic Planning Guidance…examine all major systems by 30Sep06!**

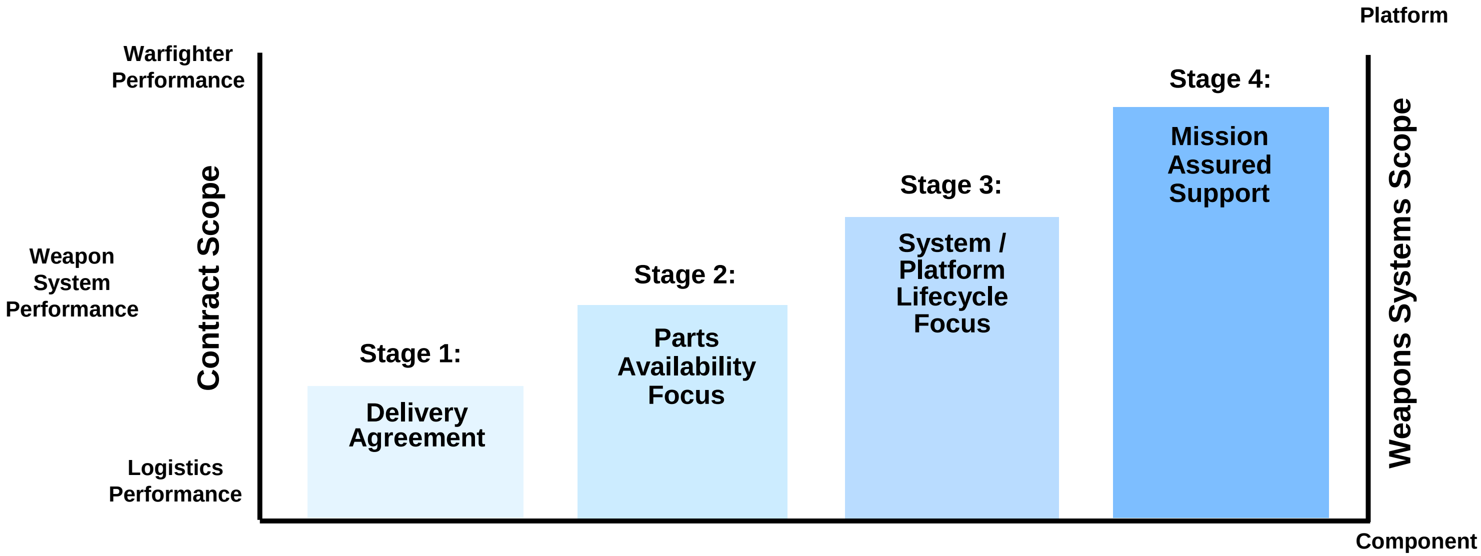
PBL & TLCSM Examples

PBL Implementation



DoD Is Aggressively Implementing Performance Based Logistics

PBL Maturity Framework



Provides assessment of PBL maturity…

- Required Practices
- Contractual Elements
- IT Enablers
- Metrics
- Functional Ownership

…to meet the following objectives

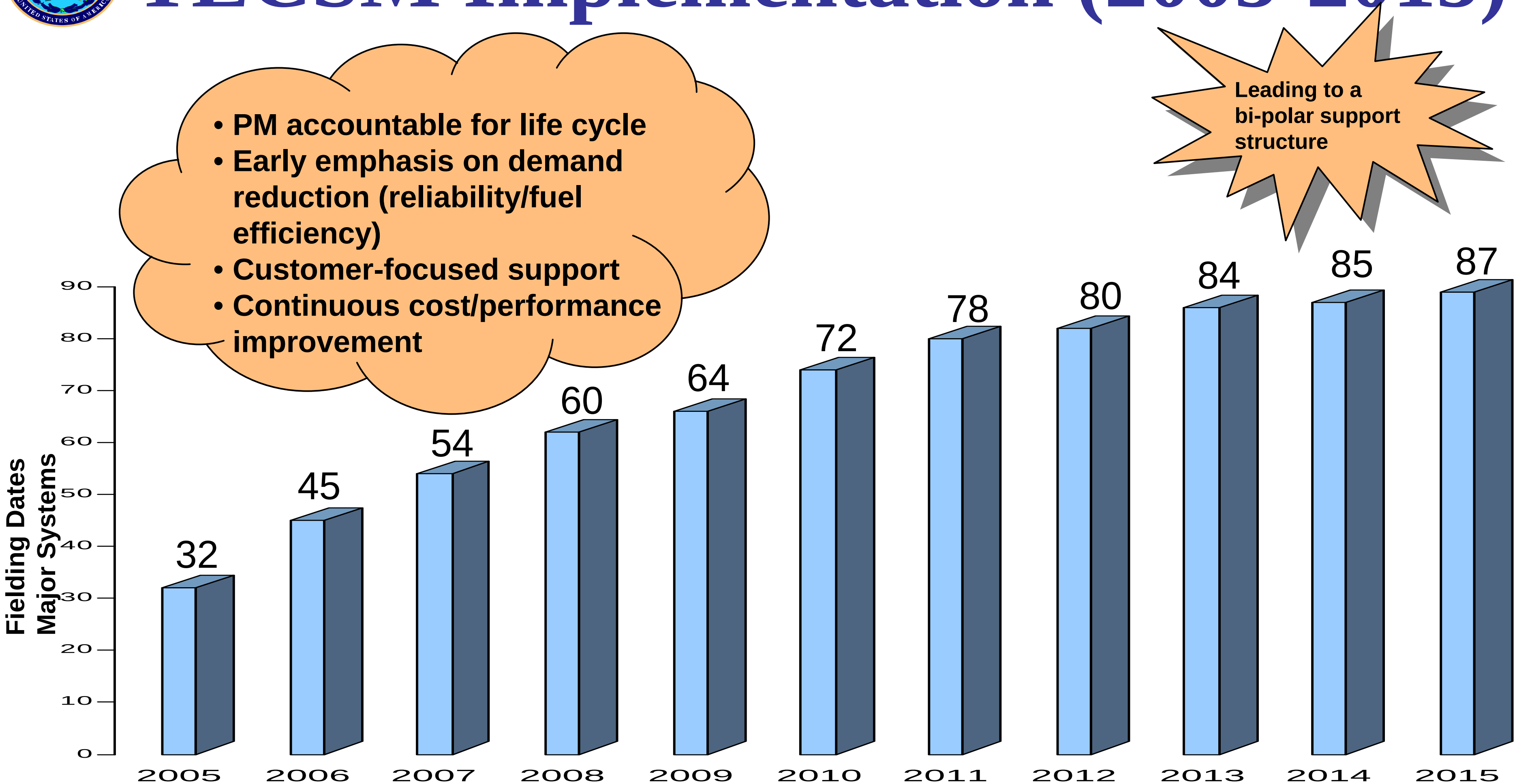
- Tool to evaluate overall PBL Progress
- Tool to assess PBL Performance
- Tool to identify requirements for improvement
- Tool to support rapid development of new PBL
- Tool to identify and address risk
- Tool to support BCA development

Total Life Cycle Systems Management - TLCSM

- **Total Life Cycle Systems Management**
  - **Fundamental to the DoD approach**
- **Key features:**
  - ***Single point of accountability;***
  - **Evolutionary acquisition;**
  - ***Supportability and sustainment as key elements of performance;***
  - ***Performance-based strategies, including logistics;***
  - ***Increased reliability and reduced logistics footprint; and***
  - ***Continuing reviews of sustainment strategies***

The Challenge: Move from influencing the re-design to influencing the design at its most basic level

TLCSM Implementation (2005-2015)



- TLCSM implemented as a go-forward strategy
- Does not explicitly address fielded legacy systems
- Consideration of legacy system varies across Service
- Legacy improvement does not compete well in resource process

QDR: Direct application of TLCSM principles to fielded systems (where appropriate).

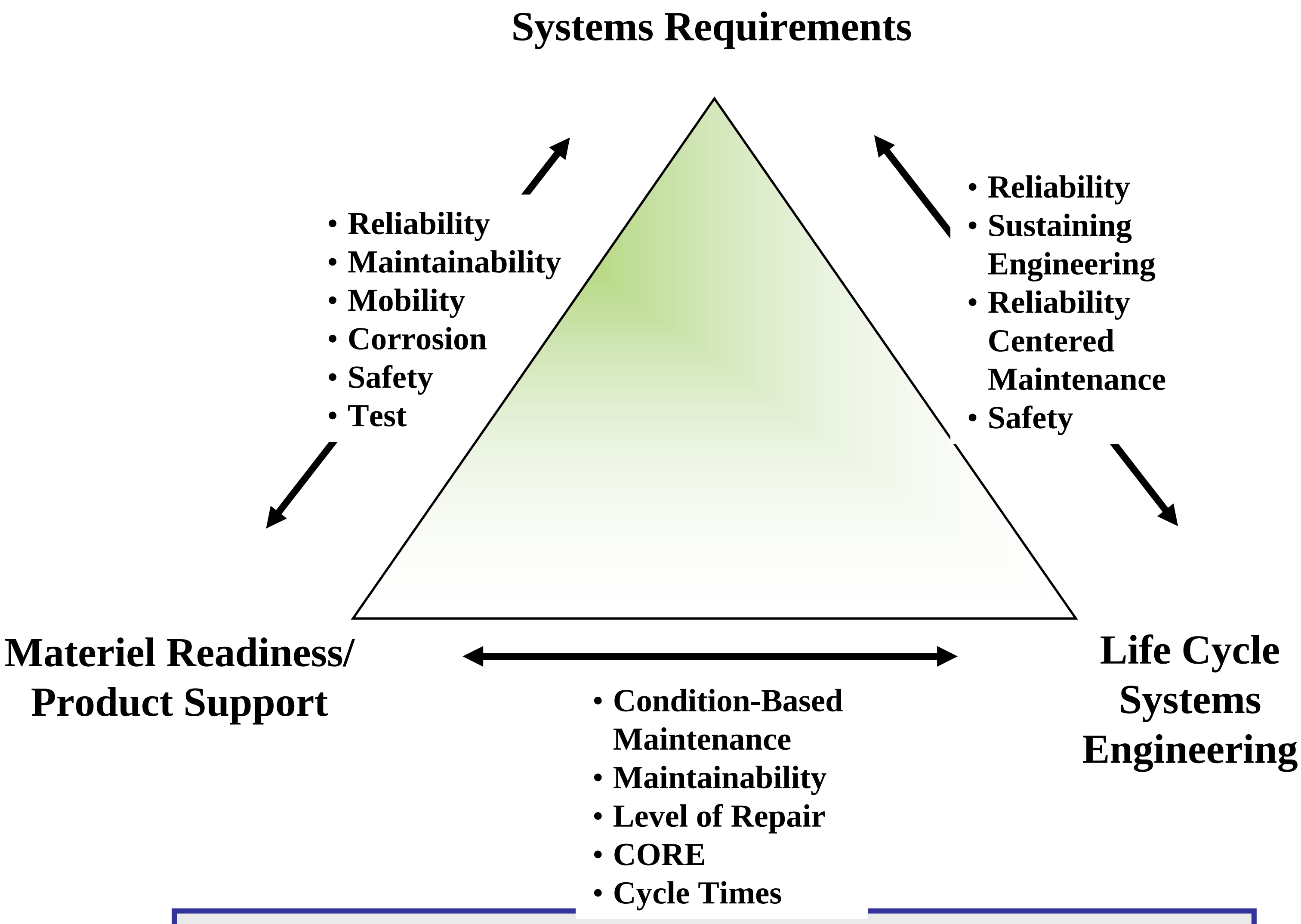
Status of Logistics Initiatives

(QDR 2001)

QDR 2001 Initiative	Completed Efforts	Remaining Work
Weapon System Support	• Established program managers as life cycle manager • Directed comprehensive application of performance-based logistics (PBL) • Demonstrated combat/cost effectiveness of PBL • Demonstrated cycle time and cost gains of lean maintenance practices	• **Implement life cycle principles on fielded platforms** • Expand to outcome-focused logistics system • Implement enabling financial processes • **Codify continuous process improvement program to include reliability, cycle time, and cost**
Consumable Item Management	• Implemented world-class practices for fuel, food, pharmaceuticals, shop materials • Demonstrated efficacy of leading commodity management practices	• Expand to logical war reserve consumable material • Codify commodity councils
Global Distribution Management	• Established USTRANSCOM as Distribution Process Owner • Transformed DLA into global stock positioning • Demonstrated combat/cost effectiveness in OEF/OIF • Ongoing asset visibility programs (RFID, UID)	• **Empower USTRANSCOM with enabling authorities** • **Transform joint logistics enroute infrastructure** • Codify enabling processes • **Fully implement RFID**

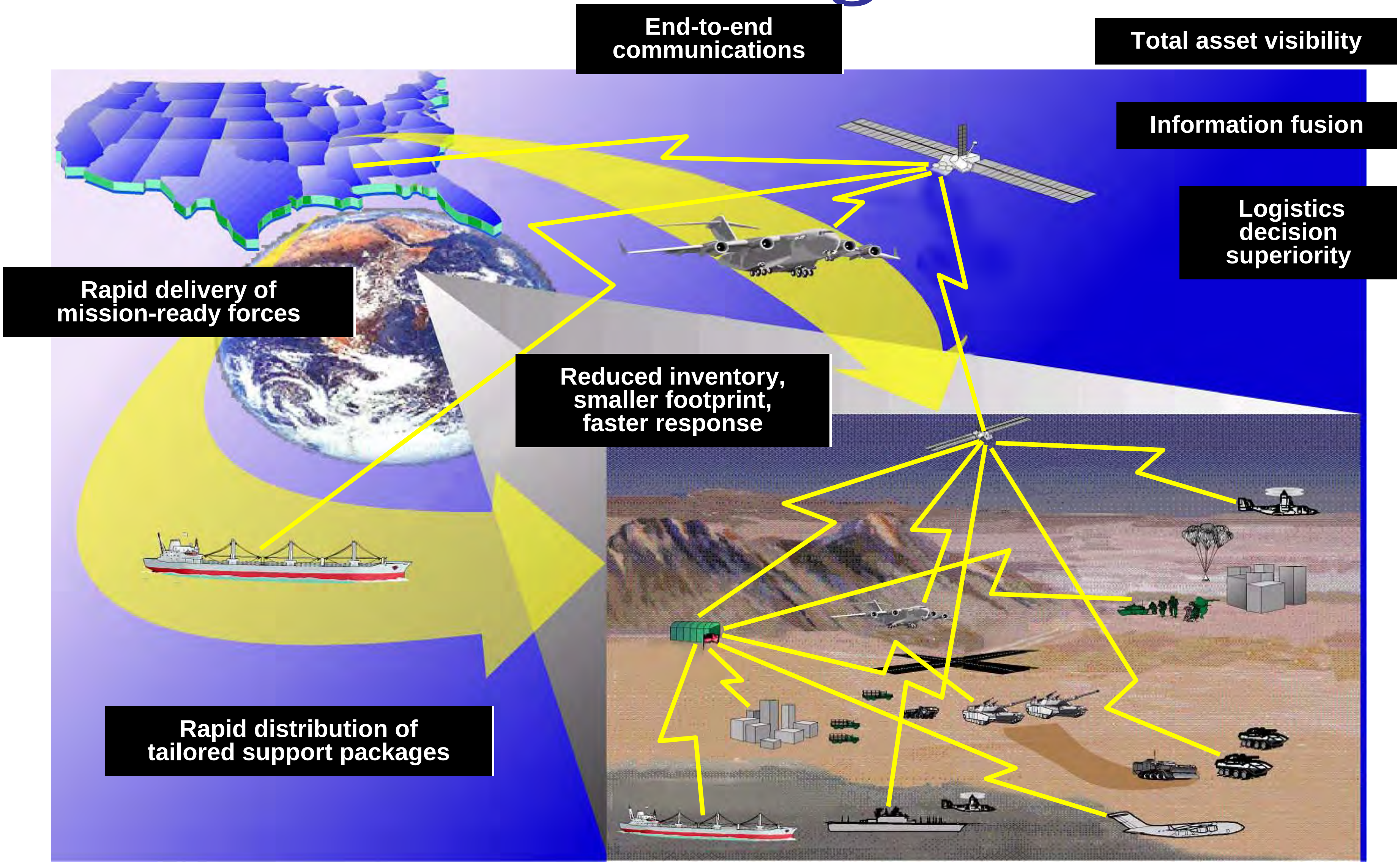
Blue Bold – QDR consideration/actions

The Life Cycle Triangle



Managing Performance Across the Life Cycle

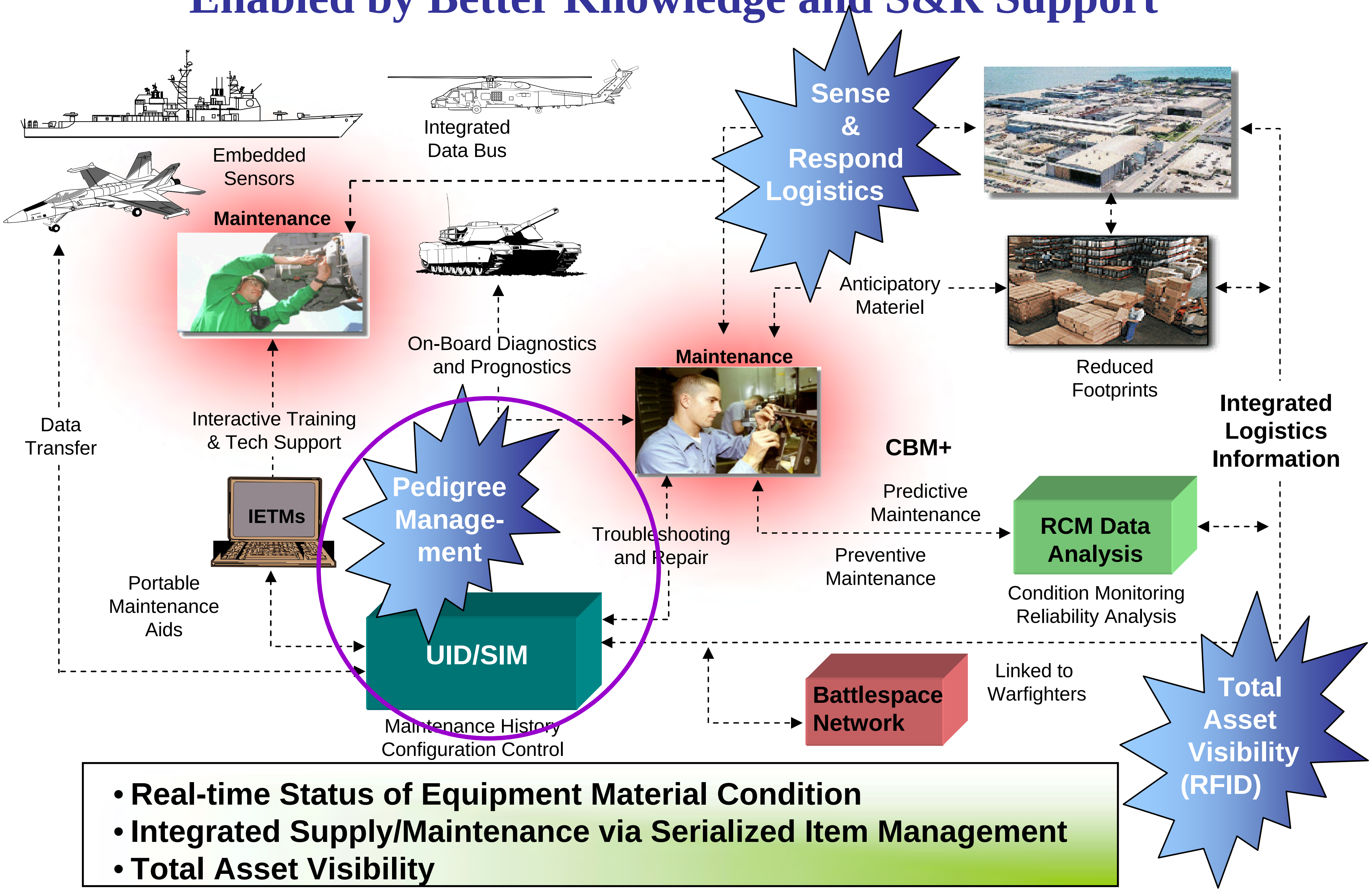
Focused Logistics



Bottom line: Forces in theater — whether forward-stationed or deployed — deliver more capability, require less support

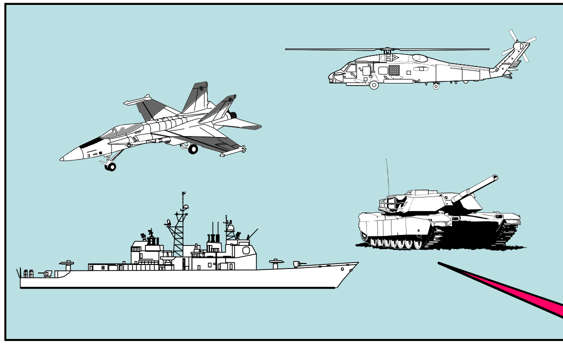
Focused Logistics Vision

Enabled by Better Knowledge and S&R Support



- Real-time Status of Equipment Material Condition
- Integrated Supply/Maintenance via Serialized Item Management
- Total Asset Visibility

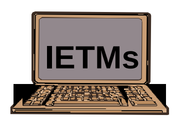
Building Blocks to S & R Focused Logistics



1. ***Product Support Engineering***
   - CBM +
   - Data Management
   - Configuration Management

2. ***Data Transmission***
   - •GCCS
   - •GCSS

Data Warehouse

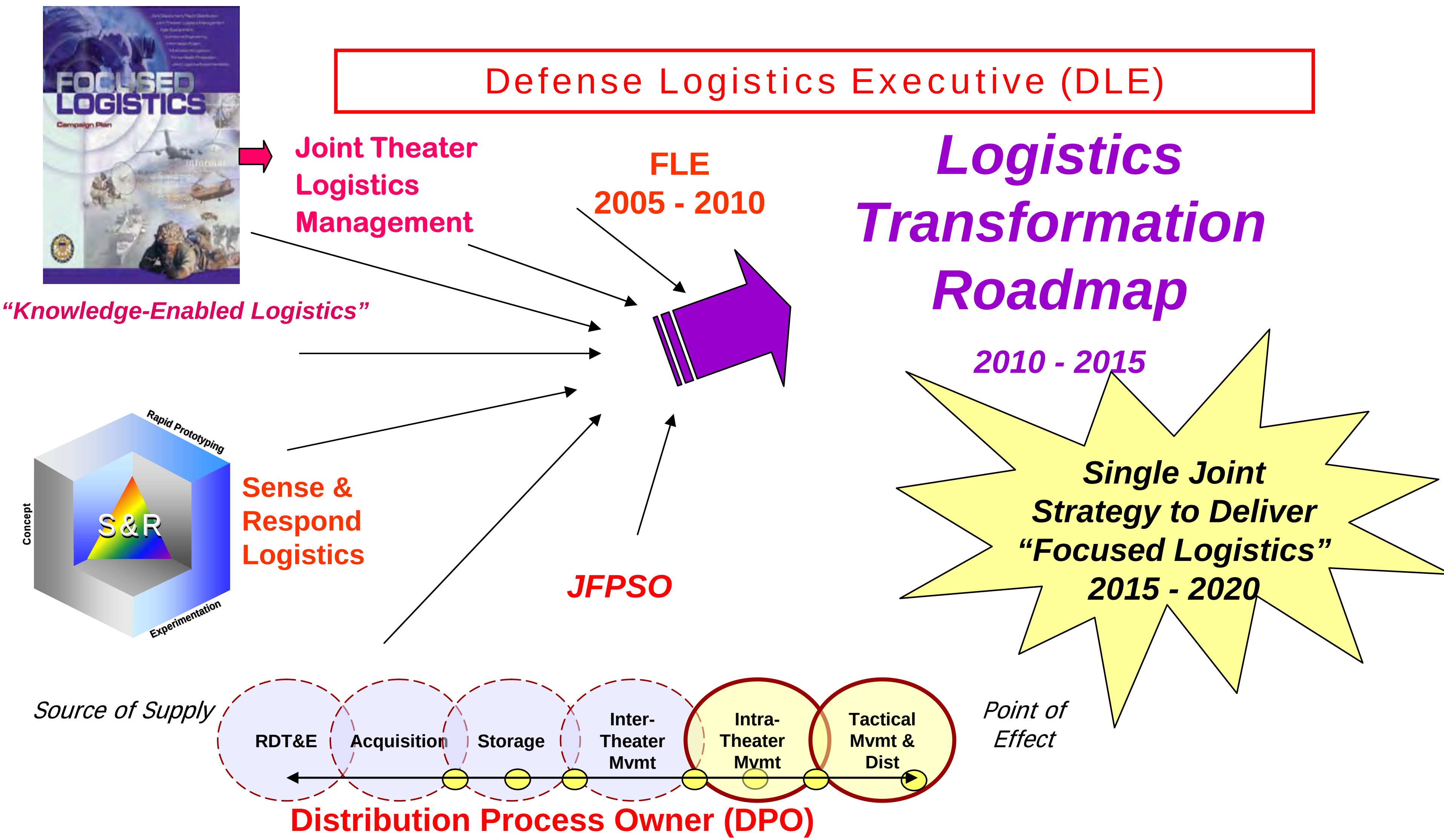


Customer Support Services
- Support System Mgmt
- Supply Chain Mgmt.
- Sustaining Engineering
- Help Desk
- Maintenance Data
- Configuration Mgmt.
- Tech Refreshment
- DMSMS

3. ***Technical Response Center***
   - Industry/Government Team
   - Maintenance & Supply Data

Technical Data is a Major Enabler to Achieve S & R
- •Technical Publications
- •Product Data Management
- •Professional Development
- •Technology Development

Defense Logistics Roadmap



* Joint Force Projection and Sustainment for Full Spectrum Operations

Maintenance Excellence Must Fit with War Fighter Vision

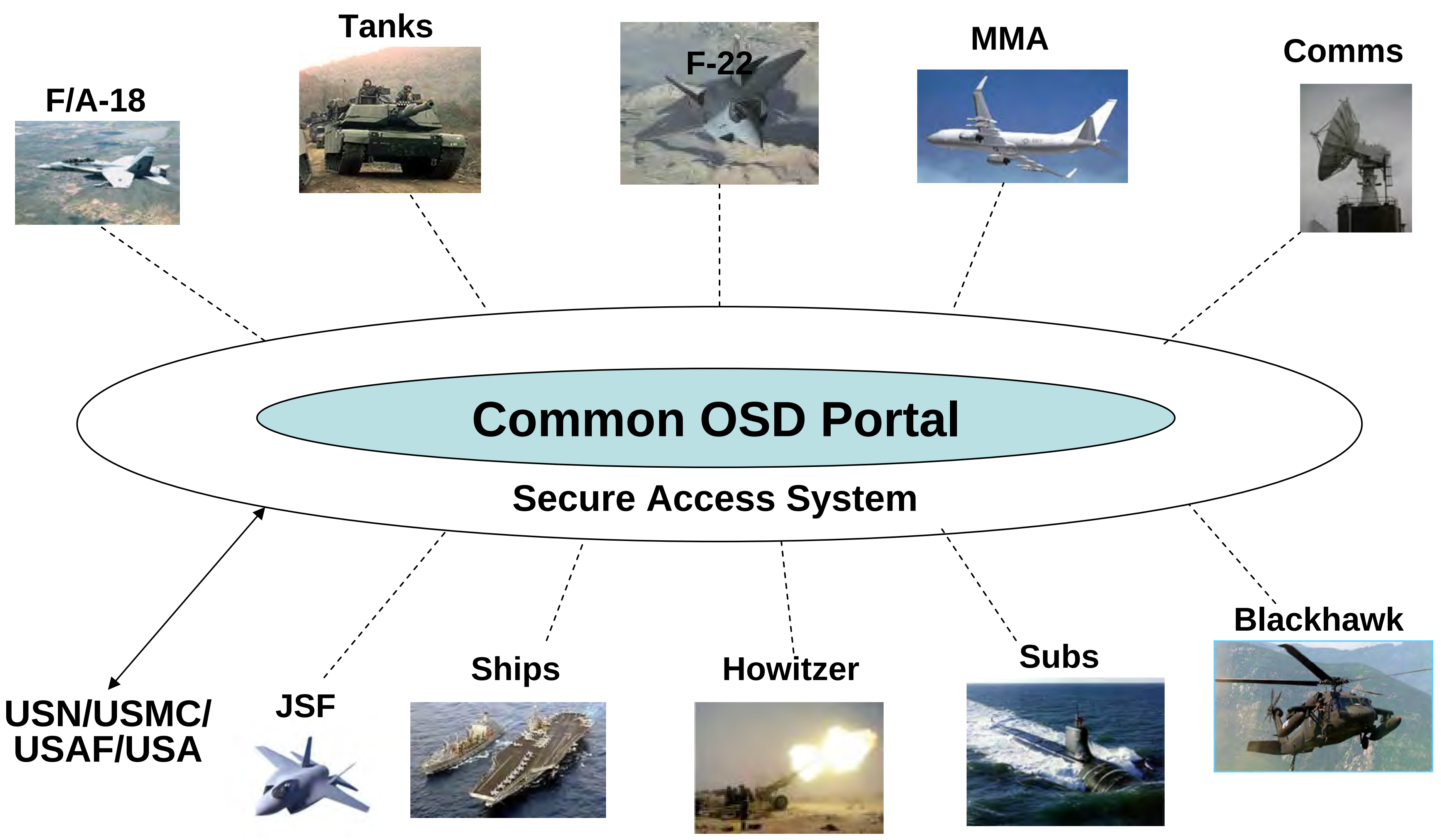
Network Centric Global Command & Control System

Global Joint Integrating Concept (JIC)

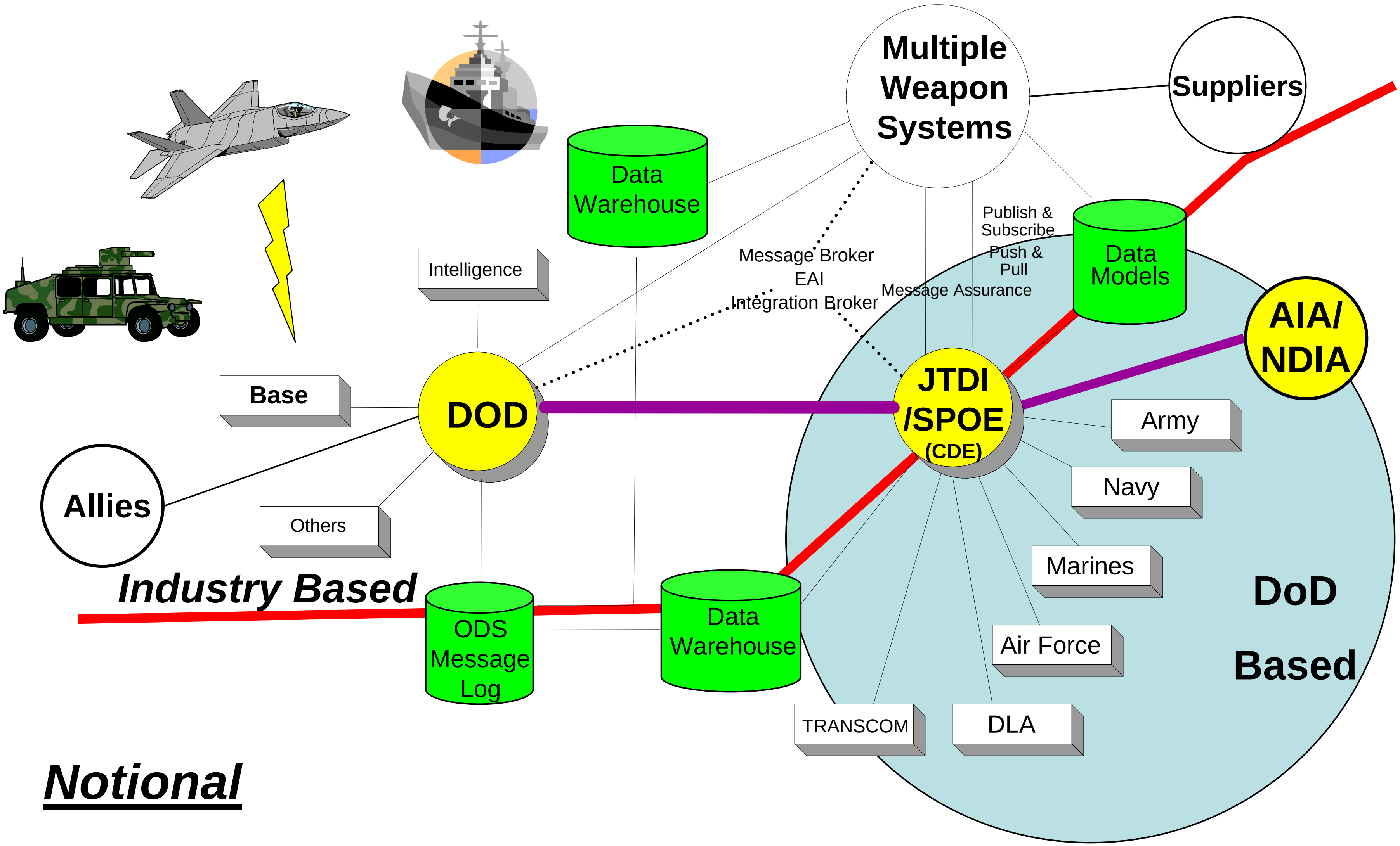
- GCCS Definition
- Integrated Engagement Space
- Critical operational capabilities identified
- Global Combat Support System

Integrated Engagement Space

Focused Logistics Enterprise



Support for FCS, JSF, DDX, F/A-18 and others



Notional

Stay Focused!

"On my signal … unleash hell…."

The Logistics Challenge: Ubiquitous, cost-effective capability to project and sustain power.

Cultural Barriers

Cultural Barriers is a politically correct disease, invented by consultants to justify high fees and adopted by some as an excuse for a lack of leadership and courage!

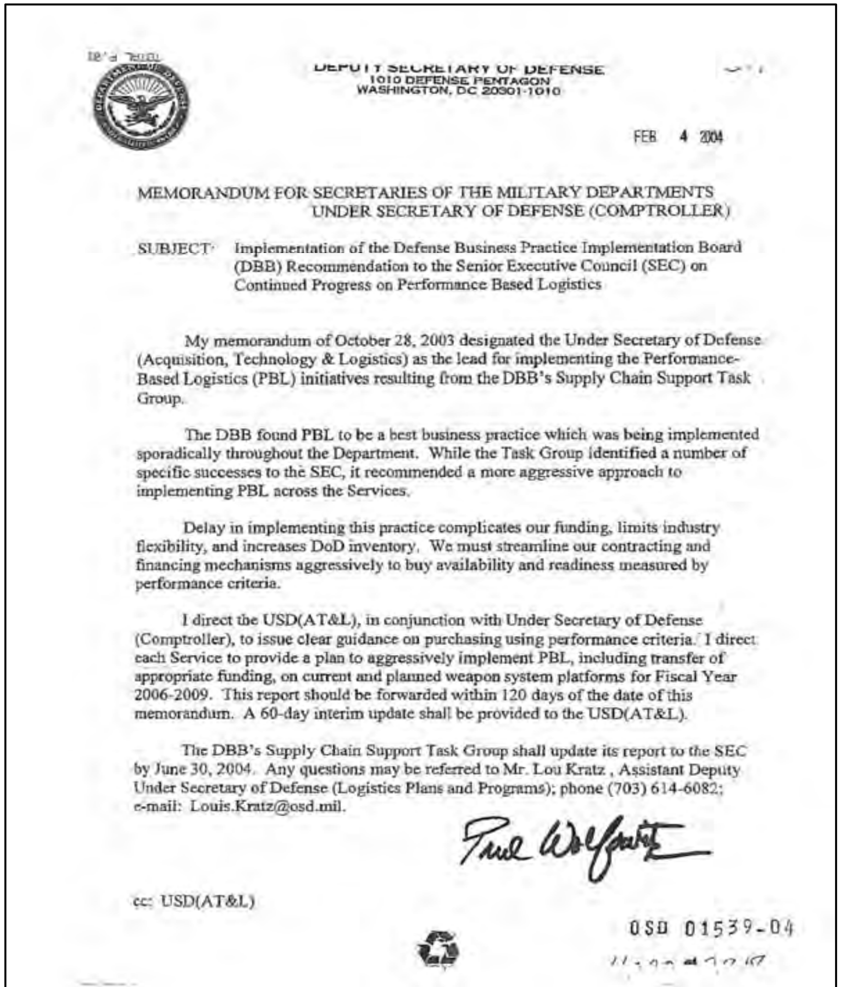
Summary

- ***Government and Industry must work together to achieve this objective***
  - ***Framework has been established***
    - ***Program Managers are Total Life Cycle Systems Managers***
    - ***PBL is the preferred sustainment strategy***
  - ***Performance based products***
  - ***CBM, UID, and RFID are important enablers***
  - ***Challenge to implement, must be cost effective***
  - ***Change is hard, but we owe it to the Warfighters to succeed***

Meeting Warfighter needs Around the Clock, Around the Globe.

BACKUP

Deputy SecDef PBL Guidance



DEPUTY SECRETARY OF DEFENSE
1010 DEFENSE PENTAGON
WASHINGTON, DC 20301-1010

FEB 4 2004

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
UNDER SECRETARY OF DEFENSE (COMPTROLLER)

SUBJECT: Implementation of the Defense Business Practice Implementation Board (DBB) Recommendation to the Senior Executive Council (SEC) on Continued Progress on Performance Based Logistics

My memorandum of October 28, 2003 designated the Under Secretary of Defense (Acquisition, Technology & Logistics) as the lead for implementing the Performance-Based Logistics (PBL) initiatives resulting from the DBB's Supply Chain Support Task Group.

The DBB found PBL to be a best business practice which was being implemented sporadically throughout the Department. While the Task Group identified a number of specific successes to the SEC, it recommended a more aggressive approach to implementing PBL across the Services.

Delay in implementing this practice complicates our funding, limits industry flexibility, and increases DoD inventory. We must streamline our contracting and financing mechanisms aggressively to buy availability and readiness measured by performance criteria.

I direct the USD(AT&L), in conjunction with Under Secretary of Defense (Comptroller), to issue clear guidance on purchasing using performance criteria. I direct each Service to provide a plan to aggressively implement PBL, including transfer of appropriate funding, on current and planned weapon system platforms for Fiscal Year 2006-2009. This report should be forwarded within 120 days of the date of this memorandum. A 60-day interim update shall be provided to the USD(AT&L).

The DBB's Supply Chain Support Task Group shall update its report to the SEC by June 30, 2004. Any questions may be referred to Mr. Lou Kratz, Assistant Deputy Under Secretary of Defense (Logistics Plans and Programs); phone (703) 614-6082; e-mail: Louis.Kratz@osd.mil.

Paul Wolfowitz

cc: USD(AT&L)

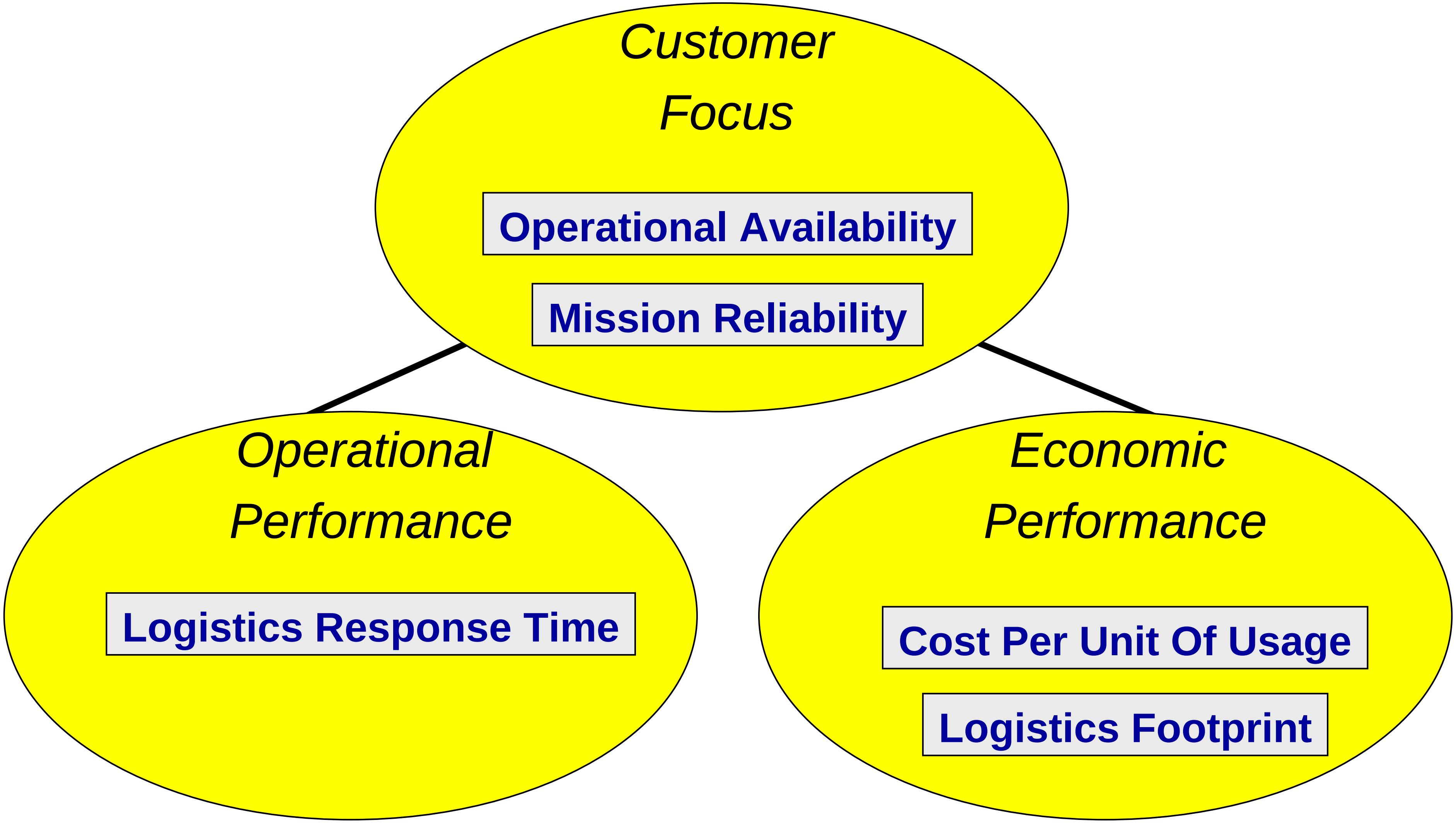
OSD 01539-04

- PBLs established as a DoD best practice
- More aggressive approach for PBL implementation
- Direction to issue "clear guidance" on performance-based purchasing
- Each Service has 120 days to provide a plan for aggressive PBL implementation

Recent PBL Efforts

- ✓ **DepSecDef PBL Guidance**
  - AT&L issue consistent guidance
  - Service plans for all ACAT I and II programs
- ✓ **Strategic Planning Guidance**
  - Service BCAs for all ACAT I and II by FY 06
  - Initial management review by September 04
- ✓ **Clear PBL BCA Guidance**
  - Total life cycle costs
  - Best value
  - Operationally driven
- ✓ **Clear PBL Contracting Guidance**
  - Accelerate PBL Contracting
  - Establish PBL Metrics
- ✓ **Established Supportability Design and Assessment Criteria** *24 Oct 03*
  - Incorporates SDOE
  - Technical Guidance by Milestone
- ✓ **New Defense Acquisition Guidebook** *On Line*
  - PM's TLCSM and PBL responsibilities clearly defined
- ✓ **Updated PBL Product Support Guide** *10 Nov 04*
  - A Tool for Program Managers
  - Incorporates latest lessons learned
- ✓ **MID 917 – PBL** *20 Oct 04*
  - Lead programs
  - Program/budget to single activity group

Total Life Cycle Systems Management Metrics



Weapon Systems Selected

Category A: (Candidates)	**23**
Category B: (Possible Candidates)	**87**
Category C: (Not Candidates)	**38**
Total	**148**

Weapon Systems Selected Continued

Category A: **<u>Candidates</u>**

- ***Joint Services***
  - MV-22 Osprey
  - Joint Strike Fighter
- ***Navy/Marine:***
  - Advanced Amphibious Assault Vehicle/ Expeditionary Fighting Vehicle
  - F/A-18 Hornet
  - LDP-17 San Antonio Class
  - E-2 Advanced Hawkeye
  - RQ-8 Fire Scout
  - Broad Area Maritime Surveillance (BAMS) UAV
  - E-6 Mercury
  - US-101 Presidential Helicopter
  - P-8 Multimission Maritime Aircraft
  - H1 (4 Blades)
- ***Army:***
  - FCS (Future Combat Systems)
  - Stryker
  - AH-64 Apache Longbow
  - Blackhawk
  - RESET Program
- ***Air Force:***
  - B-2 Spirit
  - F-22 Raptor
  - MQ-1 Predator UAV
  - F-117A Nighthawk
  - F-16 Fighting Falcon
  - C-17 Globemaster III

Weapon Systems Selected Continued

Category B: **Possible Candidates**

- ***Joint Services***
  - Aerial Common Sensor
  - UH-1 Huey
- ***Navy/Marine:***
  - AH-1 Cobra
  - EA-6B Prowler
  - KC-130 Hercules
  - UC-35C/D Ultra/Encore
  - AH-1W Super Cobra Helicopter
  - CH-53E Super Stallion Helicopter
  - CH/RH-53D Sea Stallion Helicopter
  - M1A1 Main Battle Tank
  - M60A1 Armored Vehicle Launched Bridge (M60A1 AVLB)
  - M88A1E1 Hercules Recovery Vehicle
  - C-20 Gulfstream Logistics Aircraft
  - C-130 Hercules Logistics Aircraft
  - C-40A Clipper Logistics Aircraft
  - E-2 Hawkeye Early Warning and Control Aircraft
  - E-6A Mercury Airborne Command Post
  - EA-6B Prowler Electronic Warfare Aircraft
- ***Navy/Marine Cont.:***
  - T-6A Texan II Turboprop Trainer
  - T-39N/G Sabreliner Trainer
  - T-45A Goshawk Trainer
  - RQ-2A Pioneer Unmanned Aerial Vehicle (UAV)
  - HH/UH-1N Iroquois Helicopter
  - CH-53D Sea Stallion Helicopter
  - MH-53E Sea Dragon Helicopter
  - 5-inch Mark 45 54- Caliber Lightweight Gun
  - AGM-154 Joint Standoff Weapon (JSOW)
  - Joint Direct Attack Munition (JDAM)
  - Mark 75 - 76mm/62 Caliber 3" Gun
  - Phalanx Close-In Weapons System
  - Harpoon Missile
  - AGM-88 HARM Missile
  - AGM-114B/K/M Hellfire Missile
  - AGM-65 Maverick Guided Missile
  - Penguin Anti-Ship Missile
  - RIM-116 Rolling Airframe Missile (RAM)
  - Sea Sparrow Missile
  - AIM-9 Sidewinder Missile
  - SLAM-ER Missile
  - Standard Missile
- ***Navy/Marine Cont.:***
  - Tomahawk Cruise Missile
  - Attack Submarines-SSN
  - Fleet Ballistic Missile Submarines - SSBN
  - Guided Missile Submarines - SSGN
  - Aircraft Carriers - CV, CVN
  - Amphibious Assault Ships - LHA/LHD/LHA(R)
  - Cruisers - CG
  - Destroyers - DD, DDG
  - Sea Lift
  - Landing Craft
  - Combat Logistics
  - Special Operations
  - Mine Warfare
  - Auxiliary
  - Intelligence
  - Cutters

Weapon Systems Selected Continued

Category B: <u>Possible Candidates</u> Continued

- ***Army:***
  - CH-47 Chinook
  - Patriot
  - Javelin
  - TOW Missile System
  - MLRS
  - M109 Paladin
  - Abrams
  - M2 Bradley
  - M113 Family
  - M1070 HET/m1000
  - HEMTT
  - HMMWV
  - Palletized Load System (PLS)
- ***Air Force:***
  - A-10/OA-10 Thunderbolt II
  - AC-130H/U Gunship
  - B-1B Lancer
  - C-20
  - C-32
  - C-37A
  - F-15 Eagle
  - F-16A/B Fighting Falcon
  - HC-130P/N
  - KC-10 Extender
  - KC-135 Stratotanker
  - MH-53J/M Pave Low
  - T-1A Jayhawk
  - T-38 Talon
  - T-43A
  - T-6A Texan II
  - U-2S/TU-2S
  - WC-130 Hercules

Weapon Systems Selected Continued

Category C: <u>Not Candidates</u>

- ***Navy/Marine:***
  - AV-8B Harrier II
  - CH-46E Sea Knight Helicopter
  - C-2A Greyhound Logistics Aircraft
  - C-9 Skytrain Logistics Aircraft
  - C-12 Huron Logistics Aircraft
  - EP-3E (ARIES II) Signals Intelligence Reconnaissance Aircraft
  - F-5N/F Adversary Aircraft
  - F-14 Tomcat Fighter
  - P-3C Orion Long Range ASW Aircraft
  - S-3B Viking Detection and Attack of Submarines Aircraft
  - T-2C Buckeye Jet Trainer
  - T-34C Turbomentor Training Aircraft
  - H-3 Sea King Helicopter
  - TH-57 Sea Ranger Helicopter
  - VH-3D Sea King Helicopter
- ***Navy/Marine Continued:***
  - Mark 38 - 25 mm Machine Gun System
  - U.S. Navy Mines
  - Torpedoes - Mark 46, Mark 48, Mark 50
  - AIM-54 Phoenix Missile
  - Vertical Launch ASROC (VLA) Missile
  - Frigates – FFG
- ***Army:***
  - OH-58D Kiowa Warrior
  - Avenger
  - M119 Towed Howitzer
  - M120/M121 Mortar
  - M252 Mortar
  - M93 NBC Recon System
  - M88A2 Hercules
- ***Air Force:***
  - C-141 Starlifter
  - C-21
  - MC-130E/H Combat Talon I/II
  - MC-130P Combat Shadow
  - OC-135B Open Skies
  - RC-135U Combat Sent
  - RC-135V/W Rivet Joint
  - T-37 Tweet
  - UH-1N Huey
  - WC-135 Constant Phoenix

Software Supportability: A Software Engineering Perspective

Stephany Bellomo
SAIC, Project Manager

My Background

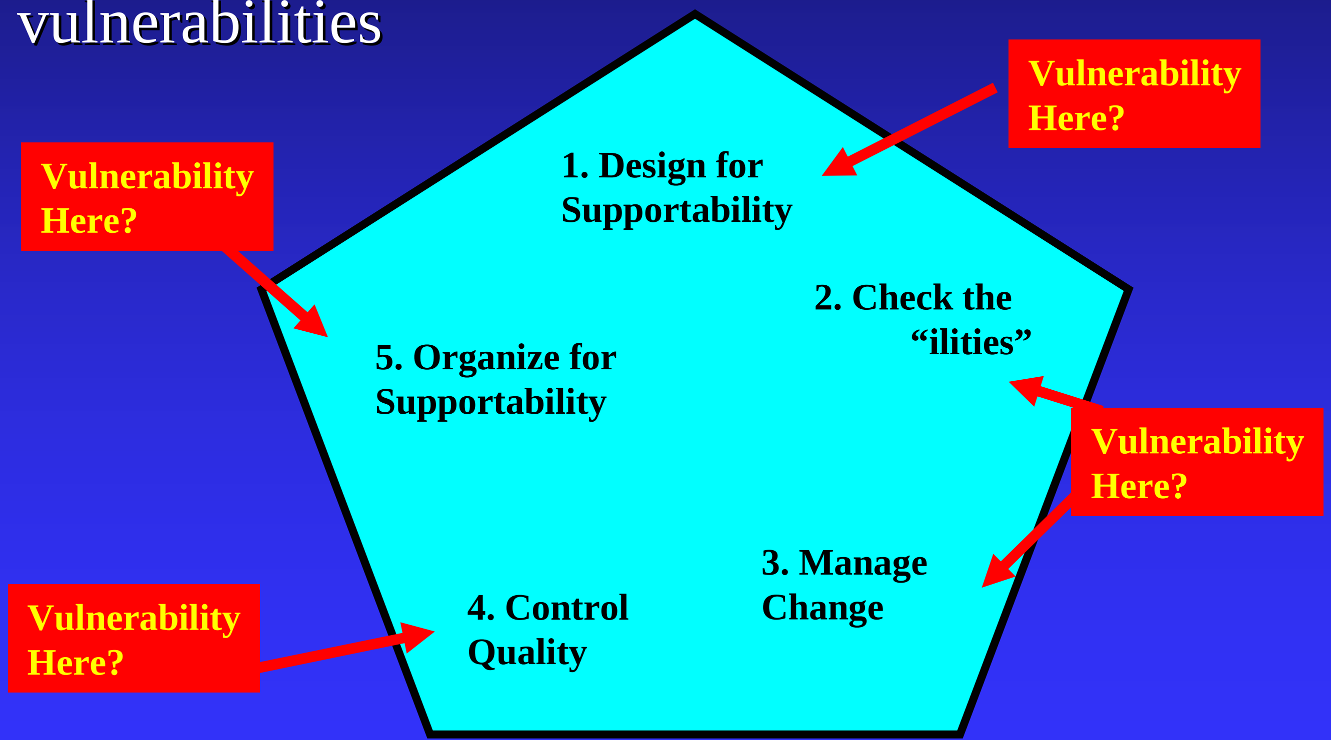
- MS, Software Engineering
- Lockheed Martin, Satellite System Programmer (C++ Developer, DBA)
- Intuit, Software Project Manager, (C++, Java, CORBA, Architecture)
- Verisign, IT Project Manager
- SAIC, Software Project Manager for CDC Select Agent Program

Overview

- 5 Supportability Principles
- Lesson's Learned
- Key Phase Recap
- Conclusion
- Contact Information

Supportability Principles Introduction

- Methodical approach to protecting system against vulnerabilities



Look for Vulnerabilities

Supportability Principle Overview

- 5 Supportability Principles
  1. Design for Supportability
  2. Check the "ilities"
  3. Manage Change
  4. Control Quality
  5. Organize for Supportability

Look for Vulnerabilities

Design Suggestions for Managers

1. **Design for Supportability**

- Designing for supportability requires diligence on the part of both managers and engineers
- What can managers do to identify vulnerabilities?
  - “What if” scenarios
  - Ask your technical team what the Achilles heel is – They will tell you!

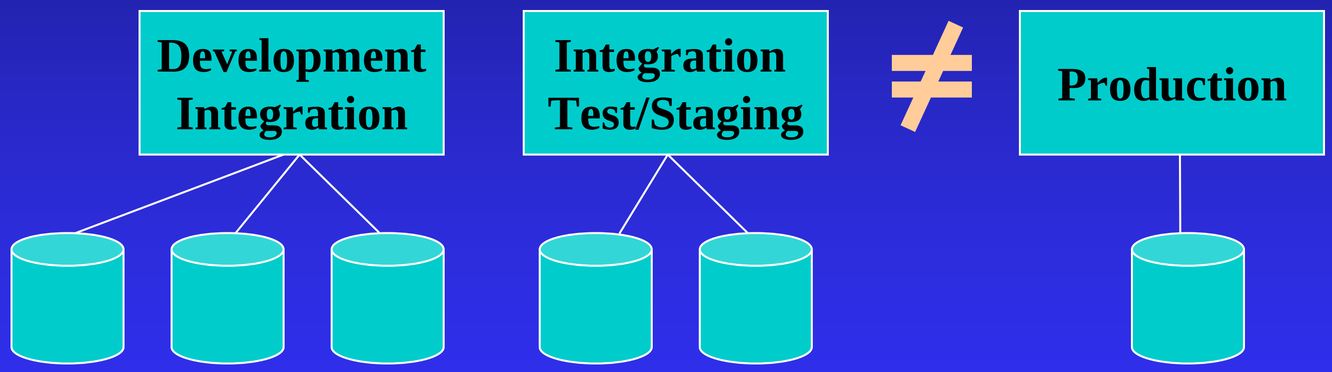
Look for Vulnerabilities

Design Suggestions for Engineers

- What can engineers to improve supportability through design?
  - Use a fully replicated production environment for pre-release testing
    - Don’t skimp
  - Parameterize using configuration files
  - Use frameworks to control design
  - Carefully evaluate COTS products before incorporating into the design
  - Incorporate distributed component design up front

Staging Example

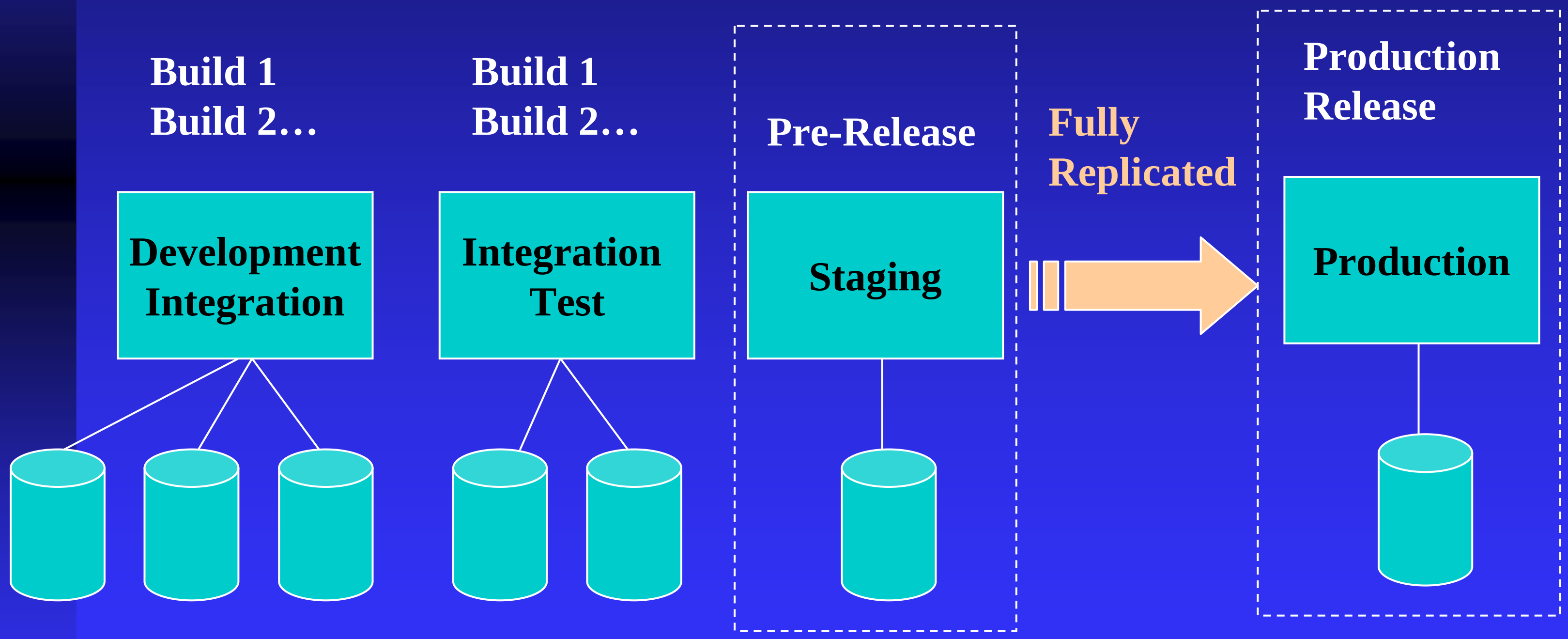
- Projects often double-use Integration Test and Staging
  - "It's not exactly the same environment as production, but theoretically it should work"



Stage = Production

Staging Example Cont.

- Fully Replicate the Pre-Release Staging Environment

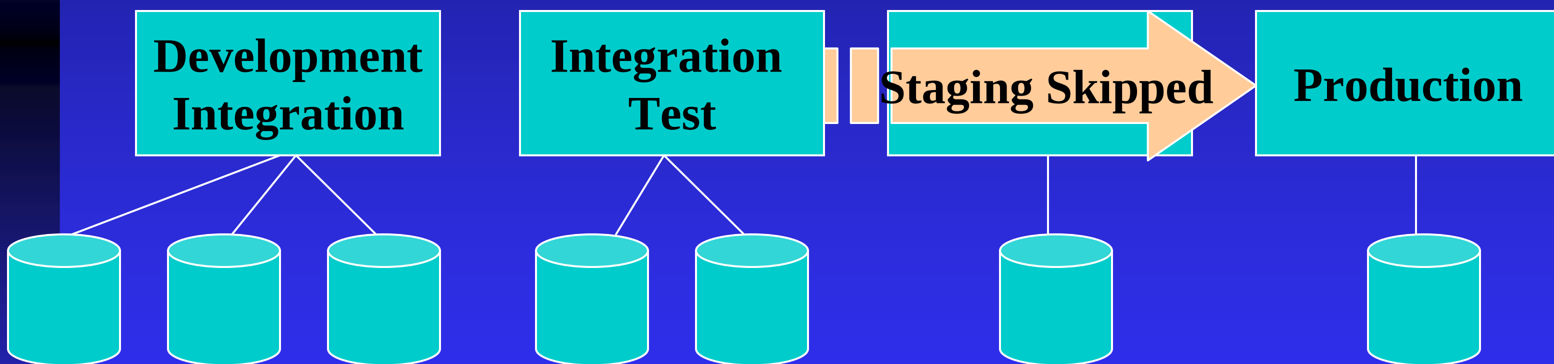


Stage = Production

From Science to Solutions™

Staging Lesson Learned

- Example: Recently technical lead skipped the staging for a small, non-production build
  - 8 hrs later still working deployment issues



- Issue identified ½ hour after pushing to Stage

Stage = Production

Configuration File Example

- Design Tips for Engineers
  - Use Configuration Files
    - Avoid hard-coding variables (I.e, IPs, hostnames, DB names, etc.)
  - Benefit – Supports dynamic changes to hardware setup

Config File

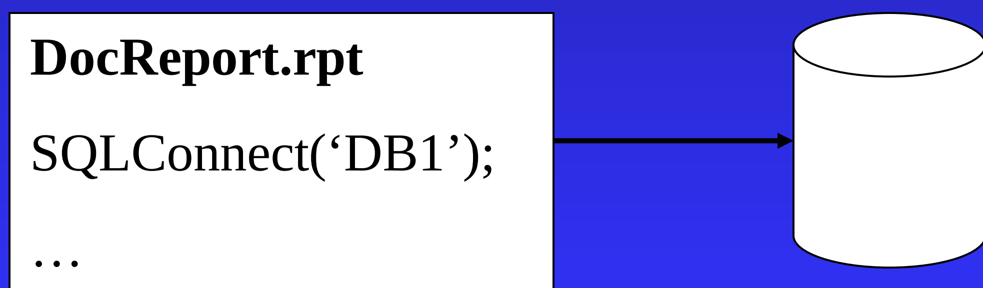
Setenv IP 122.11.333

Setenv DBNAME DB1…

Use Config Files

Configuration File Lesson Learned

- Recently migrated a legacy system to another HW configuration for high-availability (clustering)
  - Spent 2 weeks removing hard coded values
  - Host names and IPs were embedded throughout the code and reports



Use Config Files

Frameworks and Design Patterns

- Encourage developers to consider frameworks and design patterns during design phase
  - Frameworks
    - Data Entry Frameworks, Business Rules Frameworks, etc.
  - Design Patterns: Elements of Reuseable Object-Oriented Software
    - By Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides
  - COTS Best Practice
    - I.e, Documentum, Crystal Enterprise, Oracle Security, SQL Server, etc.

Focus on Frameworks

Framework Definition

- A **Framework** is a set of cooperating classes that make up a reusable design for a specific class of software
  - L. Peter Deutsch. Design reuse and frameworks in the Smalltalk-80 system
  - Quoted in Design Patterns: Elements of Reuseable Object-Oriented Software by Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides (gang of four)

Focus on Frameworks

Frameworks Lesson Learned

- Indicators that you need a framework
  - Frequently making the same types of code changes
  - Frequently adding fields to the schema
    - Example: Document Tracking Table

DocumentTracking

DocID	DocName	Reviewed DT	Approved DT
D1	Doc1	10-01-2005	10-15-2005
D2	Doc2	10-03-2005	10-17-2005

…adding tracking tables and date fields to DB for each new Event

Focus on Frameworks

SAIC
From Science to Solutions™

Frameworks Lesson Learned Cont.

- Framework-Driven Event Model
  - Event additions are data driven
  - No schema changes needed to add an Event

EventType

EventID	Event Type
E1	Review
E2	Approve
E3	New Event

Add new event here

DocEvent

DocID	EventID	EventDT
D1	E1	10-01-2005
D2	E1	10-15-2005
D1	E3	10-15-2005

Event Framework Adds Date here

Focus on Frameworks

COTS Lessons Learned

- COTS are generally a good thing, but can drive bad design decisions
  - This is an ever increasing problem as the government encourages use of COTS

- Two Real Life Examples of COTS abuse
  1. Cold Fusion Dot Com experience
  2. Business rule scripting in UI or PDFs

Use COTS Carefully

Distributed Design Intro

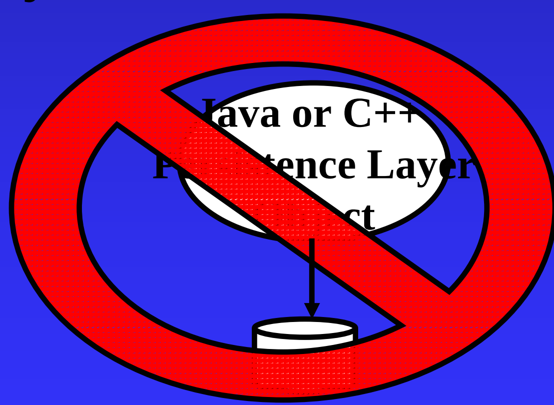
From Science to Solutions™

- Enforce Distributed Component Design through physically distributed methods, not coding standards
  - Software distributed component architecture can be enforced by RMI (I.e, Web services, COM, etc.)
  - Node distribution severs ties to object libraries
- What happens if you try to "fake it"?
  - Library dependencies aren't discovered until production release testing
    - Result – Last minute scrambling…

Distribute Early and Often

Distributed Design Don’ts

- Plan for Unforeseen System Interface Requirements to other systems
  - Build Internal System Interfaces
- Don’t rely on coded frameworks (COTS or homegrown) to encapsulate layers



Distribute Early and Often

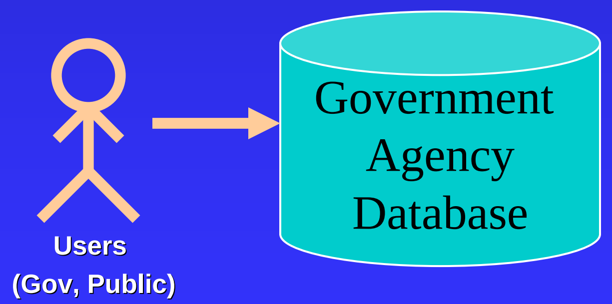
Distributed Design Lesson Learned - 1

- Example: In 1993 first job out of VA Tech, worked on a DoD satellite simulation system
  - Tasked to resolve this error for 6 months
    - ERROR: File not found!
  - Why?
    - Distributed design enforced by coding standard
    - No physical separation of software components
      - Months to untie code dependencies after physical distribution

Distribute Early and Often

Distributed Design Lesson Learned - 2

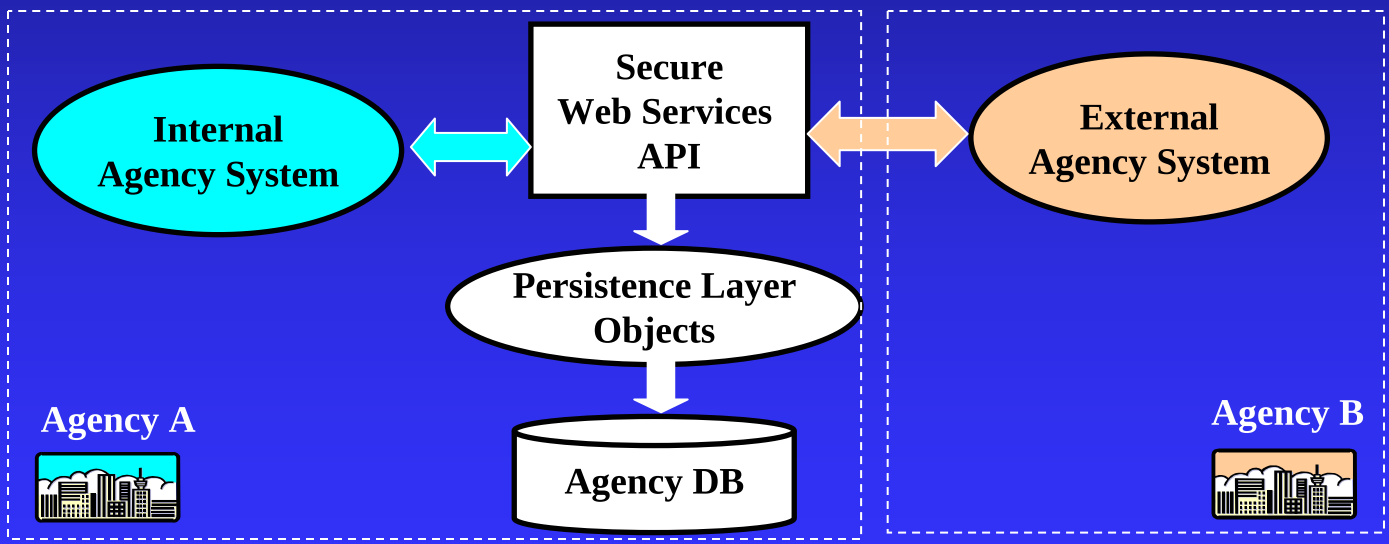
- Original SOW requirement
  - Mile-high view - Build Single Government Agency Database
- Requirements change
  - Allow another Government Agency to securely view data in database
- Good news
  - System is framework-based and extendible
  - However, still significant work to put persistence layer behind web services interface



Distribute Early and Often

Distributed Design Do's

- Do use distributed component interfaces to separate software layers (I.e., Web Services API)
  - Provides extendible data access through a secure interface



Distribute Early and Often

Check the “ilities”

2. **Check the “ilities”**
   - ✓ Security
   - ✓ Reliability
   - ✓ Flexibility
   - ✓ Maintainability
   - ✓ Scalability
   - ✓ Availability

Check the “ilities”

Configuration Management

3. **Manage Change**
   - Don’t attempt too much change at once
   - Evaluate system impacts with changing requirements
     - Use the CCB*
   - Resist the temptation to “just add it in this time”

CCB = Configuration Control Board

Change a little. Test a lot…

Database Configuration Management

- Worst configuration management issues consistently revolve around Database CM
  - I.e., Stored procedures, Schema versioning, Scripts, Hand-data entry
- Reasons for poor database CM
  - In my experience, DBAs often don't have formal Software training
    - SW Developers trained to use CM tools at entry level, but DBAs often not included in CM training
  - DBAs often don't have to integrate with others
    - Work independently
      - Don't need to update baselines to test code

Enforce Database CM

Database CM Lesson Learned

- Database Management Fundamentals
  - Creating and enforcing Database change procedures must be part of DBA Responsibility
  - Stored procedures must be and scripts stored under configuration control
    - Example – “Lost stored procedure story”
  - All databases should be made through scripts AND TESTED!!!

Enforce Database CM

Quality Control

4. **Quality Control**

- Monitor to maintain quality and identify new risks
  - Keep CMMI inspections technical
  - Develop processes and follow them
- Enforce Independent Verification and Validation
  - At a minimum, developers should not test their own code
- QA person should report to Program Manager

Anytime is good time for a Technical Question

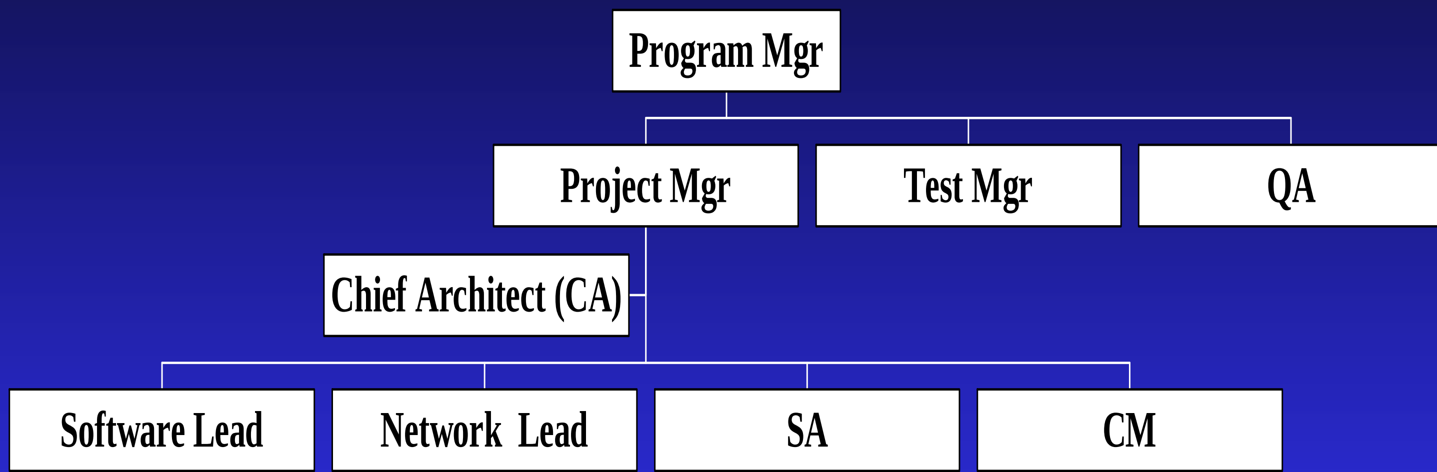
Organize for Supportability

5. Organize for Project for Supportability

- Supportability failures often occur between teams or areas of expertise
  - I.e., software team, network team, SA, Security, etc.

- Mitigation strategy
  - Assign someone the specific role of enforcing cross-disciple technical quality

Organize for Supportability Cont.



- Chief Architect leads cross-discipline teams
  - Qualified Tech Leads start as Software, Network or System Engrs
- Challenge: Finding architects that can manage outside their "Comfort Zone"

Architect: The Tie that binds

Key Phrases

- ***Look for Vulnerabilities***
- ***Stage = Production***
- ***Use Config Files***
- ***Focus on Frameworks***
- ***Use COTS Carefully***
- ***Distribute Early and Often***
- ***Change a Little. Test a lot…***
- ***Enforce Database CM***
- ***Anytime is a Good Time for a Technical Question***
- ***Architect: The Tie that Binds***

Conclusion

- In all project activities, ask yourself these questions:
  1. Does this Design Decision promote Supportability?
  2. Have we considered all the "ilities"?
  3. How well are we Managing Change?
  4. Are we adequately Controlling Quality?
  5. Are we organized for Supportability?

Contact Information

- My contact information:
  - Stephany.a.bellomo@saic.com
- Feel free to send me questions and/or comments

NDIA Systems Engineering Conference

Program Support: Perspectives on Technical Planning and Execution

Dave Castellano

Deputy Director, Systems Engineering

DEFENSE SYSTEMS
Office of the Under Secretary of Defense for Acquisition, Technology and Logistics

October 24-27, 2005

Top Five Systems Engineering Issues*

- Lack of awareness of the importance, value, timing, accountability, and organizational structure of SE on programs
- Adequate, qualified resources are generally not available within government and industry for allocation on major programs
- Insufficient SE tools and environments to effectively execute SE on programs
- Requirements definition, development, and management is not applied consistently and effectively
- Poor initial program formulation

*** Based on an NDIA Study in January 2003**

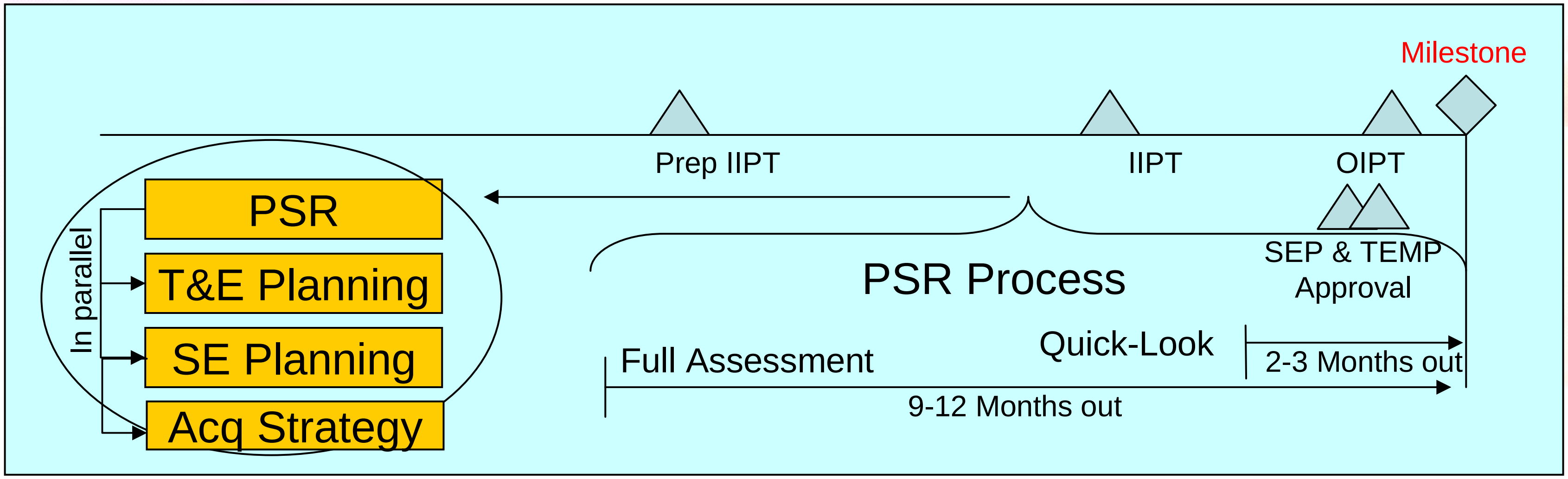
Recap: What We Have Done To Revitalize Systems Engineering

- Issued Systems Engineering (SE) policy
- Issued guidance on SE and Test & Evaluation (T&E)
- Integrating Developmental T&E with SE policy and assessment functions – focused on effective, early engagement of both
- Instituted system-level assessments in support of OSD major acquisition program oversight role
- Established SE Forum – senior-level focus within DoD
- Working with Defense Acquisition University to revise SE, T&E, and enabling career fields curricula
- Leveraging close working relationships with industry and academia

Necessary but not sufficient!

General Approach: Program Outreach Review Products

- Full reviews conducted 9-12 months before Milestone
  - Detailed findings, risks & actionable recommendations
  - Conducted in "PM support" vice "OSD oversight" mode
- "Quick-Look" reviews conducted 2-3 months before Milestone
  - Same form and formats as full assessment; conducted "for record" review
- Quarterly Defense Acquisition Executive Summary (DAES) assessments inputs
- Test & Evaluation Master Plan (TEMP) and Systems Engineering Plan (SEP) development and approval



Systems Engineering Plans

DoD Systems Engineering Shortfalls*

- Common failures on acquisition programs include:
  - Inadequate understanding of requirements
  - Lack of systems engineering discipline, authority, and resources
  - Lack of technical planning and oversight
  - Stovepipe developments with late integration
  - Lack of subject matter expertise at the integration level
  - Availability of systems integration facilities
  - Incomplete, obsolete, or inflexible architectures
  - Low visibility of software risk
  - Technology maturity overestimated

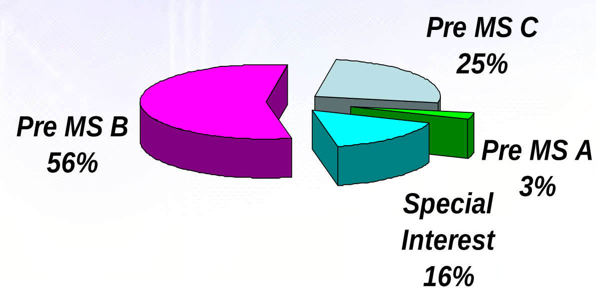
Major contributors to poor program performance

*** Findings from PSRs and DoD-directed Studies/Reviews**

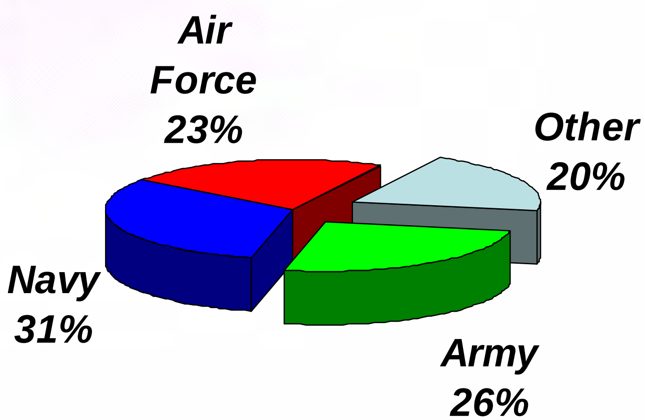
Systems Engineering Plan Activity
(since November 2004)

- Number of SEPs reviewed: 59
- Programs submitting SEPs: 36
  - Number of SEPs approved: 8
  - Number of SEPs pending: 5
- Reviews planned for rest of FY06: 103

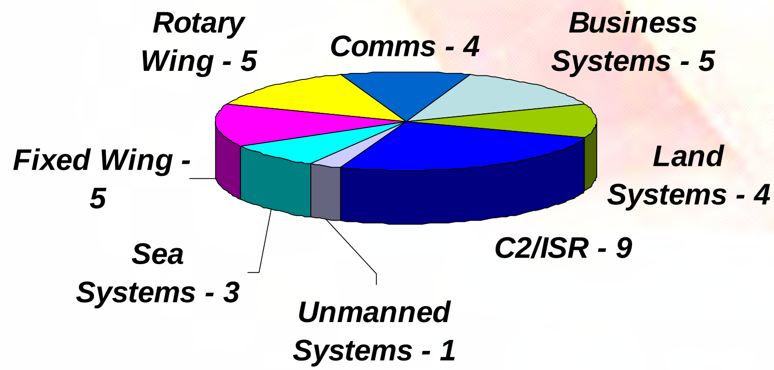
SEP Program Milestones



Component-Managed Acquisitions



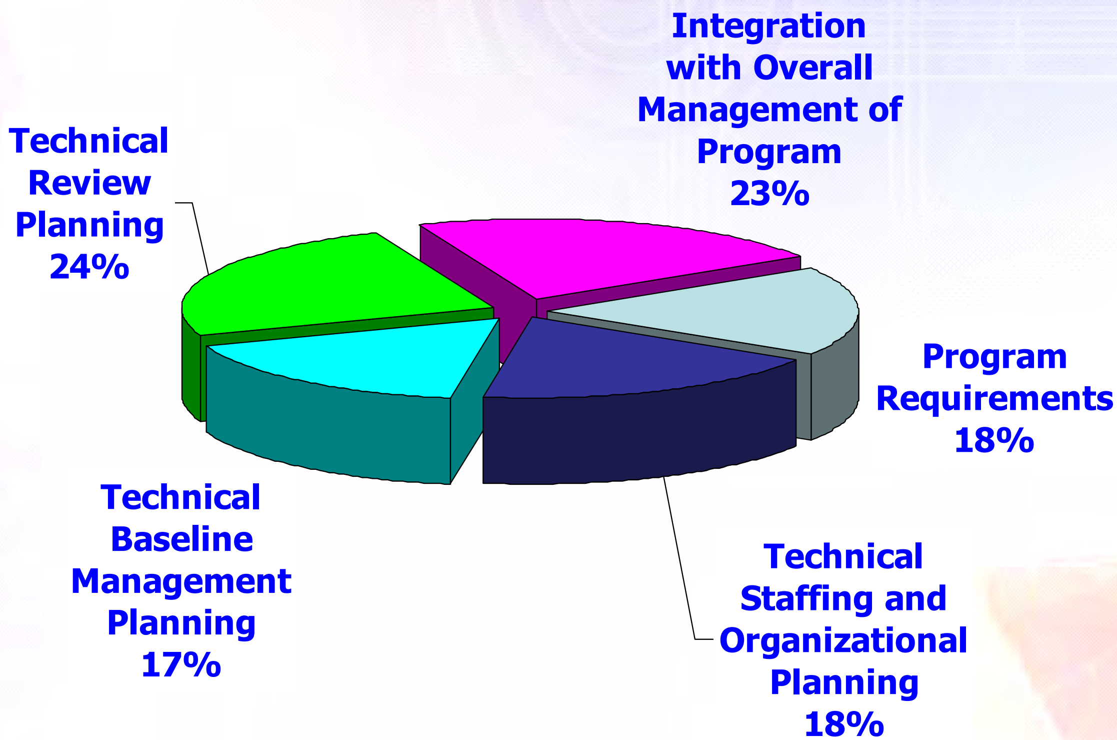
Programs by Product Line



Version 1.0; CM# 05-10-002-P

Emerging SEP Comments**

(not systemic across all programs)



****BASED ON ANALYSIS OF 27 OUT OF 39 PROGRAMS**

Program Support

General Review Areas

ASSESSMENT METHODOLOGY FOR PRE-MILESTONE C

ASSESSMENT METHODOLOGY FOR PRE-MILESTONE B

ASSESSMENT METHODOLOGY FOR PRE-MILESTONE A

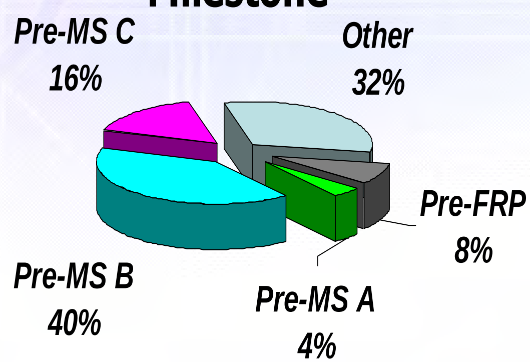
http://www.acq.osd.mil/ds/se

Program Support Review Activity
(since March 2004)

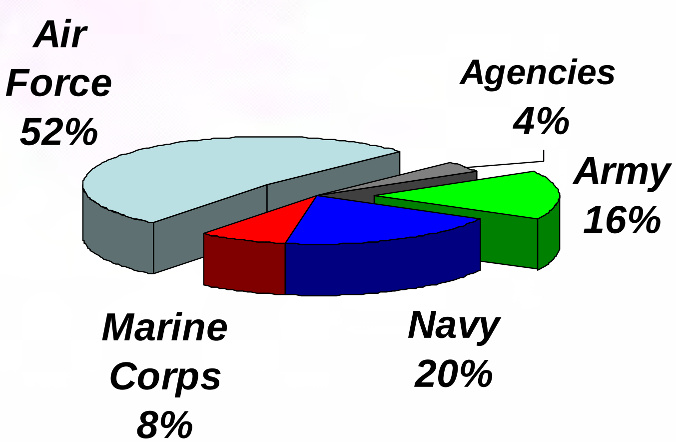
- Number of PSRs completed: 25
- Number of AOTRs completed: 4

- Reviews planned for rest of FY06
  - PSRs: at least 24
  - AOTRs: 2

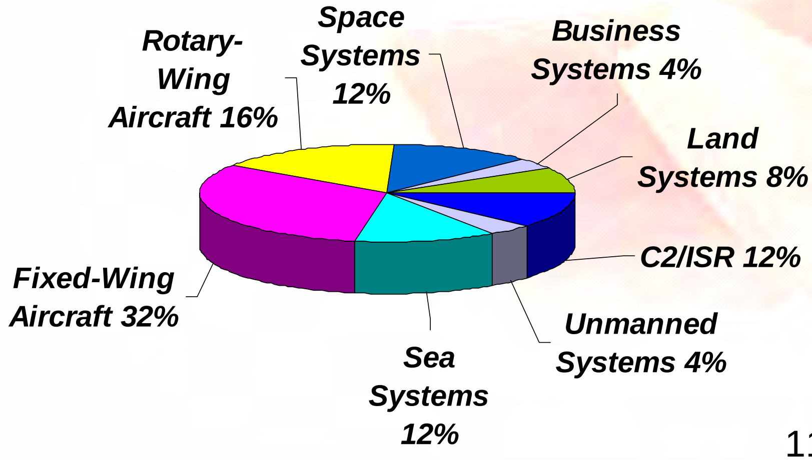
Reviews Conducted Prior to Each Milestone



Service-Managed Acquisitions



Programs by Product Line



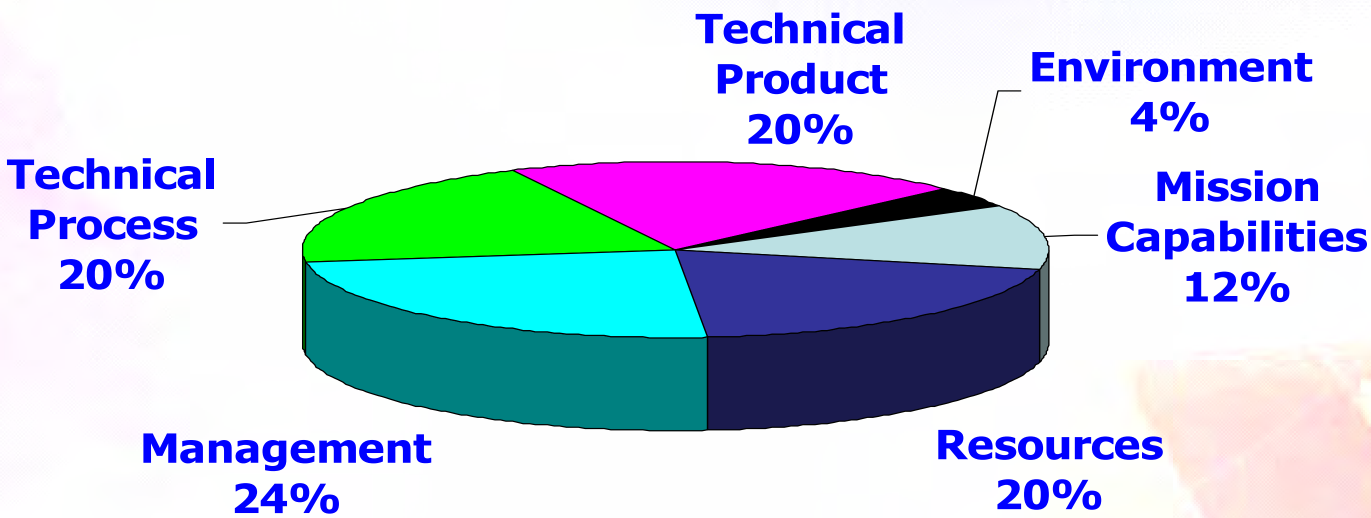
Samples of Program Support Review "Strengths"

- Experienced and dedicated program office teams
- Strong teaming between prime contractors, sub-contractors, program offices and engineering support
- Use of well defined and disciplined SE processes
- Proactive use of independent review teams
- Successful management of external interfaces
- Corporate commitment to process improvement
- Appropriate focus on performance-based logistics
- Notable manufacturing processes
- Focus on DoD initiatives
- Excellent risk management practices

But not on all Programs…

Emerging Program Support Findings**
(not systemic across all programs)

- Findings across the 6 general review areas…
  (based on assessment methodology areas)



****BASED ON ANALYSIS OF 14 OUT OF 22 REVIEWS**

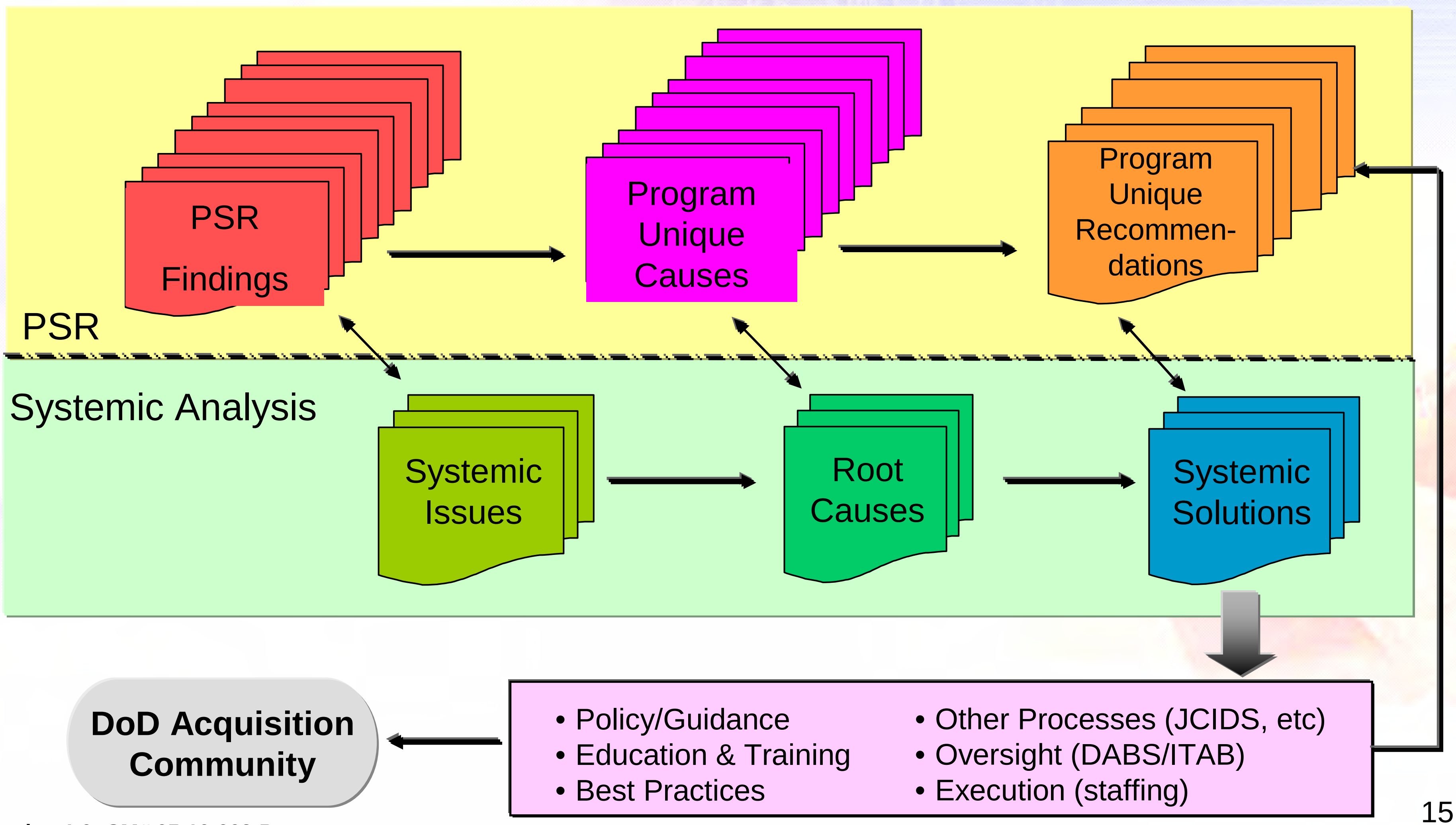
Driving Technical Rigor Back Into Programs
"How PMs are reacting to PSR recommendations?"

- Mission Capabilities - Requirements
  - User requirements not fully defined and/or in flux
  - ☑ Established requirements management plan with all stake holders, including proactive plan for Net-Ready KPP
- Resources - Personnel
  - Experienced, dedicated PM office staff, but stretched too thin
  - ☑ Expanded, empowered WIPT to bring in technical authority SMEs, users, and DCMA
- Management - Schedule Adequacy
  - Technical review planning demonstrated schedule was high risk
  - ☑ Lengthen schedule to include full suite of SE technical reviews, supported by adjusted program funding
- Technical Process - Test & Evaluation
  - Insufficient reliability growth program to meet user requirements by IOT&E
  - ☑ Increased the number of test articles and added sub-system level test events
- Technical Product - Supportability/Maintainability
  - Logistics demonstration plan just prior to IOT&E
  - ☑ Demonstration re-scheduled prior to MS C

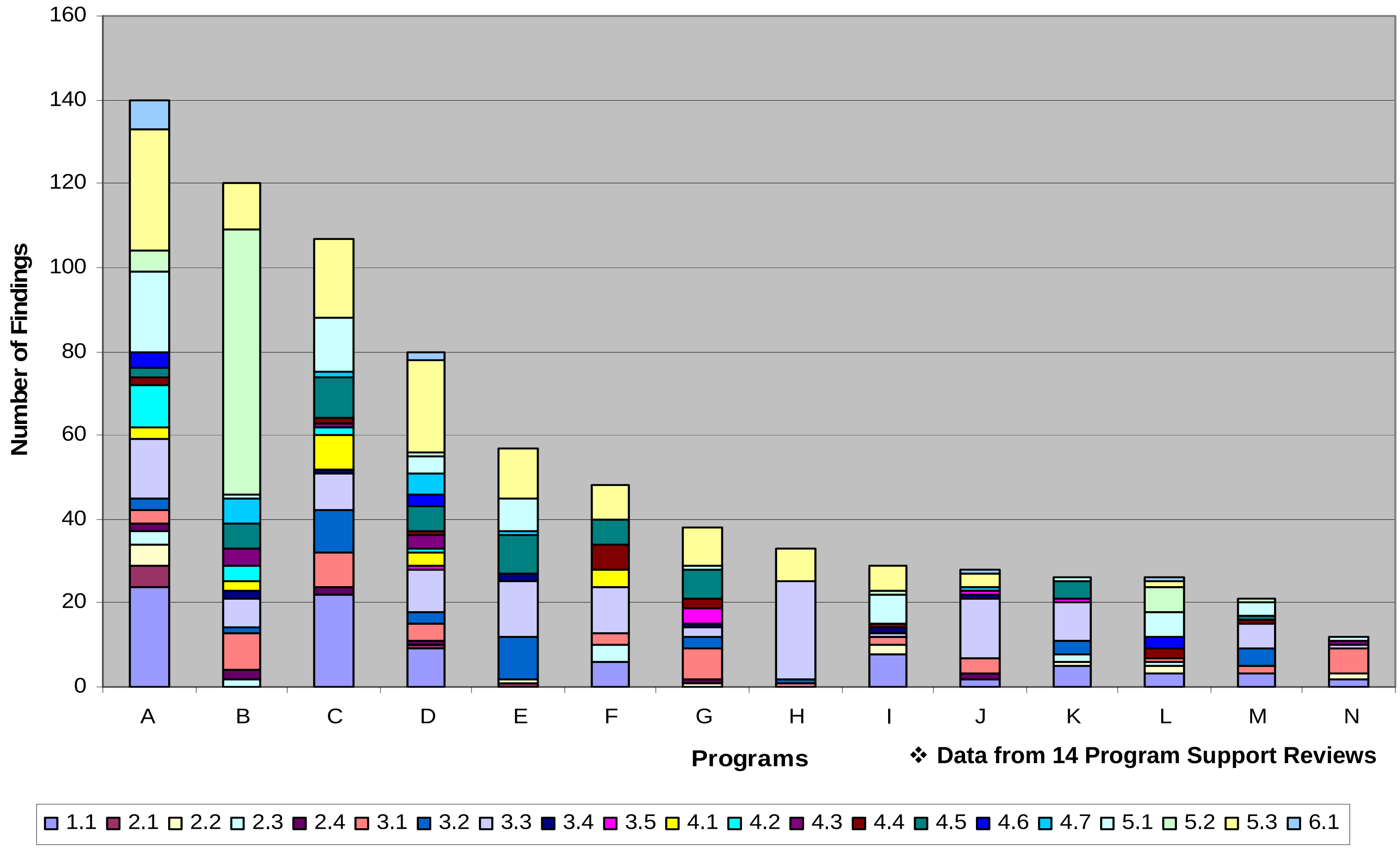
Better than 90% acceptance of recommendations

Systemic Analysis Perspective

"How do we find solutions to the systemic problems?"



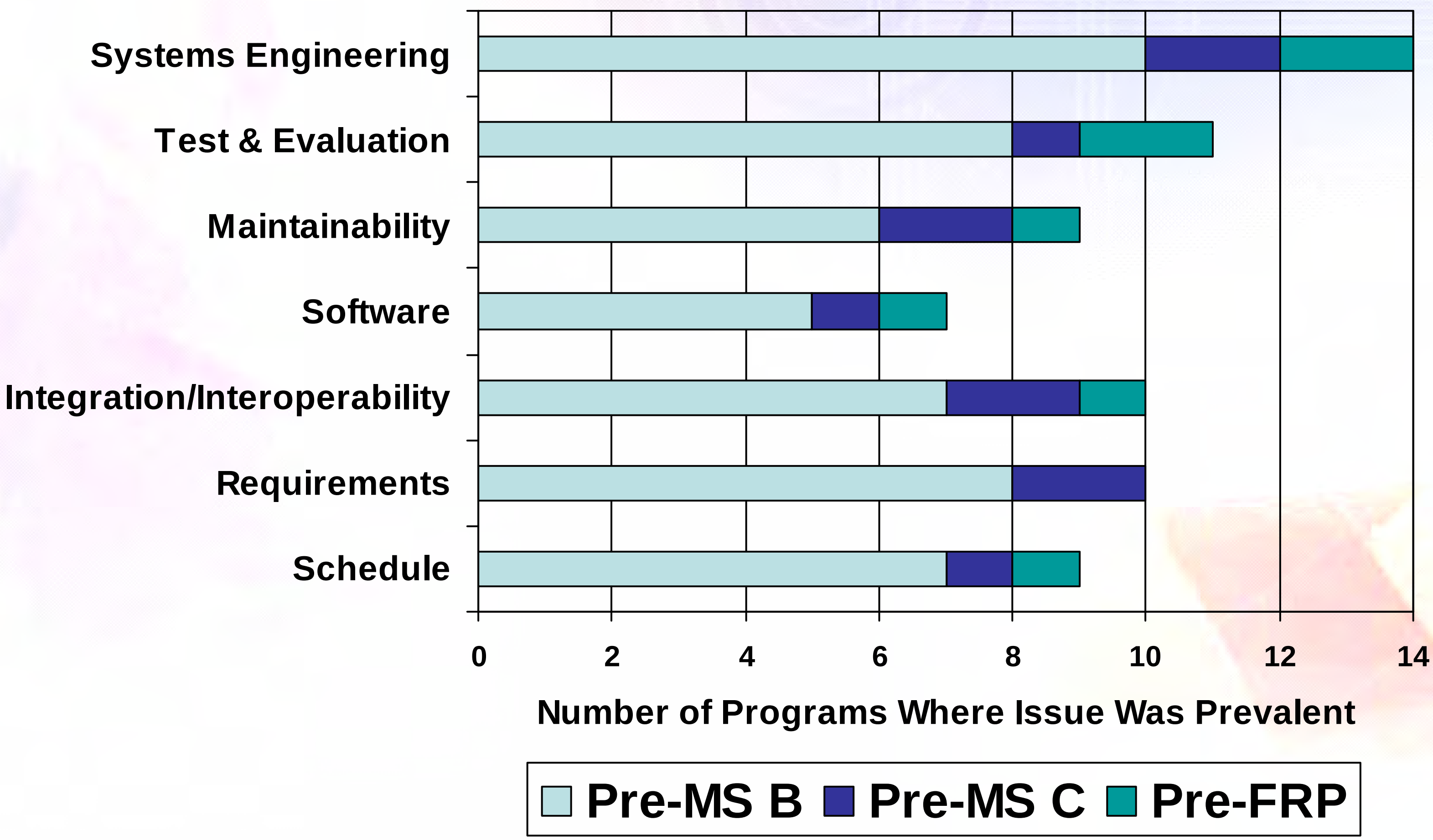
Number and Type of Findings by Program



Numbers represent sections of the PSR Metholodogy

Systemic Analysis Perspective

"What are the systemic problem areas?"



Representative Issues

- **Representative Issues for *Schedule***
  - Schedules too aggressive
  - Detailed schedules missing key components
  - Schedule concurrency (e.g. T&E activities)
- **Representative Issues for *Requirements***
  - Requirements don't support planned modifications, increasing capacity
  - Requirements changed without consideration or coordination with PM/PO and dependent programs
  - "Shortsighted" requirements, i.e. safety critical, bandwidth to support future capabilities
- **Representative Issues for *Integration/Interoperability***
  - Integration plans lacking key components
  - Multi-platform, scalable design benefits not realized due to low hw/sw commonality
  - Interoperability with Joint Forces not adequately addressed

Representative Issues
(2 of 3)

- **Representative Issues for *Software***
  - Software processes not institutionalized
  - Software development planning doesn't adequately capture lessons learned to incorporate into successive builds
  - Systems and spiral software requirements undefined
  - Software architecture immature
  - Software reuse strategies are inconsistent across programs
  - Software support plan missing

- **Representative Issues for *Maintainability***
  - Maintainability requirements incomplete or missing
  - Diagnostic effectiveness measures are either too ambiguous or missing
  - Tailoring out of criticality calculations translates to inability to monitor the maintainability status of reliability critical items

Representative Issues
(3 of 3)

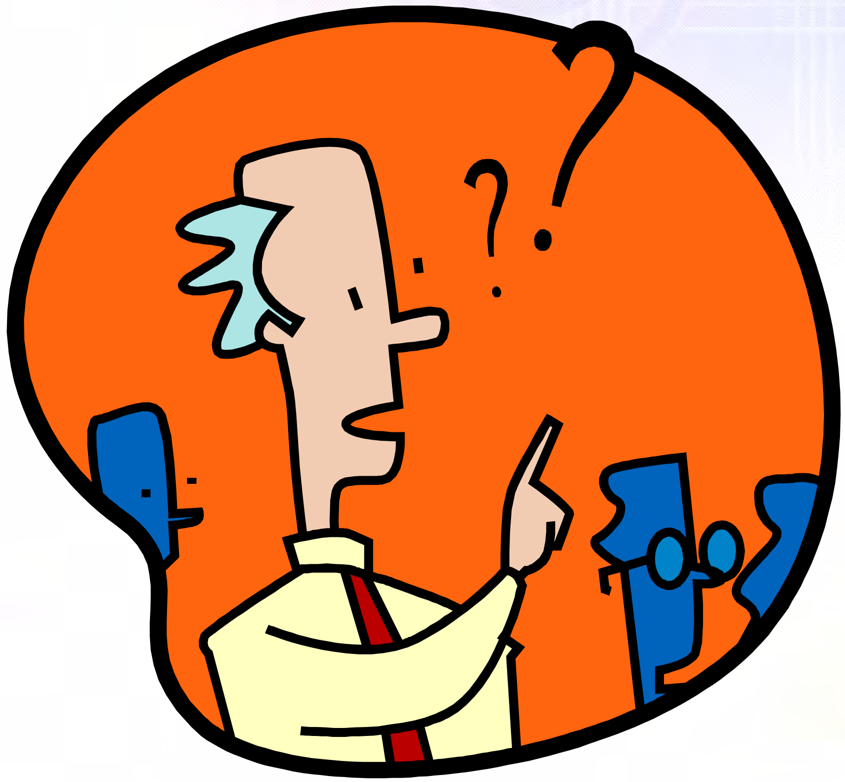
- **Representative Issues for *Test and Evaluation***
  - No reliability details (hours, profile, exit criteria, confidence level, OC curve)
  - Lack metrics
  - Basis for some threat-based requirements not fully explained or rationalized

- **Representative Issues for *Systems Engineering***
  - Lack of disciplined SE process, metrics, etc
  - PO not conducting PRR prior to LRIP
  - Missing Joint CONOPs
  - Missing System Functional Review (SFR) and PDR during SDD

Summary

- We are working to meet the Under Secretary's imperatives in support of transformation by:
  - Providing a context for decisions
  - Putting credibility into the acquisition process
  - Driving systems engineering back into programs
- Our ultimate goal in conducting PSRs is to help all programs achieve mission success through:
  - Early and persistent application of SE
  - Event-driven technical reviews and test programs

Questions…perhaps Answers



A-P-T Research, Inc.

System Safety Engineering An Overview for Engineers and Managers

P. L. Clemens
October 2005

Topics…

- **What is System Safety Engineering?**
- **When should System Safety be used?**
- **How is System Safety done?**
- **Who should perform System Safety analyses?**
- **What does System Safety Cost?**
- **Why do System Safety?**

What's a SYSTEM?

(and a few other basics)...

- SYSTEM: **an entity, at any level of complexity, intended to carry out a function, e.g.:**
  - **A doorstop**
  - **An aircraft carrier**
  - **An operating procedure**
  - **An implantable insulin pump**
- **Systems pose** HAZARDS. **Hazards threaten harm to** ASSETS.
- ASSETS **are RESOURCES having value to be protected, e.g.:**
  - **Personnel**
  - **The environment**
  - **Productivity**
  - **The product**
  - **Equipment**
  - **Reputation**
- RISK, **is an attribute of a hazard-asset combination — a measure of the degree of harm that is posed.**

What's System Safety?

It has two chief aspects...

1

- A DOCTRINE of Management Practice:
  - **Hazards (threats to Assets) abound and must be identified.**
    - **Risk is an attribute of a hazard that expresses the degree of the threat posed to an asset — risks must be assessed.**
      - **A non-zero Risk Tolerance Limit must be set — a management function.**
      - **Risks of Hazards exceeding the Tolerance Limit must be suppressed (or accepted by management).**

2

- A Battery of ANALYTICAL METHODS **to support practice of the DOCTRINE — The analytical methods are divisible into:**
  - TYPES, **addressing What / When / Where the analysis is done**
  - TECHNIQUES, **addressing How the analysis is done**

The Types & Techniques of Analysis...

TECHNIQUES (How)...

- **Preliminary Hazard Analysis (PHA*)[1/2/3]**
- **Failure Modes and Effects Analysis (FMEA)[1/3]**
- **Fault Tree Analysis[2/4]**
- **Event Tree Analysis[3/4]**
- **Cause-Consequence Analysis[3/4]**
- **Hazard & Operability Study (HAZOP)[1/3]**
- **Job Hazard Analysis (JHA/JSA)[1/3]**
- **Digraph Analysis[1/3]**
- **many others…**

TYPES (What / When / Where)...

- **Preliminary Hazard Analysis (PHA*)**
- **System Hazard Analysis**
- **Subsystem Hazard Analysis**
- **Operating and Support Hazard Analysis**
- **Occupational Health Hazard Analysis**
- **Software Hazard Analysis**
  - **many others…**

The TYPES **and** TECHNIQUES **are to…**
• *IDENTIFY HAZARDS*, **and to…**
• *ASSESS THEIR RISKS.*

But, WHAT IS RISK?

[1] **Hazard Inventory Tree** [2] **Top Down** [3] **Bottom Up** [4] **Logic**

What is RISK?

RISK: An expression of the combined *SEVERITY* and *PROBABILITY* of *HARM* to an *ASSET*.

SYSTEM ASSETS* may be:

- Personnel
- Equipment
- Productivity
- Product
- Environment
- ...others

PROGRAMMATIC ASSETS* may be:

- Cost
- Schedule
- Mission
- Performance
- Constructability
- ...others

RISK is an *attribute* of a HAZARD-ASSET combination!

THREATS to ASSETS are called *HAZARDS*.

Hazards are THREATS to ASSETS

HAZARDS
MUST BE IDENTIFIED!
...or System Safety and Risk Management cannot be practiced!

HAZARDS...

are best described as terse Loss Scenarios, each expressing

SOURCE → MECHANISM → OUTCOME

Thusly:

"Faulty control logic producing yaw overdrive and model damage."

***NOT*: "Pranged wind tunnel model."**

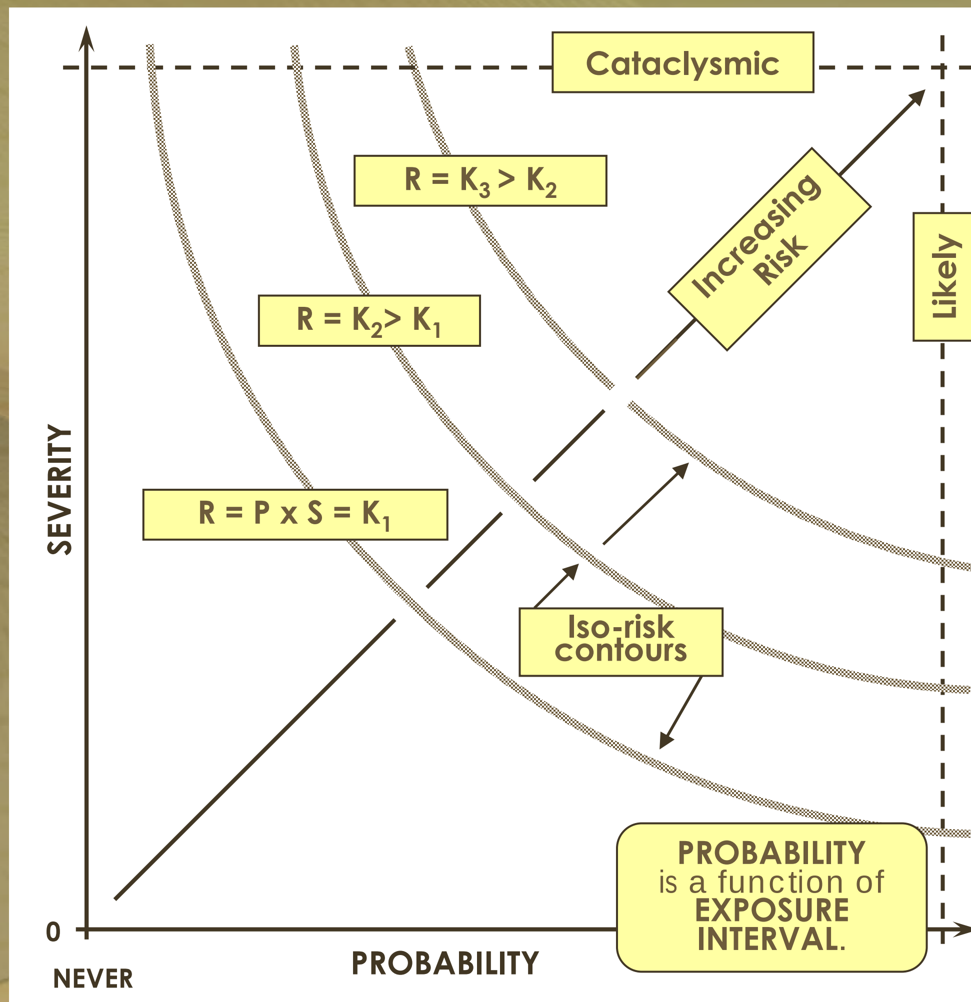
OR

"Occupancy of an unventilated confined space leading to death from asphyxia."

***NOT*: "Running out of air."**

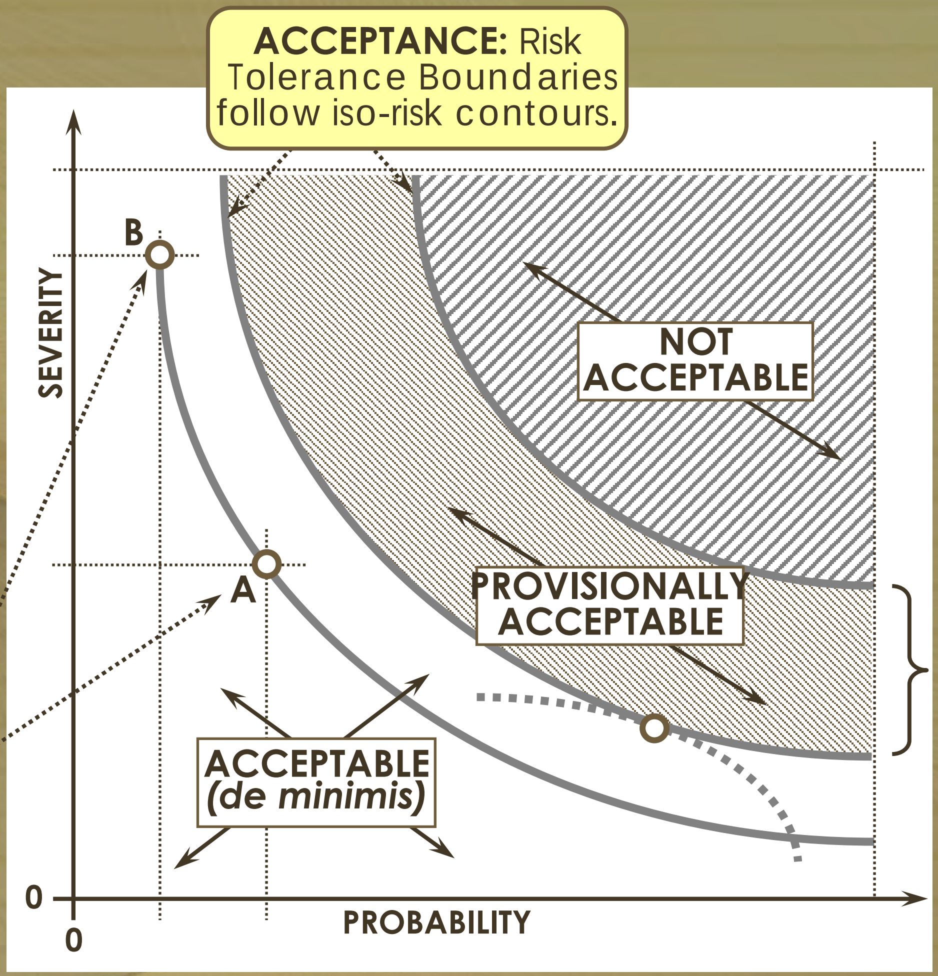
The Risk Plane...

SEVERITY
and
PROBABILITY,
the
two variables
that
constitute risk,
define a
RISK PLANE.



RISK
is
CONSTANT
along any
ISO-RISK
CONTOUR.

Using ISO-Risk Contours...

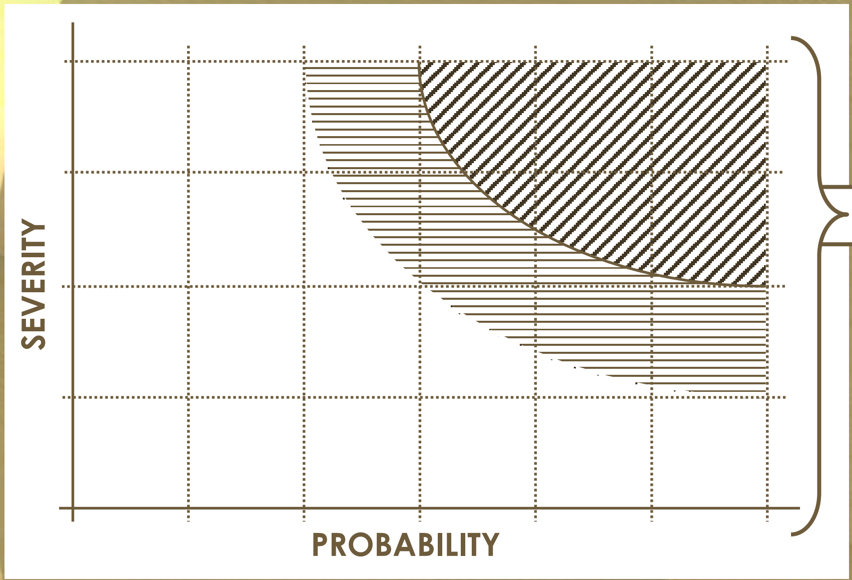


Note that risk at **A** equals risk at **B**.

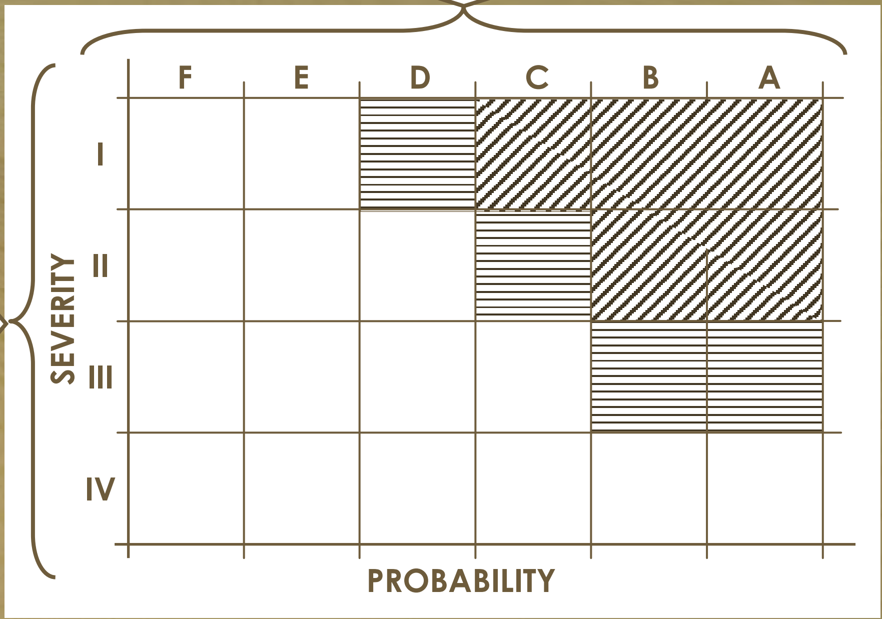
Further Risk Reduction Desirable.

M-05-02600-9

The Risk Plane Becomes a Matrix...



Segmenting the Risk Plane into tractable cells produces a Matrix to enable using subjective judgment.



Matrix cell zoning approximates the continuous, iso-risk contours in the Risk Plane. Zones in the Matrix define
Risk Tolerance Boundaries.
Jeopardy

A Typical Risk Assessment Matrix*...

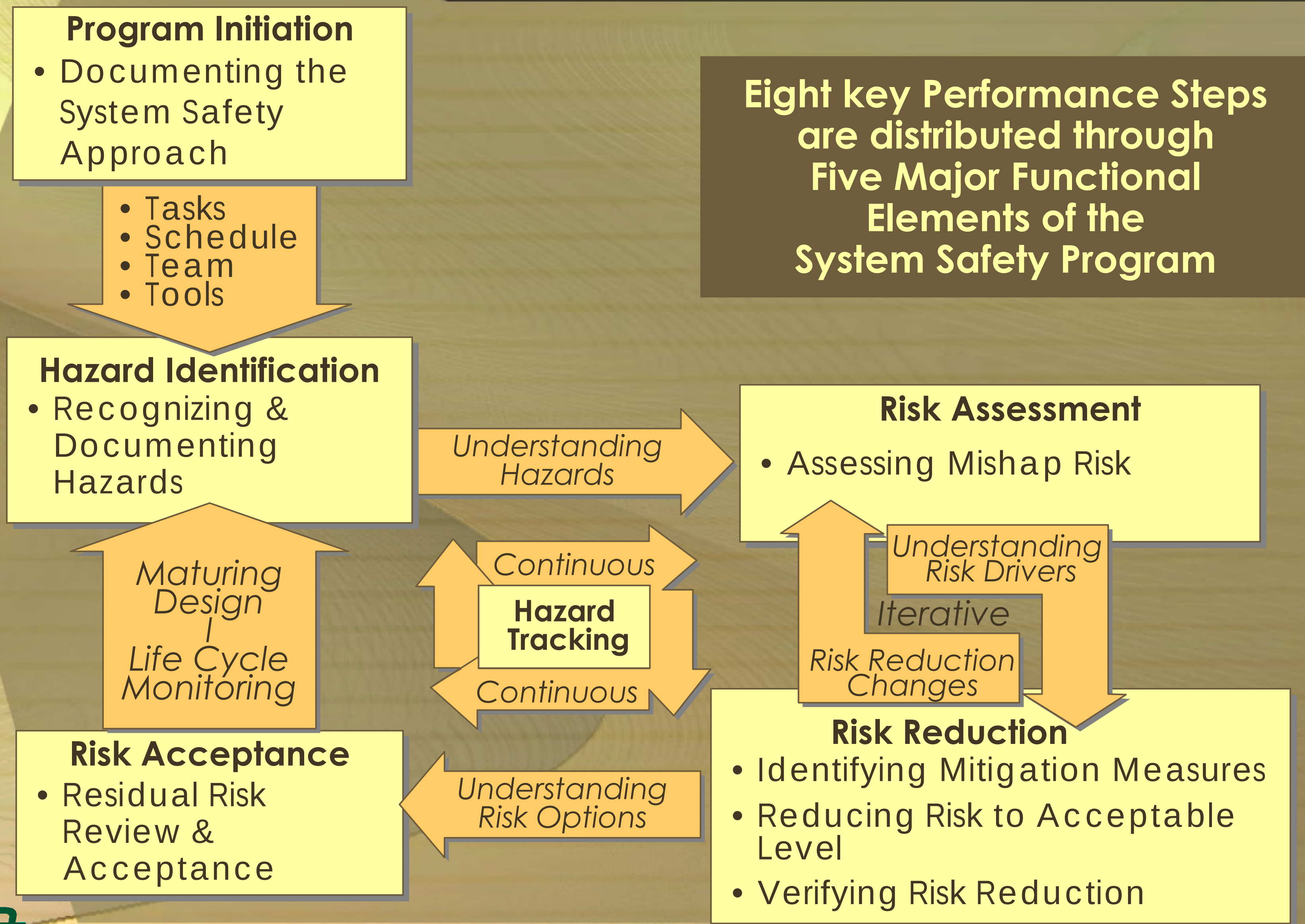
A guide for applying subjective judgment...

Severity of Consequences				Probability of Mishap**					
Category / Descriptive Word	Personnel Injury / Illness	Equipment Loss $	Down Time	F Impossible	E Improbable	D Remote	C Occasional	B Probable	A Frequent
I Catastrophic	Death	>1M	>4 Mo						1
II Critical	Severe Injury or Severe Illness	250K to 1M	2Wks to 4Mo				2		
III Marginal	Minor Injury or Minor Illness	1k to 250K	1 Day to 2Wks		3				
IV Negligible	No Injury or Illness	<1K	<1 Day						

*Adapted from MIL-STD-882D **Life Cycle: Personnel: 30 yrs / Others: Project Life

Risk Code/ Action	Code	Action
	1	Imperative to suppress risk to lower levels
	2	Operation requires written, time-limited waiver, endorsed by management
	3	Operation permissible

The "Flow" of System Safety Practice…



Major System Safety

Cross-Link Disciplines…

- **Programmatic Risk Management**
- The "…ilities"
  - **Reliability**
  - Availability
  - Maintainability
  - Survivability
- Configuration Management
- Procedures Preparation
- …others…

PROGRAMMATIC RISK MANAGEMENT treats its own special classes of hazards, posing risk to, e.g.:
- Cost
- Schedule
- Performance
- Constructability
- …others

ISN'T RELIABILITY ENGINEERING *ENOUGH*?

USUALLY NOT!

- Reliability explores the Probability of Success, *alone*.
- System Safety explores the Probability of Failure *AND* its Severity Penalty.

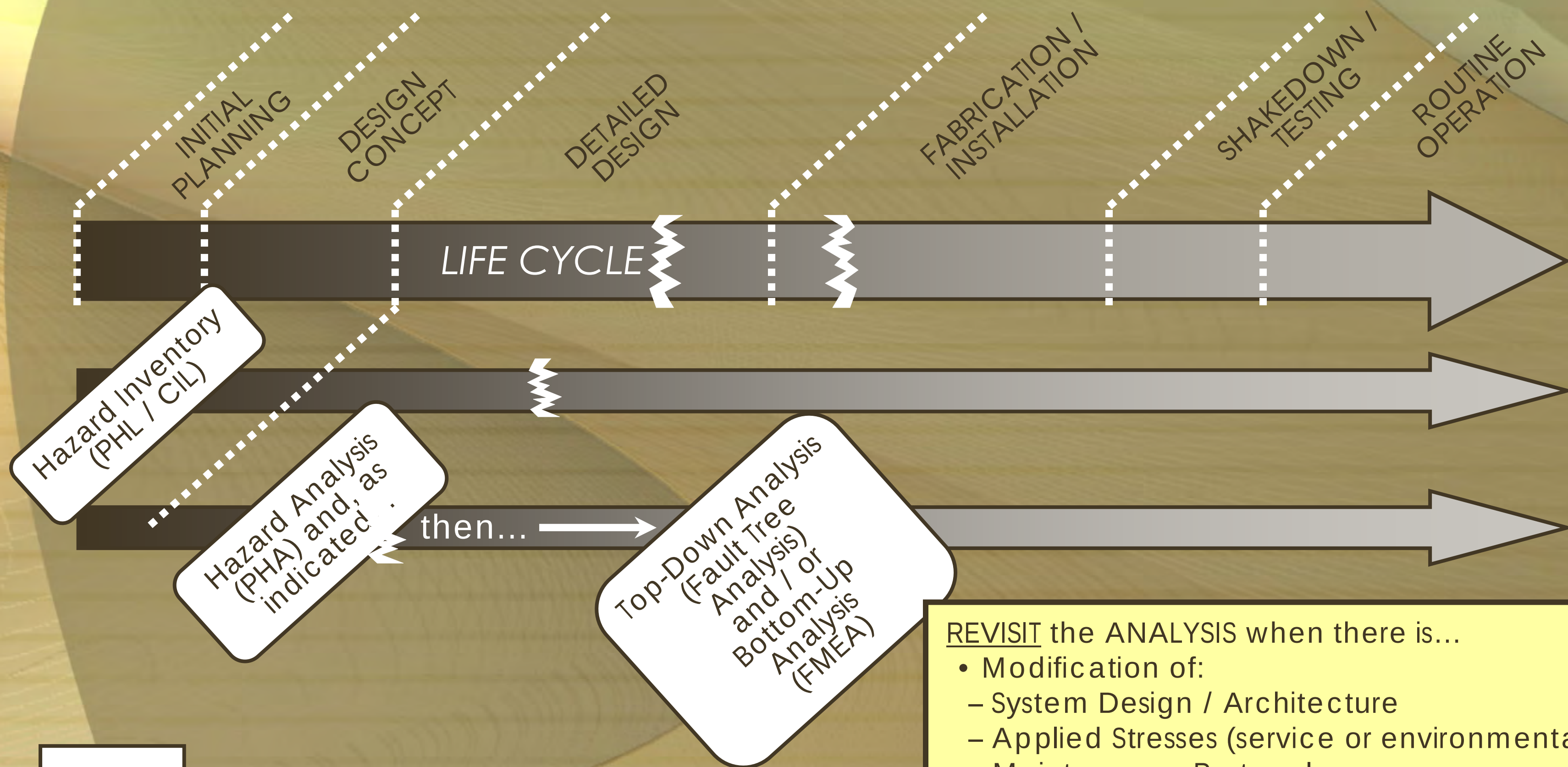
Topics…

- What is System Safety Engineering?
- **When should System Safety be used?**
- How is System Safety done?
- Who should perform System Safety analyses?
- What does System Safety Cost?
- Why do System Safety?

System* Safety Application throughout Life Cycle...

DON'T OVERLOOK:
- Operational / Mission Phases
- Maintenance
- Decommissioning
- Etc...

A typical approach:



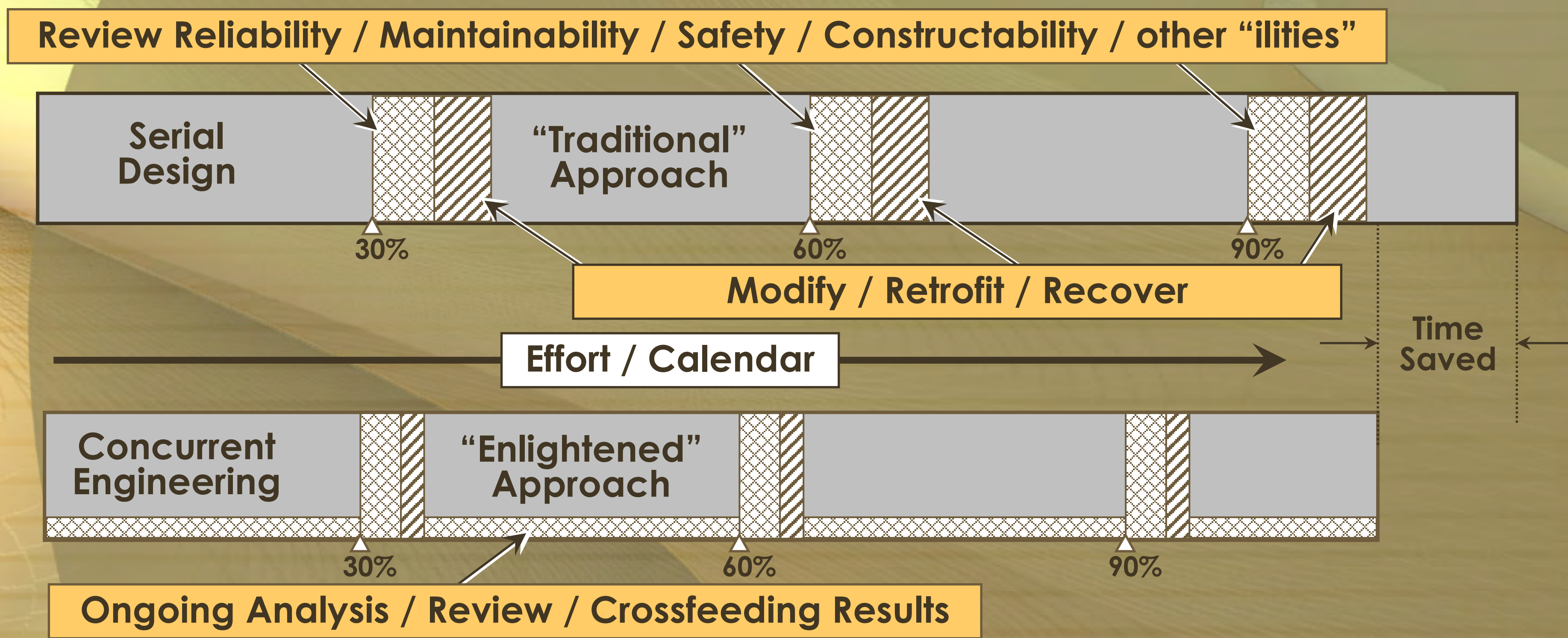
REVISIT the ANALYSIS when there is...
- Modification of:
  - System Design / Architecture
  - Applied Stresses (service or environmental)
  - Maintenance Protocol
- A "Near Miss"
- A Loss Event (to support autopsy)

*NOTE

"System" includes hardware, software, procedures, training / certification, maintenance protocol, etc. — the *GLOBAL* System.

Comparing Two Work Models

for Design-Build Efforts*...



CONCURRENT DESIGN RESULTS:

- Continuous, iterative feedback of analysis results into design
- Earlier accommodation to findings
- Manhours and calendar time conserved
- Fewer "surprises" / performance-threatening retrofits
- Fewer awkward compromises — more coherent design

*Journal of the American Society of Safety Engineers; November, 1999

What systems benefit *best* by System Safety application?

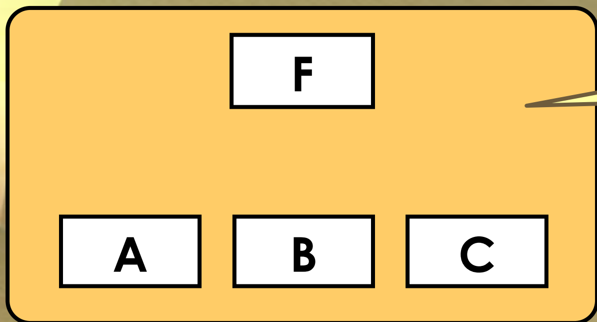
- **Use System Safety if the system…**
  - **is complex — i.e., interrelationships among elements is not readily apparent, and/or**
  - **uses untried or unfamiliar technology, and/or**
  - **contains one or more intense energy sources — i.e., energy level and/or quantity is high, and/or**
  - **has reputation-threatening potential, and/or**
  - **falls under the purview of a mandating regulation (e.g., 29 CFR 1910.119)**

Why / When use more specialized analytical techniques?

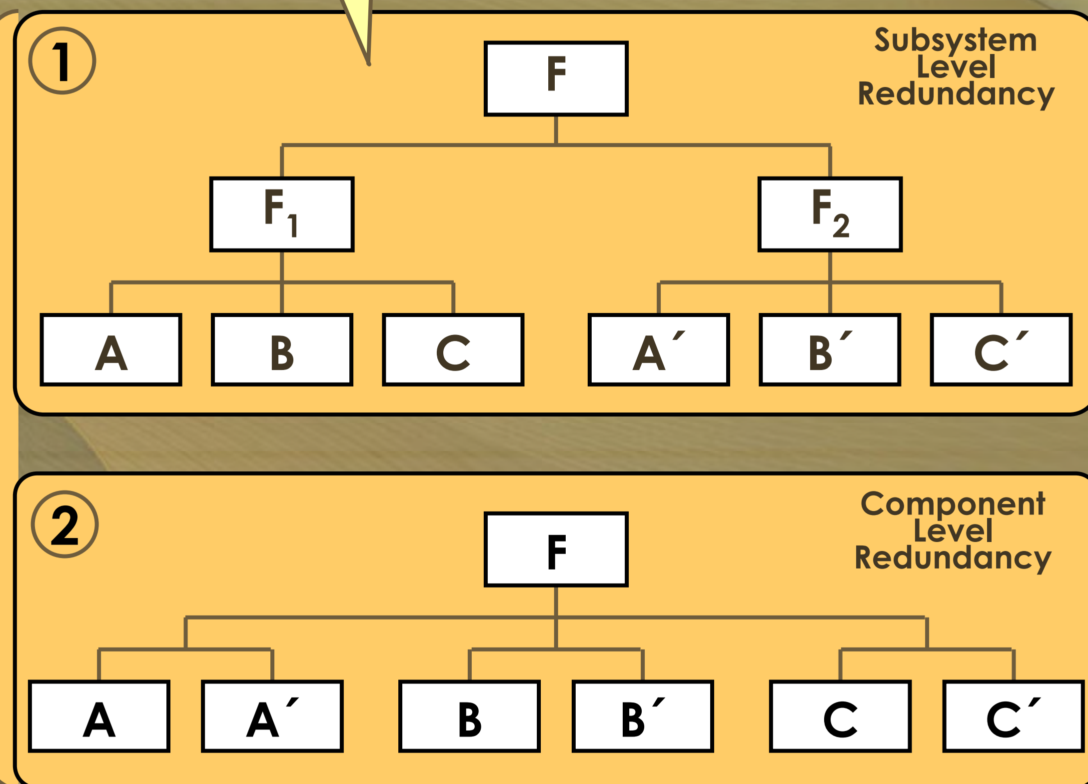
Top-down Analysis
(e.g., Fault Tree Analysis)
and / or
Bottom-up Analysis
(e.g., Failure Modes and Effects Analysis)

- **when SYSTEM COMPLEXITY exceeds PHA capability, and/or…**
- **to evaluate risk more precisely in support of RISK ACCEPTANCE DECISIONS, and/or…**
- **to support DESIGN DECISIONS on matters of component selection/system architecture, etc.**

Design Decisions — an example...



Risk too high? Then
Go Redundant!



But ***WHERE*** to redundify?
- System?
  - Subsystem?
    - Assembly?
      - Subassembly?
        - Component?
          - Piece Part?

Variations in system architecture, using the same components, can produce profound differences in system reliability and safety!

When should System Safety Analyses be *Re*-visited?

- **Has there been a change in…**
  - **System design / architecture?**
  - **System use / applied stresses (i.e., service stresses / environmental stresses)?**
  - **Maintenance protocol?**
- **A "near miss?"**
- **A loss event?**

Then,
REVIEW / REVISE
the
ANALYSIS!

Topics…

- What is System Safety Engineering?
- When should System Safety be used?
- **How is System Safety done?**
- Who should perform System Safety analyses?
- What does System Safety Cost?
- Why do System Safety?

An Overview of Selected Analytical Techniques...

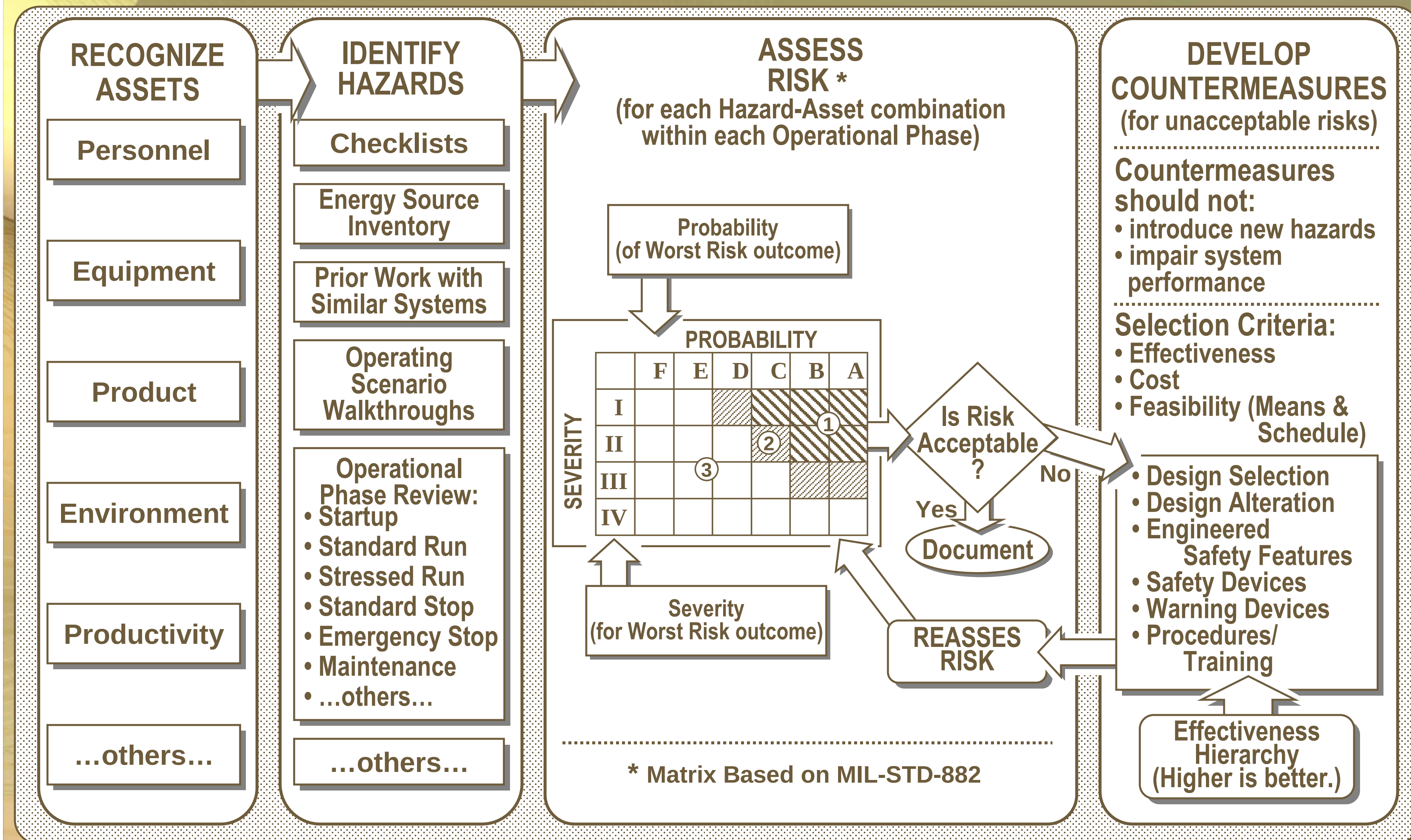
- **Preliminary Hazard Analysis**
  - **Hazard Inventory**
  - **Top-Down, or Bottom-Up, or Inside-Out**
- **Failure Modes and Effects Analysis**
  - **Hazard Inventory**
  - **Bottom-Up**
- **Fault Tree Analysis**
  - **Logic Tree**
  - **Top-Down**

Preliminary Hazard Analysis*…

- WHAT: **Line-item listing of "all" system hazards, with subjective evaluations of severity/probability/risk for each.**
- HOW: **Engineering judgment; intuitive skills; checklists; operational walkthroughs; prior similar work.**
- ADVANTAGES: **Provides inventory of "all" system hazards/risks.**
- DISADVANTAGES: **Incomplete. Ignores combined hazard effects. Conceals total system risk. Non-quantitative.**

* Preliminary Hazard Analysis (PHA) is an unfortunate misnomer. The method is best applied early in system life cycle but can be used at any time. It produces a running inventory of system hazards and is a convenient repository for the results of system safety analyses done by any methods that might be used.

Preliminary Hazard Analysis Flow...



A Typical PHA Worksheet...

HAZARD No.	Chem/Int-001	HAZARD TITLE:	Flange Seal A-29 Leakage	REVISED:	7/22/93

Provide brief name for hazard.

HAZARD DESCRIPTION

Flange Seal A-29 leakage, releasing pressurized $UnFo_3$ chemical intermediate from containment system, producing toxic vapors on contact with air and attacking nearby equipment.

Describe hazard, indicating: source, mechanism, worst-credible outcome.

EXPOSURE INTERVAL	25 years	ACTIVITY/PROCESS PHASE:	Startup/Standard Operation/Stop/Emergency Shutdown

Identify applicable operating phases.

INITIAL RISK ASSESSMENT

Identify (X) all applicable asset(s).

(with existing of planned/designed-in countermeasures)

HAZARD ASSET(S): (check all applicable)		SEVERITY: (worst credible)	PROBABILITY: (for exposure interval)	RISK CODE: (from Matrix)
Personnel:	X	I	D	2
Equipment:	X	II	C	2
Downtime:	X	III	C	3
Environment:	O			0
Product:	O			0

ADDITIONAL COUNTERMEASURES*

Surround flange with sealed annular stainless steel catchment housing, with gravity run-off conduit led to Detecto-Box™ containing detector/alarm feature and chemical neutralizer (S/W). Inspect flange at two-month intervals and re-gasket during annual plant maintenance shut-down (P). Provide personal protective equipment and training for response/cleanup crew (S/P).

For each asset, assess severity, and probability for the worst-credible outcome. Show risk (from assessment matrix) for hazard-asset combination "as-is" – i.e., with no added countermeasures.

Describe added countermeasures to control Probability / Severity – reduce Risk.
THESE COUNTERMEASURES MUST BE IN PLACE PRIOR TO SYSTEM OPERATION!

***Mandatory for Risk Codes 1 & 2, unless permitted by Waiver. Personnel must not be exposed to Risk Code 1 or 2 hazards.**

Code Each Countermeasure: (D) Design Alteration / (E) = Engineered Safety Features
(S) = Safety Devices / (W) = Warning Devices / (P) =Procedures/ Training

POST-COUNTERMEASURE RISK ASSESSMENT

(with additional countermeasures in place)

HAZARD ASSET(S): (check all applicable)		SEVERITY: (worst credible)	PROBABILITY: (for exposure interval)	RISK CODE: (from Matrix)
Personnel:	X	I	E	3
Equipment:	X	II	D	3
Downtime:	X	III	D	3
Environment:	O			0
Product:	O			0

COMMENTS

Re-evaluate before sign-off — reconsider Environment as asset.

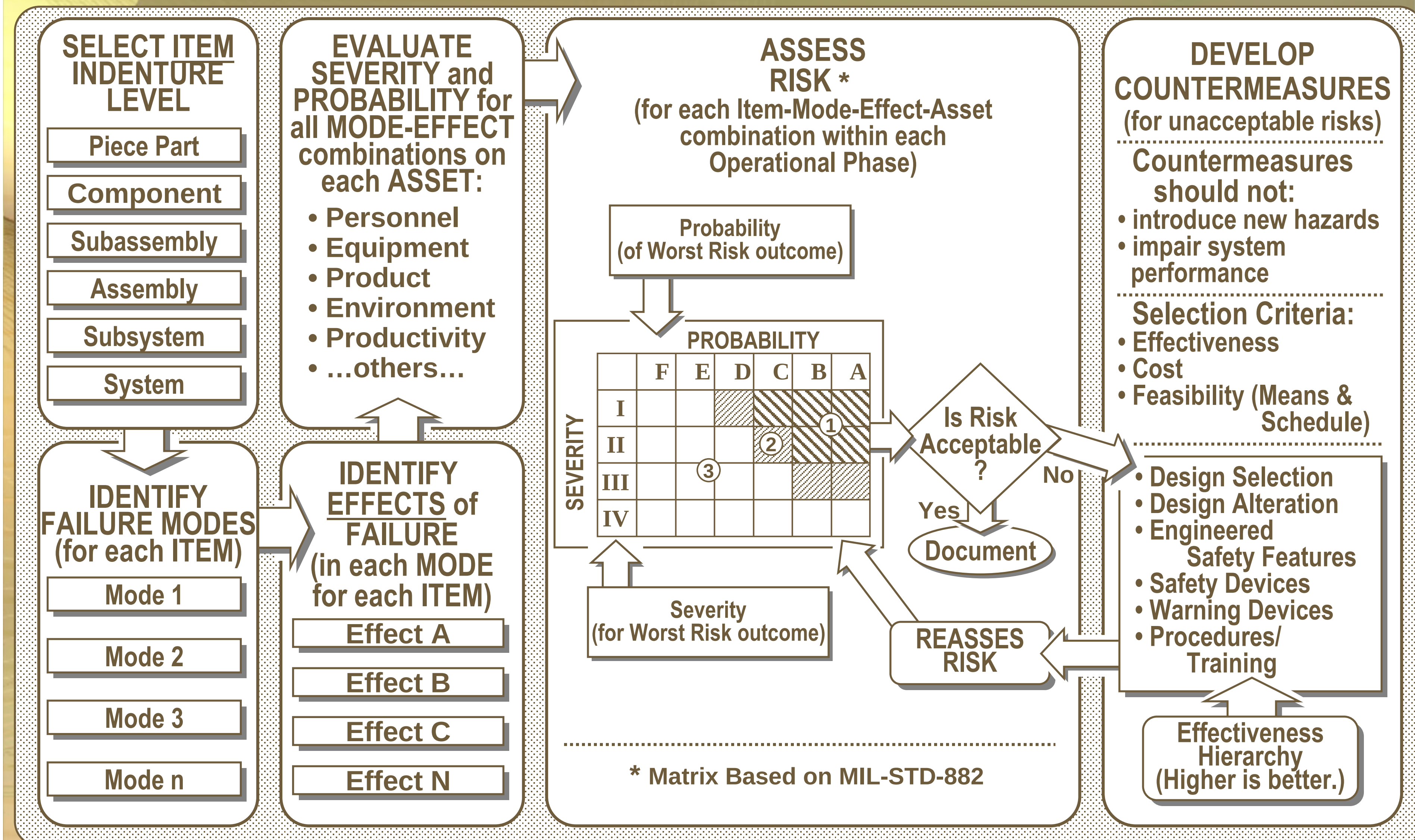
Reassesses Severity/Probability and show risk (from assessment matrix) for original hazard-asset combinations, presuming new countermeasures to be in place, if risk is not acceptable, additional countermeasures must be developed.

Prepared by / Date: (Designer/Analyst)	Reviewed by / Date: (System Safety Manager)	Approved by: (Project Manager)

Failure Modes and Effects Analysis...

- WHAT: **Item-by-item evaluation of consequences of individual failures within system. Evaluates severity and/or risk for each consequence. (Sometimes called Failure Modes, Effects, and Criticality Analysis, when severity and/or risk are assessed.)**
- HOW: **Develops answers to two questions:**
  - **(1) How can this item fail? (Modes)**
  - **(2) What are system consequences for each failure? (Effects)**
- ADVANTAGES: **Tightly Disciplined. Exhaustively identifies potential single-point failures.**
- DISADVANTAGES: **Ignores combined fault / failure effects. Conceals total system risk. High sensitivity to indenture level selection. Very resource hungry.**

Failure Modes and Effects Analysis Flow…



A Typical FMEA Worksheet...

FMEA No.: N/246.n
Project No.: Osh-004-92
Subsystem.: Illumination
System.: Headlamp Controls
Probability Interval.: 20 years

FAILURE MODES AND EFFECTS ANALYSIS

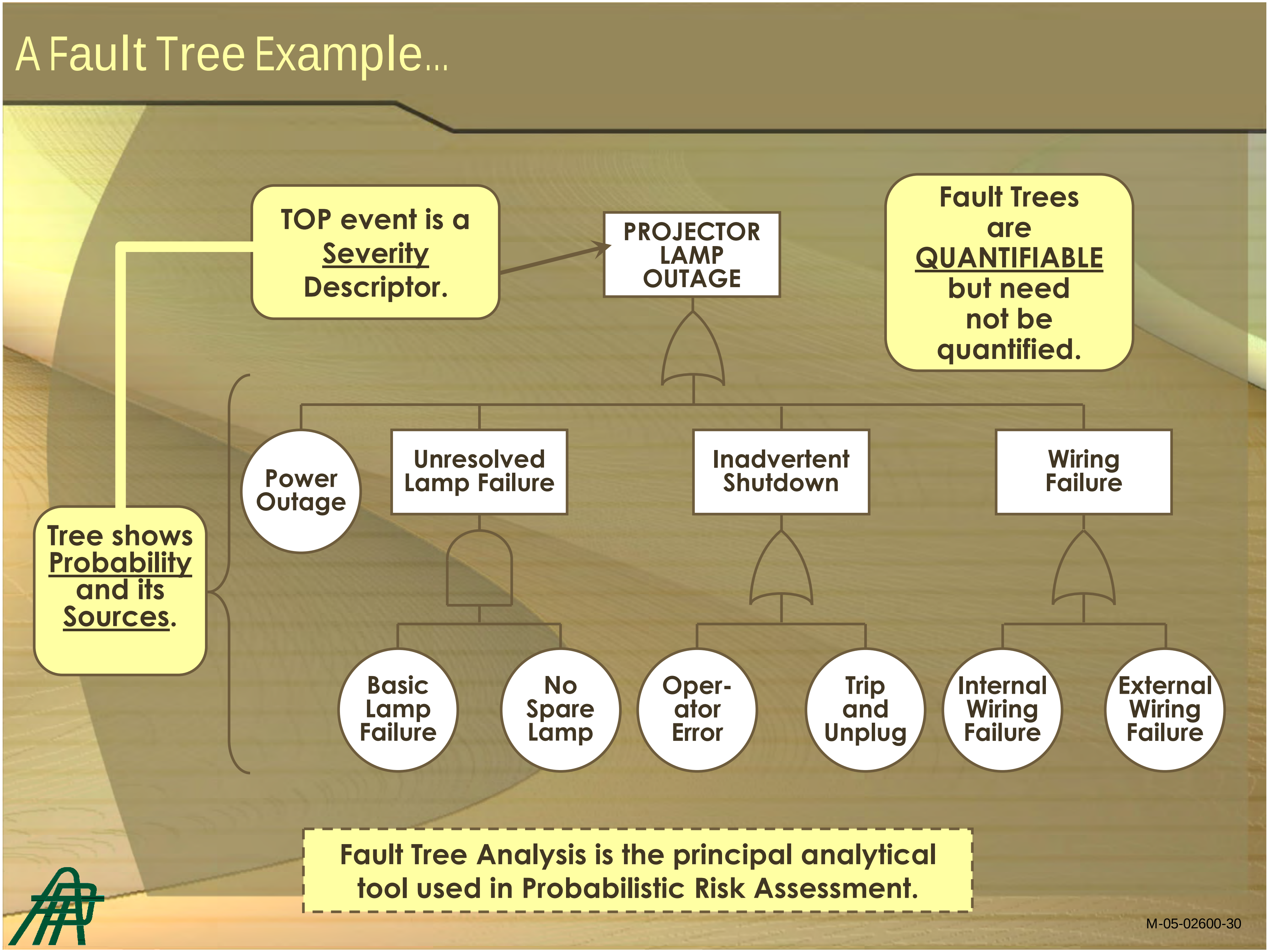
Sheet 11 of 44
Date.: 6 Feb '92
Prep. by.: R.R. Mohr
Rev. by.: S. Perleman
Approved by.: G. Roper

IDENT. No.	ITEM/ FUNCTIONAL IDENT.	FAILURE MODE	FAILURE CAUSE	FAILURE EFFECT	TARGET	RISK ASSESSMENT SEV	PROB	Risk Code	ACTION REQUIRED/REMARKS
R/N.42	Relay K-28 / Contacts (normally open)	Open w / command to close	Corrosion/or mfg.defect/or basic coil failure (open)	Loss of forward illumination/ Impairment of night vision/potential collisions(s) w/unilluminated obstacles	P E T M	I III I I	D D D D	2 3 2 2	Redesign headlamp circuit to produce headlamp fail-on, w / timed off feature to protect battery, or eliminate relay / use HD Sw. at panel.

P: Personnel / **E**: Equipment / **T**: Downtime / **M**: Mission / **V**: Environment

Fault Tree Analysis…

- WHAT: **Symbolic logic modeling of fault paths within system to result in foreseeable loss event — e.g.: sting failure; loss of primary test data; failure to ignite on command; premature ignition; ventilator failure.**
- HOW: **Apply Operations Research logic rules — trace fault / failure paths through system.**
- ADVANTAGES: **Gages system vulnerability to foreseen loss event, subjectively or quantitatively. Guides vulnerability reduction. Supports trade studies.**
- DISADVANTAGES: **Treats only foreseen events, singly. Handles sequence-sensitive scenarios poorly. Resource hungry.**


A Fault Tree Example…
TOP event is a Severity Descriptor.
PROJECTOR LAMP OUTAGE
Fault Trees are QUANTIFIABLE but need not be quantified.
Power Outage
Unresolved Lamp Failure
Inadvertent Shutdown
Wiring Failure
Tree shows Probability and its Sources.
Basic Lamp Failure
No Spare Lamp
Oper-ator Error
Trip and Unplug
Internal Wiring Failure
External Wiring Failure
Fault Tree Analysis is the principal analytical tool used in Probabilistic Risk Assessment.
M-05-02600-30

Topics...

- What is System Safety Engineering?
- When should System Safety be used?
- How is System Safety done?
- **Who should perform System Safety analyses?**
- What does System Safety Cost?
- Why do System Safety?

Who best performs the analysis?

- **A Small Team, with…**
  - **Expertise in the appropriate disciplines, and**
    - **In-depth understanding of the system, and**
      - **Proficiency at applying the System Safety analytical techniques.**

SOLO ANALYSIS is *HAZARDOUS!*

BUT… **ONLY MANAGEMENT can make RISK ACCEPTANCE decisions!**

Topics…

- What is System Safety Engineering?
- When should System Safety be used?
- How is System Safety done?
- Who should perform System Safety analyses?
- **What does System Safety Cost?**
- Why do System Safety?

What does System Safety COST?

AN EXAMPLE…

- **NASA / ARC Unitary Plan Wind Tunnel Modernization**
  - **Full-System PHA**
  - **FMEA for all "Critical Controls"**

5% to 6% of total design project cost

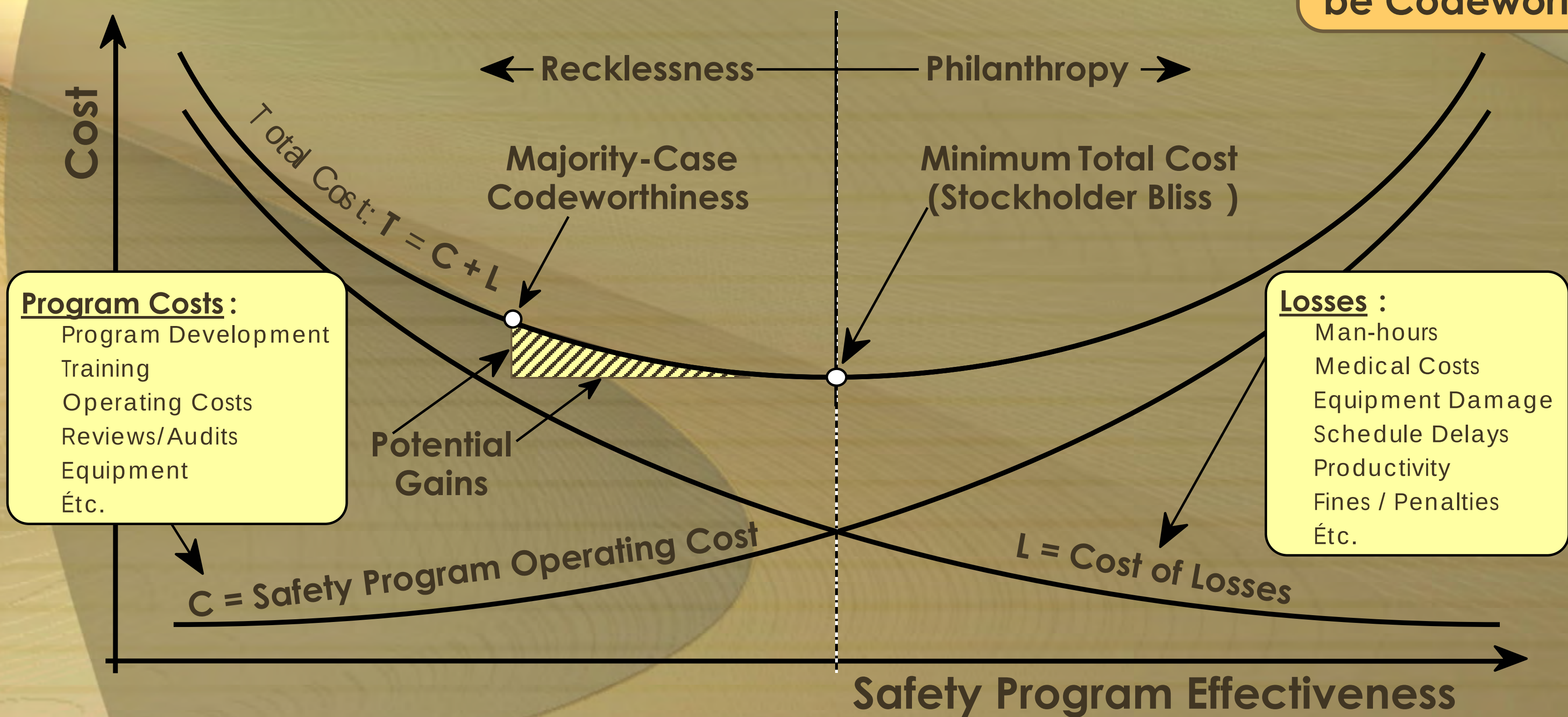
System Safety is "…simply documenting, in an orderly fashion, the thought processes of the prudent engineer."

L. T. Kije 1963

Overcoming the Codeworthiness Shortfall…

Safety effort beyond the codes has payoff*…

All Systems and Operations *MUST* be Codeworthy!



*Adapted from: Tarrants, W. E.; "The Measurement of Safety Performance" (Fig. 9.2); Garland; ISBN 0-8240-7170-0

Topics…

- What is System Safety Engineering?
- When should System Safety be used?
- How is System Safety done?
- Who should perform System Safety analyses?
- What does System Safety Cost?
- **Why do System Safety?**

Why do System Safety?

- to guide design decisions.
- to guide risk acceptance decisions.
- to conform to applicable codes.
- to ensure adequate safeguarding of assets.
- to demonstrate and document "due diligence."

Isn't Reliability Engineering *Enough*?...

No! ...not really:

“You don't <u>need</u> System Safety — we're doing <u>Reliability Engineering</u>!”
BEWARE!

RELIABILITY ENGINEERING

- views PROBABILITY alone — ignores SEVERITY.
- often ignores potential for CO-EXISTING faults (e.g., FMEA).
- Often ignores COMMON CAUSE threats.

<u>RELIABILITY ENGINEERING</u> views the *probability* that the system will operate on command, and throughout the period of need, with unimpaired performance.

<u>SYSTEM SAFETY</u> views the *probability* that the system will fail in a way that results in loss, AND the *severity* of loss.

A system may be very RELIABLE at it's intended function, and *equally* reliable at inducing LOSS!

A Closing Caveat...

We <u>never</u> analyze a *<u>system</u>*...
we analyze only a
conceptual model
of a system.

Make the <u>model</u>
match the <u>system</u>
as closely as possible!

To dig deeper…

- **System Engineering "Toolbox" for Design-Oriented Engineers** — B. E. Goldberg, et al. A compendium of methods dealing both with hazard recognition/risk assessment and with reliability engineering, this work describes a broad spectrum of analytical techniques. For each technique, the authors present a working level description, advice on applications, application procedure, examples, a description of advantages and limitations, and a bibliography of other resources. — 1994 — NASA Reference Publication 1358; Soft cover; large format; 303 pp

- **System Safety and Risk Management** — P. L. Clemens and R. J. Simmons. Intended as a guide for engineering college educators, this text presents the basic elements of system safety practice and risk management principles. Lesson-by-lesson chapters and demonstration problems deal with applying selected analytical techniques. Hazard inventory methods are presented, as are logic tree approaches. — 1998 — National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Public Health Service; Soft Cover; large format; 282 pp. (NIOSH Order No. 96-37768)

- **Safeware — System Safety and Computers** — Nancy G. Leveson. An especially learned treatment of system safety viewed as a discipline to be applied in practical ways to the resolution of problems in discovering and managing risk. Fundamentals are treated in depth (e.g., the concept of causality). Analytical methods are presented, and there relative advantages and shortcomings are discussed. The importance of the role of software is emphasized, and problems in developing software risk assessments with reasonable confidence are discussed. Appendices analyze disasters and include a detailed treatment of the six Therac-25 massive overdose cases. — 1995 — Addison-Wesley; Hard cover; 680 pp. (ISBN 0-201-11972-2)

more digging...

- **Assurance Technologies** — Principles and Practices — Dev G. Raheja. Directed to design engineers at all levels of expertise, this volume devotes separate chapters to each of the product/system assurance technologies — i.e.: reliability engineering, maintainability engineering, system safety engineering, quality assurance engineering, logistics support engineering, human factors engineering, software performance assurance, and system effectiveness. (Introductory material provides background information on the influence of the assurance technologies on profits and on statistical concepts.) The treatment of each topic provides both an overview and in-depth, detailed coverage, with carefully selected illustrative examples. — 1991 — McGraw-Hill, Inc.; Hard cover; 341 pp. (ISBN 0-07-051212-4)

- **Loss Prevention in the Process Industries** — F. P. Lees. Monumentally important, tutorially prepared, and globally thorough exposition of risk assessment and reliability engineering principles and techniques, generously laced with case studies. — 1996 — Butterworths; Hard cover; Three volumes; 1316 pp. (ISBN 0-7506-1547-8)

Contact Information:

Pat Clemens

256.327.3707

A-P-T Research, Inc.

pclemens@apt-research.com

Carnegie Mellon
Software Engineering Institute
Pittsburgh, PA 15213-3890

A Method for Reasoning About an Acquisition Strategy

Mary Catherine Ward

Joseph P. Elm

Sponsored by the U.S. Department of Defense

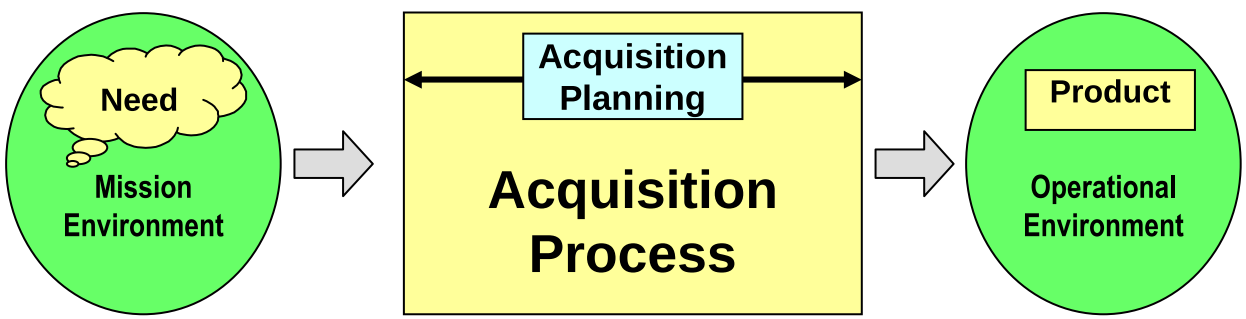
Acquisition Process

Transforms a "Need" into a "Product"

Complex process in a challenging environment

Success requires careful planning and diligent execution

- Planning starts with the development of an ACQUISITION STRATEGY



Research Focus

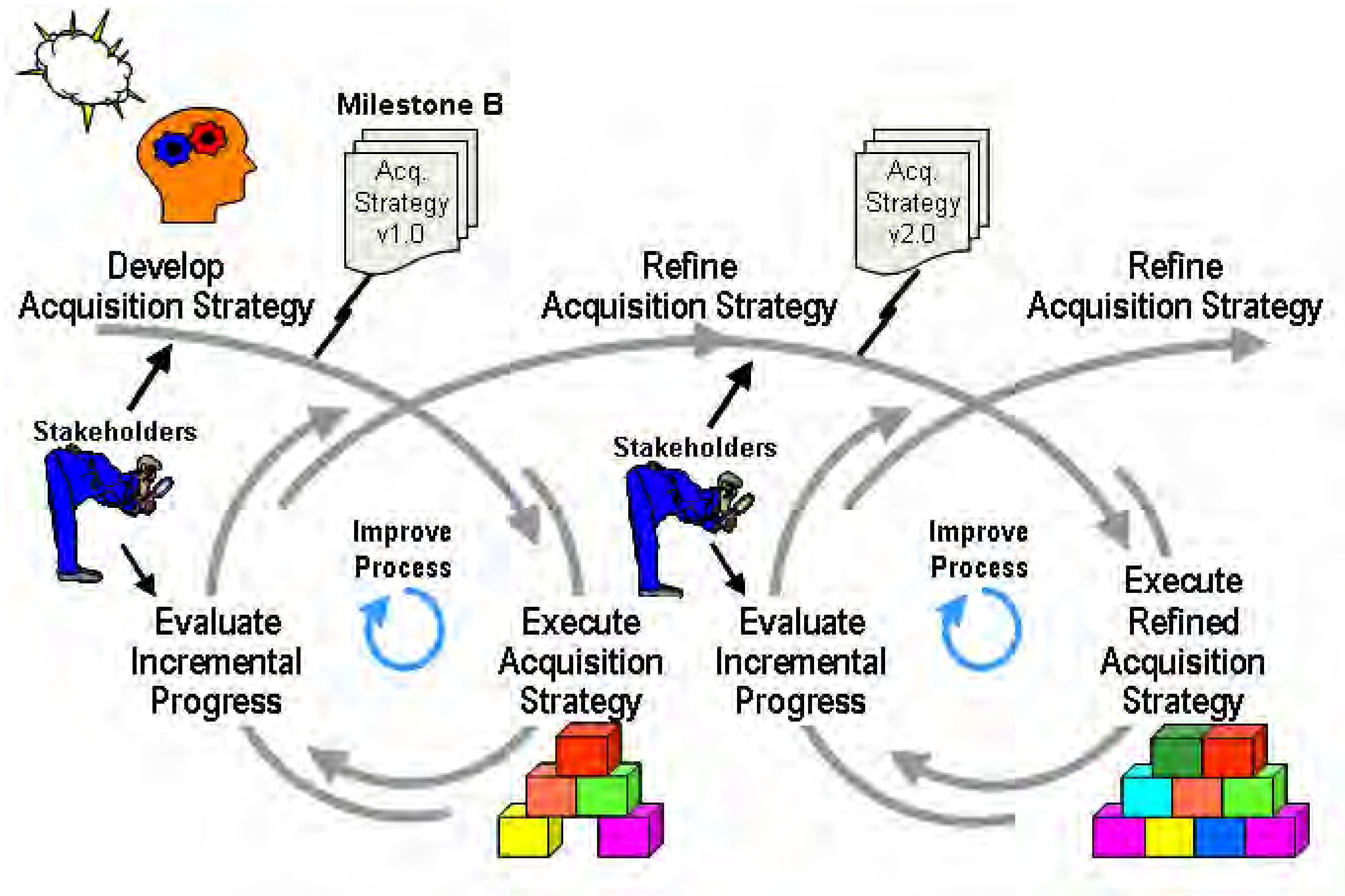
Key problems with acquisition strategy development

- Disassociated from its foundation: risk reduction
- Unique nature of software risks not always considered in larger acquisition strategy

Research focus

- Support a more systematic approach to reasoning about software risk on a program
  - Drivers
  - Strategy Elements

Acquisition Strategy

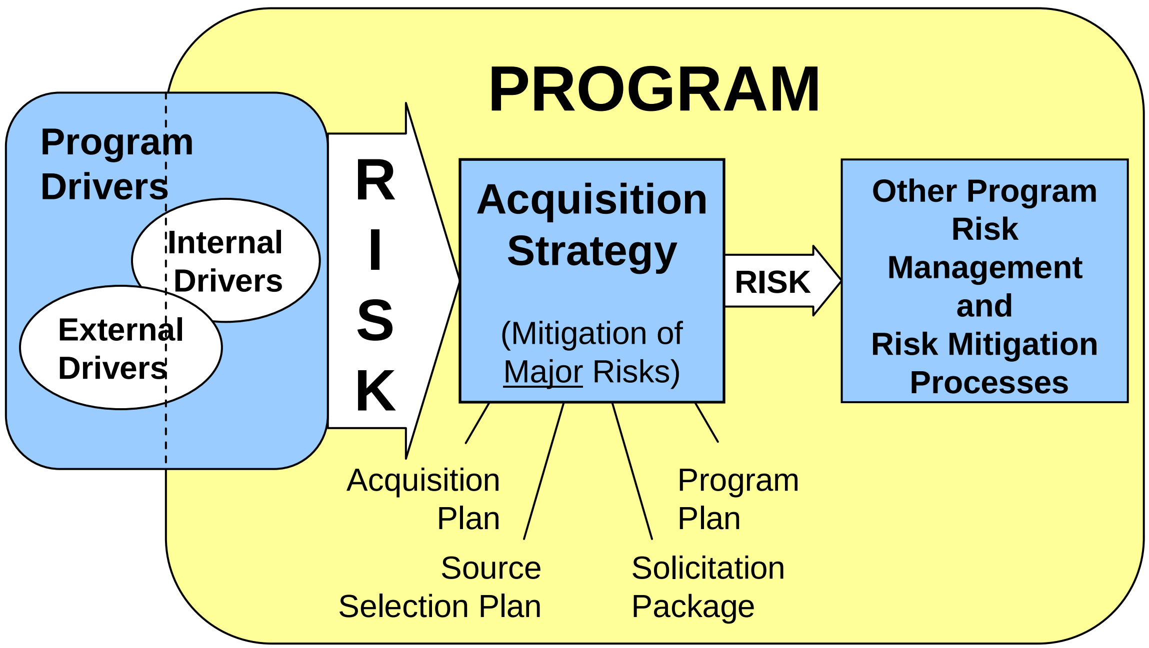


A Systems Engineering Approach to Acquisition Strategy Development

1. Define the objectives of the acquisition strategy
2. Decompose the strategy into individual strategy elements
3. Identify and evaluate the factors that drive strategic choices for each strategy element
4. Choose strategies for each element that best address the driving factors
5. Integrate the strategy elements into a coherent acquisition strategy

Step 1
Acquisition Strategy Objective

… Risk Mitigation !



Step 2

Strategy Elements*

Program Structure

Acquisition Approach

Business Considerations

- Competition
- Solicitation Type
- Source Selection
- Contract Approach

Risk Management

Test and Evaluation

Product Support

* Partial list

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Strategy Elements 2

Strategy Element	Strategic Choices
Acquisition Approach	• Single step • Evolutionary – incremental • Evolutionary - Spiral
Business Considerations: *Competition*	• Full and Open • Full and Open After Exclusion of Sources • Sole Source Contracting
Business Considerations: *Solicitation*	• Invitation for Bid (IFB) • Request for Proposal (RFP) with SOW • Request for Proposal (RFP) with SOO • Request for Quotation (RFQ) • Request for Information (RFI)

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Strategy Elements 3

Strategy Element	Strategic Choices

Business Considerations:
Contract Approach
	• **Fixed-Price (FP) Contracts**
	  • Firm FP
	  • FP with Economic Price Adjustment
	  • FP / Prospective Price Redetermination
	  • Fixed-Ceiling-Price with Retroactive Price Redetermination
	  • Firm FP, Level-of-Effort Term
	• **Cost Contracts**
	  • Cost Contract
	  • Cost-Sharing Contract
	  • Cost-Plus-Fixed-Fee Contract
	• **Incentive Contracts**
	  • Fixed-Price Incentive Contract
	  • Fixed-Price Contract With Award Fees
	  • Cost-Plus-Incentive-Fee Contract
	  • Cost-Plus-Award-Fee Contract

Strategy Elements 4

Strategy Element	Strategic Choices
Training	• Self-Training • Computer-Based Training • Distance Learning • Classroom Training • Field Training
Product Support: *Source of Support*	• Contractor Logistics Support • PMO Support • Depot Support • Organic Support

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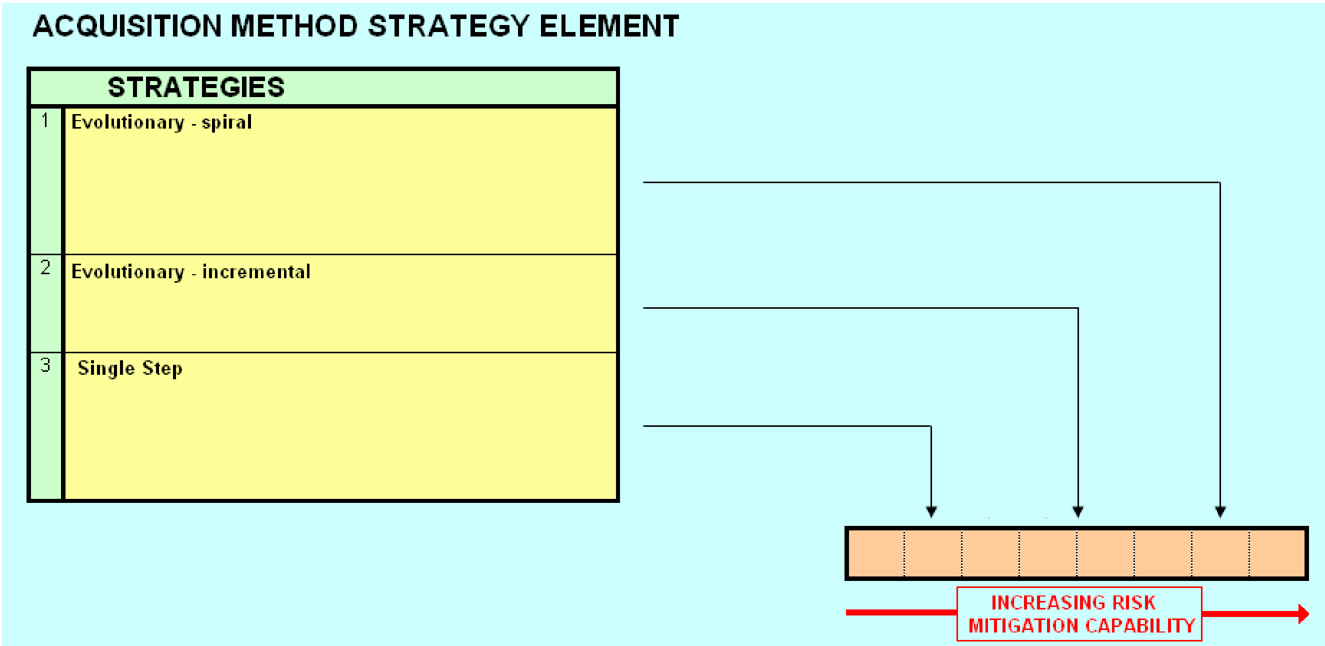
Ranking Strategic Choices

For each strategy element, rank the strategic choices per their ability to mitigate risk



Step 3

Acquisition Strategy Drivers

Software Criticality Category	Acquisition Environment Category	Program-matic Category	Organiza-tional Category	Life Cycle Category
Software Criticality	Policies and Mandates	Mission Needs and Scope	PMO Capability	Product Definition & Specification
	Supplier Availability	Funding	Stakeholders	Architecture and Design
		Schedule	Supplier Capability	Verification and Test
				Deployment
				Maintenance and Support
				Disposal

Strategy Drivers 1

Driver Category	Strategy Driver
Software Criticality	• **Magnitude of Software** • **Reliance on software**

Acquisition Environment	• **Policies and Mandates**
	  • *Conflict among mandates*
	  • *Conflict with project objectives*
	• **Supplier Availability**

Programmatic	• **Mission Needs and Scope**
	  • *Definition*
	  • *Flexibility*
	• **Funding**
	  • *Funding Constraints*
	  • *Funding Profile*
	• **Schedule**
	  • *Schedule Constraints*
	  • *Urgency*

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Strategy Drivers 2

Driver Category	Strategy Driver

Organizational	• **Program Management Office capabilities**
	  • *PMO Staff Skills*
	  • *PMO Staff Capacity*
	  • *PMO Staff Stability*
	  • *PMO Process Focus*
	• **Stakeholders**
	  • *Number and Diversity*
	  • *Level of Engagement (responsiveness and quality)*
	  • *Level of Agreement*
	• **Supplier Capability**
	  • *Supplier Staff Skills*
	  • *Supplier Staff Capacity*
	  • *Supplier Staff Stability*
	  • *Supplier Performance to Date*

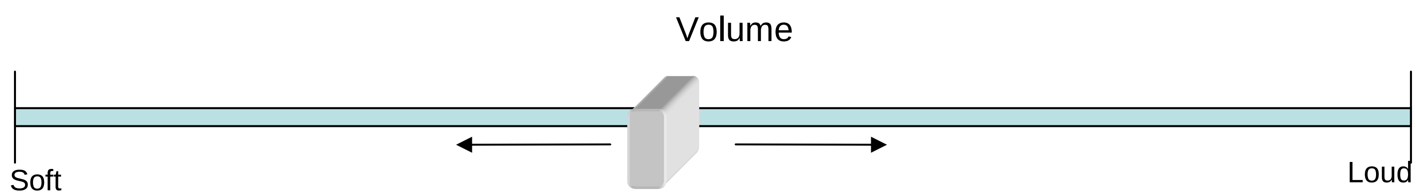
Strategy Drivers 3

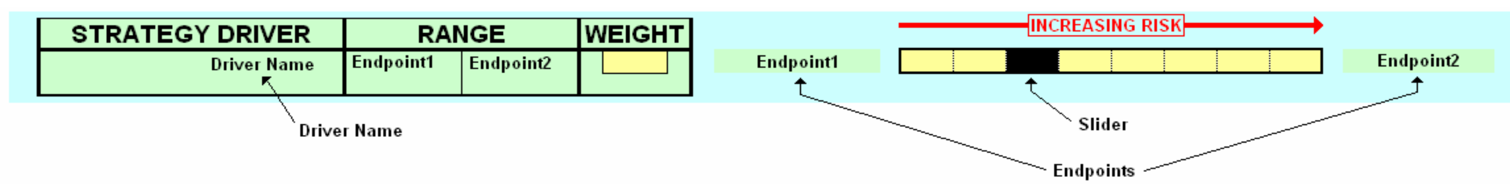
Driver Category	Strategy Driver
Life-cycle: *Product Definition and Specification*	• Requirements Volatility • Requirements Understanding • Quality Attribute Definitions • Interoperability
Life-cycle: *Architecture and Design*	• Precedence • Quality Attribute Constraints • Technology Readiness • Legacy Considerations • COTS / GOTS / Reuse
Life-cycle: *Verification and Test*	• Test Environment Complexity • Test Environment Availability • Number of System Configurations

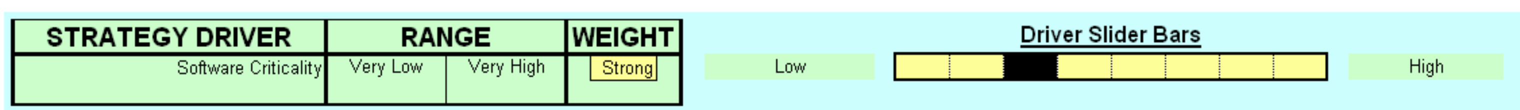
Strategy Drivers 4

Driver Category	Strategy Driver
Life-cycle: *Deployment*	• Number of Sites • User Readiness • Maintainer Readiness • Transition / Data Migration
Life-cycle: *Maintenance and Support*	• Number of System Configurations • Update Readiness • Support Duration • Re-competition Readiness • Operational Environment • Legacy Considerations • Availability of Data Rights
Life-cycle: *Disposal*	• Security • Archiving

Driver Evaluation using Slider Bars







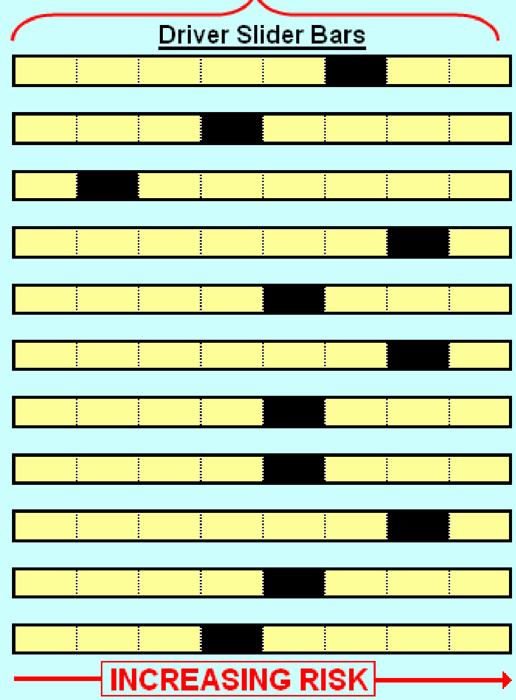
Evaluating Drivers

Version: 0.2 **Date:** 14-Sep-05

STRATEGY DRIVER ASSESSMENT

Place an "X" in the box representing your evaluation for each driver (one "X" per row)

DRIVER	RANGE				
Software Criticality	Very Low	Very High	Very Low		Very High
Policies and Mandates	Low	High	Low		High
Supplier Availability	High	Low	High		Low
Funding Constaints	Few	Many	Few		Many
Funding Profile	Mismatched	Matched	Matched		Mismatched
Schedule Constraints	Few	Many	Few		Many
PMO Staff Skills	Strong	Weak	Strong		Weak
PMO Staff Capacity	Adequate	Inadequate	Adequate		Inadequate
Requirements Volatility	Low	High	Low		High
Quality Attribute Constraints	Low	High	Low		High
Technology Readiness	Mature	Immature	Mature		Immature



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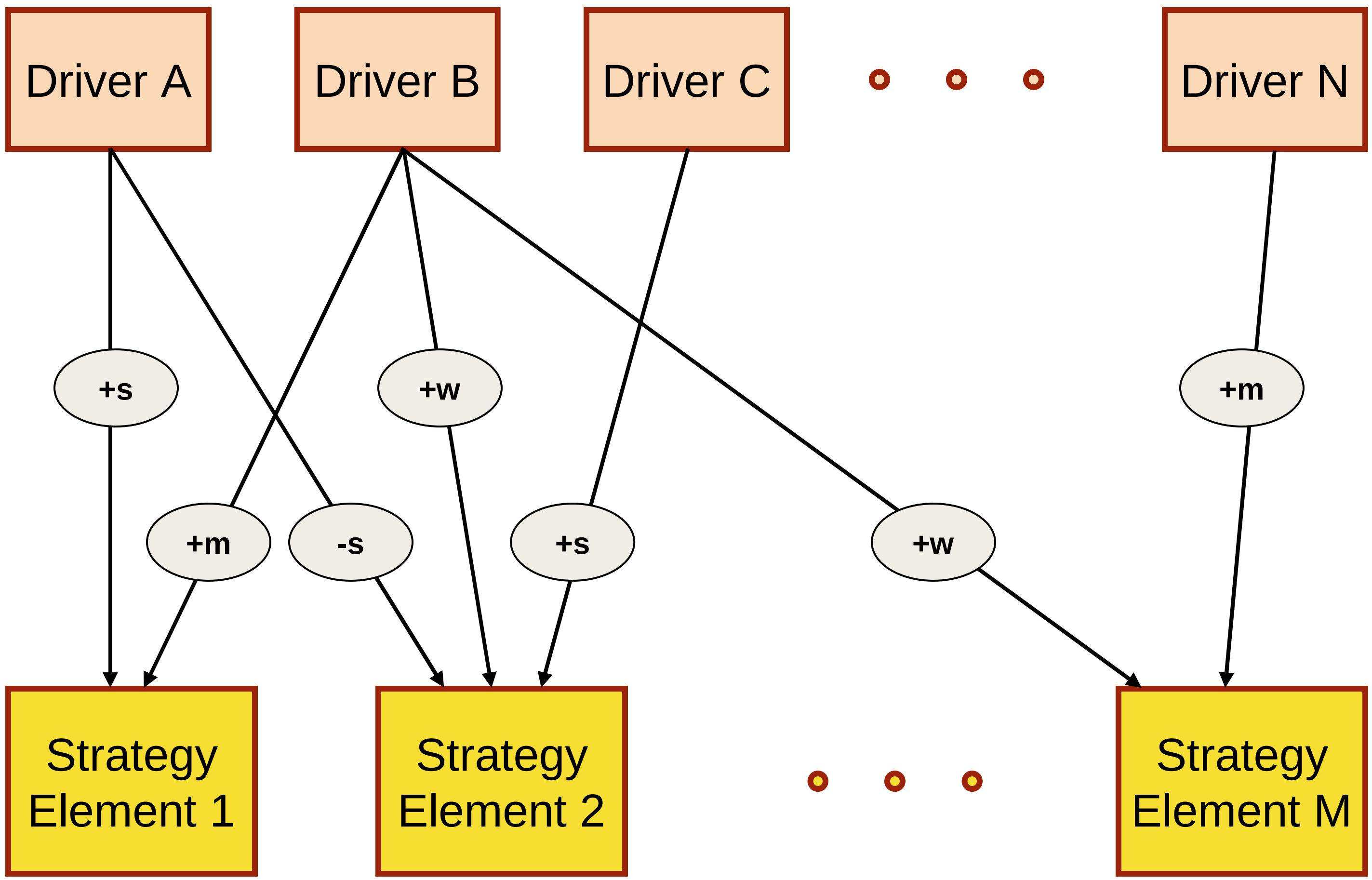
Mapping Drivers to Strategies 1



Mapping Drivers to Strategies 2

KEY

- (blank) Weak or No Linkage
- M Medium Linkage
- S Strong Linkage

STRATEGY DRIVERS	STRATEGY ELEMENTS											
	Pgrm			Business						Product		
	Milestone Decision Points	Acquisition Phases	**Acquisition Approach**	Competition	Solicitation Type	Source Selection	Contract Approach	**Risk Management**	**Test and Evaluation**	Training	Installation	Source of support
Software Criticality	S	S	S	S	S	S	S		S	S	S	M
Acquisition Environment												
Policies and Mandates	S	S	S	S	S	S	S		S	S	S	S
Supplier Availability		S	S	S	S	S	S			M	M	S
Programmatic Category Drivers												
Mission Needs and Scope	S	S	S	S	S	S	S	M	S	S	S	S
Funding												
Funding Constraints	S	S	S	S	S	S	S	M	S	S	S	S
Funding Profile	S	S	S	S		M	S		M	M	M	S
Schedule												
Schedule Constraints	S	S	S	S	S	S	S	M	S	S	S	S
Urgency	S	S	S	S	S	S	S	M	S	S	S	S

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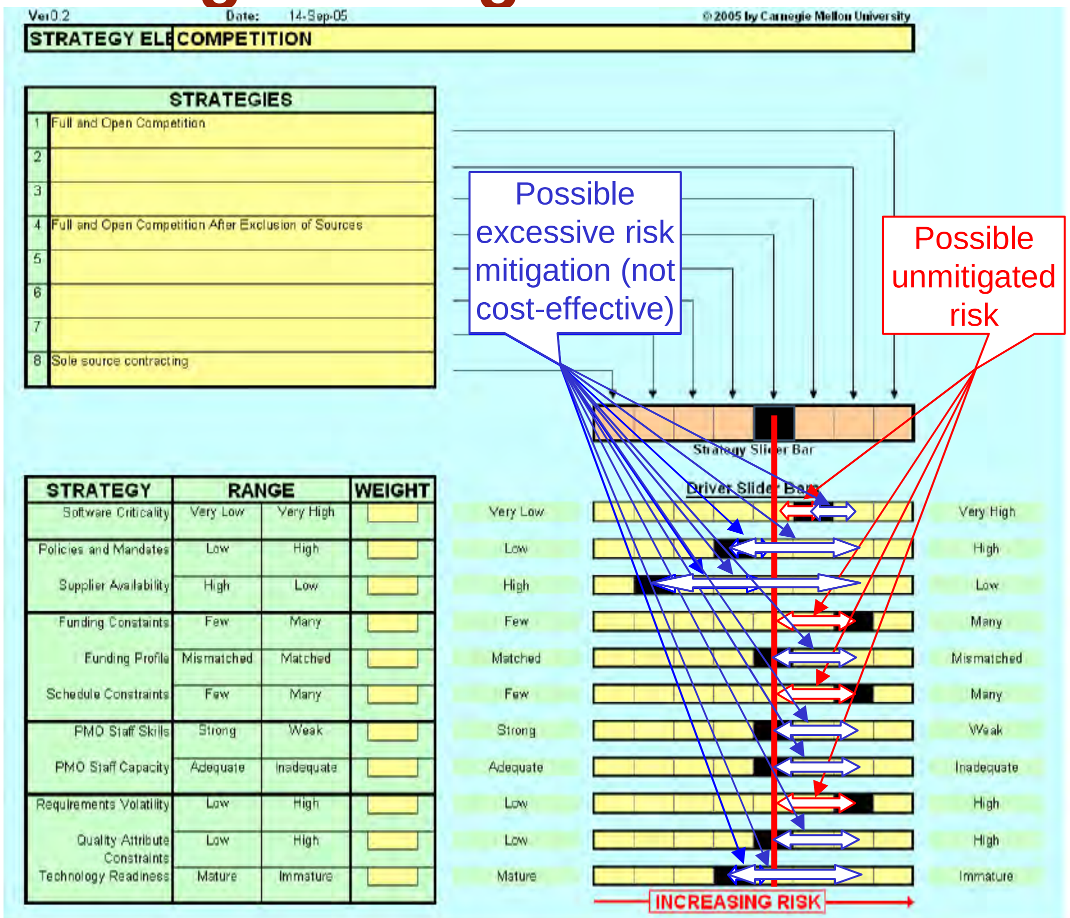
Step 4
Evaluating Strategic Choices



Research Status

Original effort (funded by US Army) is complete

- Technique piloted with US Army GCCS program.
- Technical Report ("*Techniques for Developing an Acquisition Strategy by Profiling Software Risks*") available on SEI web site (http://www.sei.cmu.edu) Dec 05
- Spreadsheet tool available on SEI web site Dec-05

Future efforts

- Refine the process via "use and learn"
- Expand technical report to include guidance for more strategy elements.

Conclusion

Questions ?

Contact information

- Mary Catherine Ward mcw@sei.cmu.edu
- Joseph P. Elm jelm@sei.cmu.edu

8^{th} Annual
System Engineering Conference
October 2005

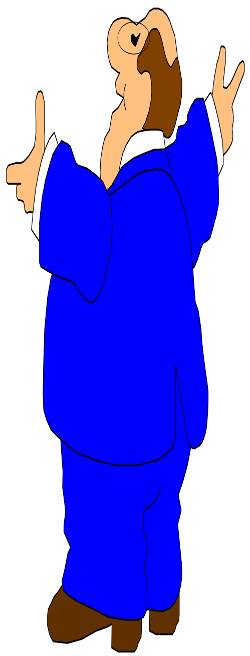
National Defense Industry Association (NDIA)
System Engineering Division

The Proper Specification of Requirements

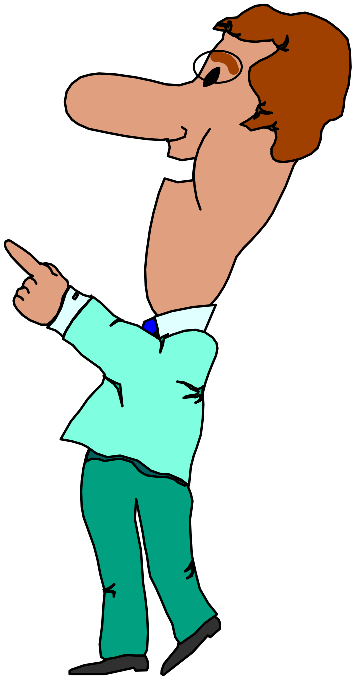
Al Florence **The MITRE Corporation**

Overview

- Introduction
- Nature of Requirements – what are they?
- Critical Attributes of Requirements
- Examples
  - Initial Specification of Requirement
  - Critique on Requirement
  - Re-Specification of Requirement
- Types of Requirements
- Conclusion
- References & Suggested Readings
- Contact Information



Introduction 1 OF 2



- Some of the biggest challenges faced by engineers are those of requirement definition, specification, analysis, validation and verification.
- In many documents of requirements the requirements are ambiguous and inconsistent.
- They may not be uniquely identified making them untraceable and untestable.
- In many cases they are not specified at the correct level: too high or too low a level, at the system or at the design level, not at the software/hardware requirements level.

If these challenges are mitigated the risk of developing systems that do not satisfy their requirements will be reduced.

Introduction 2 OF 2

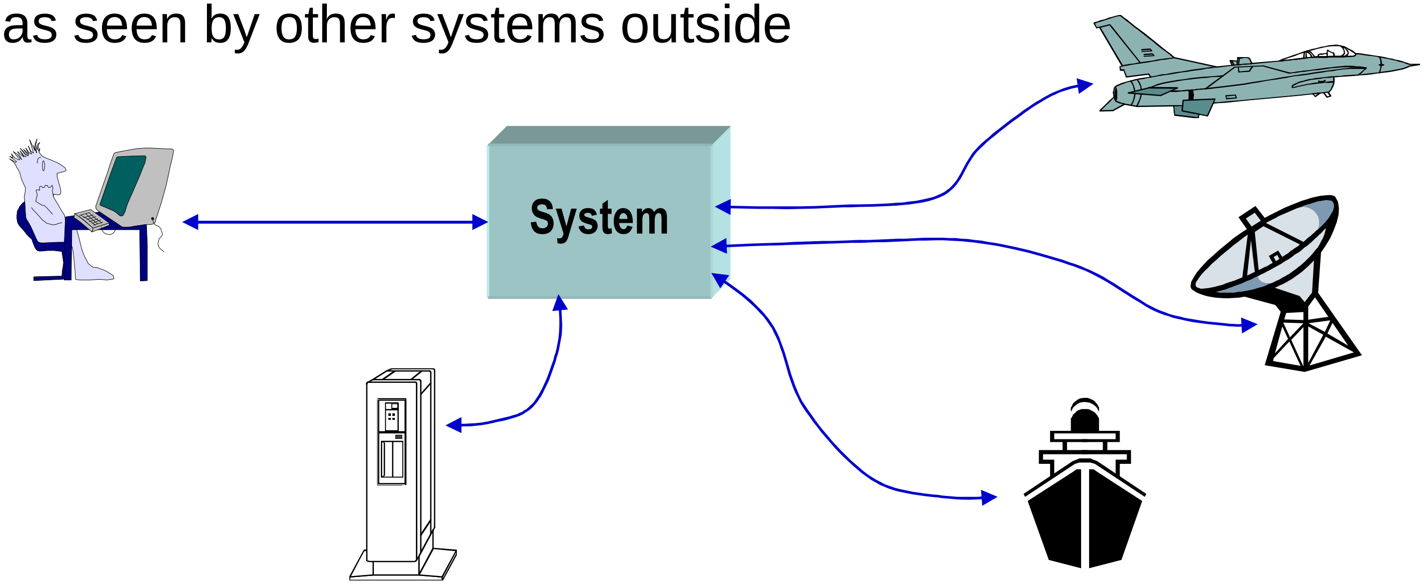
- Presented are some examples that address the challenges faced by individuals during the specification of requirements
- A Government agency, while re-developing legacy systems, reversed engineered the existing requirements.
- The examples represent several legacy systems that are in the process of redevelopment in a modernization effort.
- The examples depict only the requirements effort – they do not reflect any other lifecycle activities: design, implementation, test or operation.

Nature of requirements - *what are they?* 1 OF 2

- IEEE Std 830-1998 – IEEE Recommended Practice for Software Requirements Specifications:

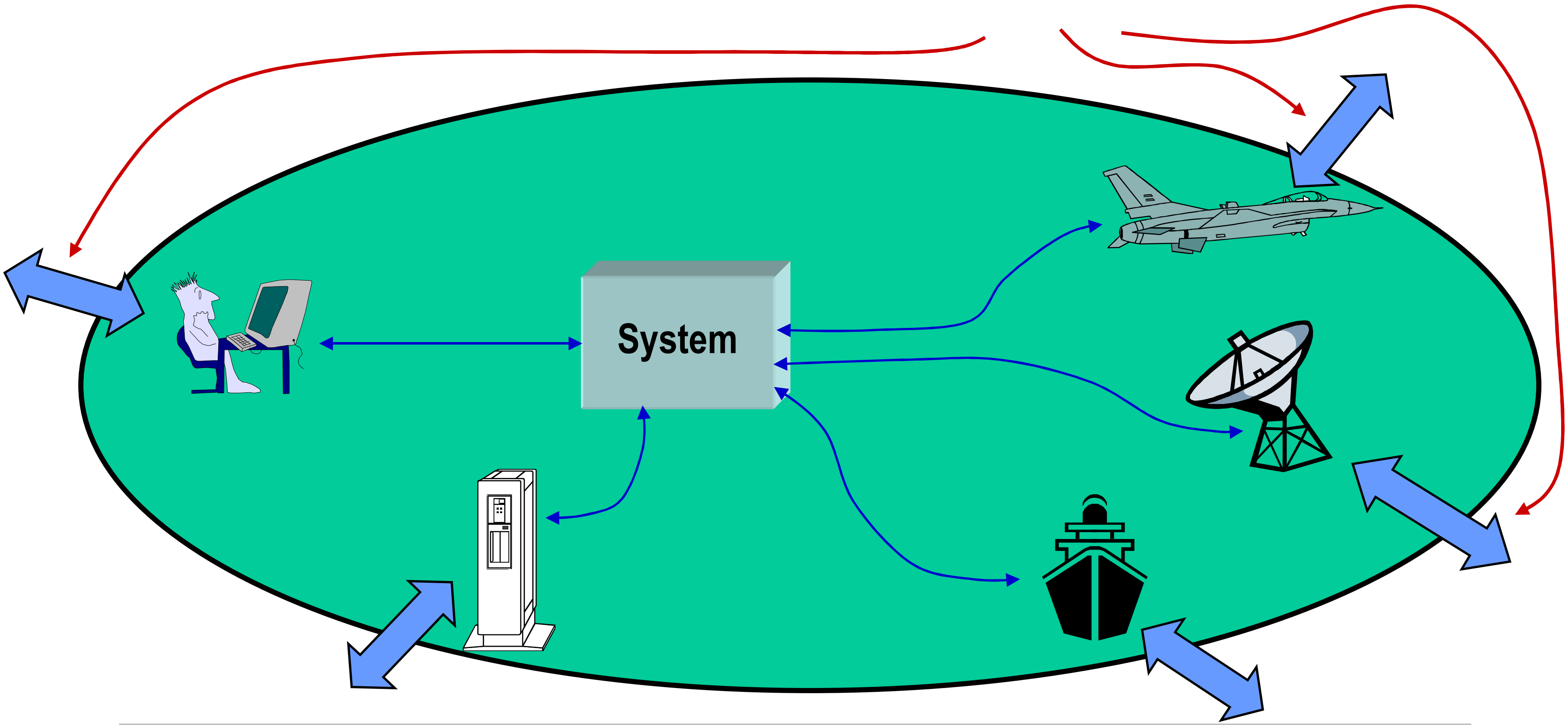
  "A requirement specifies an externally visible function or attribute of a system"

  – We can see inputs and the outputs, but not what happens inside
- For any product (SW, HW, total system), the behavioral requirements for that product specify its externally visible behavior
  – as seen by other systems outside



Nature of requirements - *what are they?* 2 OF 2

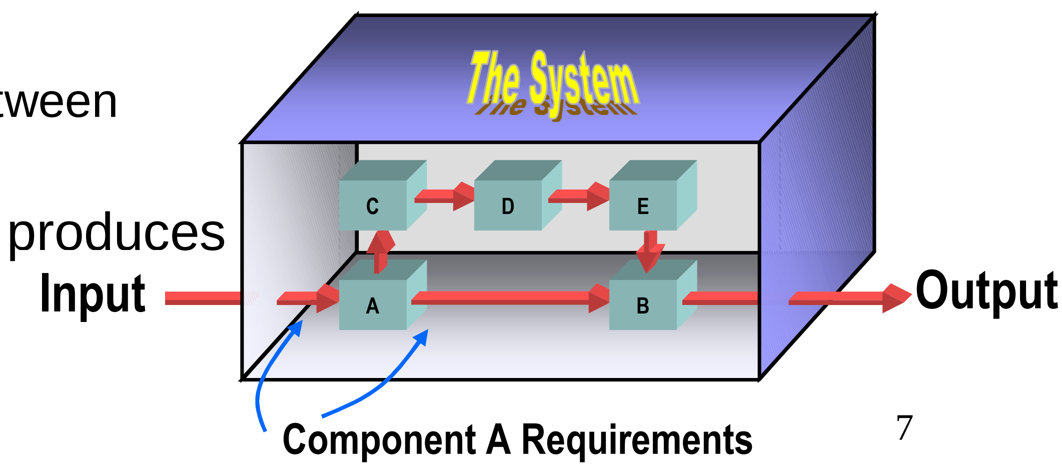
- But each such system could be part of a larger system
  - Which has its own requirements (externally visible behavior)



For the rest of this briefing, “requirement” denotes externally visible behavior

Context of requirements

- All requirements are defined in context of a specific component (e.g., black box)
  - Which may consist of additional constituent components (e.g., subsystem, modules,...)
  - Hence there are multiple levels of requirements based on level of component
    - System level, subsystem level, software configuration item (SCI) level, component level, software unit level,...
- Component design (its architecture) consists of:
  - The requirements for behavior of each constituent component
  - The interrelationships between the components
- Interaction of components produces the behavior of parent component



Critical Attributes 1 OF 3

The following are some critical attributes that requirements must adhere to:

Completeness: **Requirements should be as complete as possible.**

(They should reflect system objectives and specify the relationship between the software and the rest of the subsystems.)

Traceability: **Each requirement must be traceable to some underlying source, such as a system-level requirement.**

(Each requirement should have a unique identifier so that the software design, code, and test plans can be precisely traced back to the requirement.)

Testability: **All requirements must be testable in order to demonstrate that the software end product satisfies its requirements.**

(In order for requirements to be testable they must be specific, unambiguous, and quantitative whenever possible. Avoid vague, general statements.)

Critical Attributes 2 OF 3

Consistency: **Requirements must be consistent with each other; no requirement should conflict with any other requirement.**

(Requirements should be checked by examining all requirements in relation to each other for consistency and compatibility.)

Feasibility: **Each requirement must represent a feasible representation.**

(Requirements that have questionable feasibility should be analyzed during requirements analysis to prove their feasibility.)

Unique identification: **Uniquely identifying each requirement is essential if requirements are to be traceable and testable.**

(Uniqueness also helps in stating requirements in a clear and consistent fashion.)

Critical Attributes 3 OF 3

Design Free: **Software requirements should be specified at a requirements level not at a design level.**

(The approach should be to describe the software requirement functionally from a system point of view, not from a software design point-of-view, i.e. describe the system functions that the software must satisfy. A requirement reflects "what" the software shall accomplish while the design reflects "how" the requirement is implemented.)

Use of "shall" and related words: **In specifications, the use of the word "shall" indicates a binding provision.**

(Binding provisions must be implemented by users of specifications. To state non-binding provisions, use "should" or "may". Use "will" to express a declaration of purpose (e.g., "The Government will furnish..."), or to express future tense.[2)]

Examples

- With domain knowledge of the system, several teams reverse-engineered and defined requirements.
- They represented:
  - the users
  - the contractors
  - the acquisition organization
- This author was assigned as a consultant to guide the teams in the proper specification of requirements.
- The following examples show some of the requirements:
  - as initially specified by the teams
  - followed by this author’s critique (against the critical attributes)
  - and as re-specified based on the critique

Example 1

Initial specification:

Software will not be loaded from unknown sources onto the system without first having the software tested and approved.

Critique:

- If it's tested and approved, can it be loaded from unknown sources?
- If the source is known, can it be loaded without being tested and approved?
- Requirement is ambiguous and stated as a negative requirement, which makes it difficult to implement and test.
- A unique identifier is not provided, which makes it difficult to trace.
- The word "shall" is missing.

Re-specification:

3.2.5.2 Software shall be loaded onto the operational system only after it has been tested and approved.

Example 2

Initial specification:

3.4.6.3 The system shall prevent processing of duplicate electronic files by checking a new SDATE record. An e-mail message shall be sent.

Critique: .

- Two "shalls" under one requirement number.
- Vague requirement: need to define the e-mail message.
- The requirement has design implications, SDATE record.
- A requirement should specify what the data in the record are and not the name of the record as it exists in the design and implementation..
- As specified it cannot be implemented or tested.

Re-specification:

3.4.6.3 The system shall:

a. prevent processing of duplicate electronic files by checking the date and time of the submission, and

b. send the following e-mail message:

1. request updated submission date and time, if necessary, and
2. the processing was successful, when successful.

Example 3 1 OF 2

Initial specification:

3.2.5.7 The system shall process two new fields (provides production count balancing info to states) at the end-of-state record.

Critique:

- This requirement cannot be implemented or tested.
- It is incomplete. What are the two new fields?
- "Info" should be spelled out.

Re-specification:

3.2.5.7 The system shall provide the following data items (provides production count balancing information to states) at the end-of-state record:

a. SDATE, and

b. YR-TO-DATE-COUNT

Example 3 2 OF 2

Re-Critique:

- This rewrite has design implications SDATE record and YR-TO-DATE-COUNT.
- From a requirements viewpoint it should specify what the data in the records are, not the name of the record as it exists in the design and implementation.

Re-Re-Specification:

3.2.5.7 The system shall provide the following data items (provides production count balancing information to states) at the end-of-state record:

a. submission date and time, and

b. year-to-date totals.

Example 4

Initial specification:

3.2.5.9 All computer-resident information that is sensitive shall have system access controls. Access controls shall be consistent with the information being protected and the computer system hosting the data.

Critique:

- Two "shalls" under one identifier.
- The requirement is vague and incomplete. Need to identify the sensitive information.
- What does "consistent" mean?
- As specified it cannot be implemented or tested.

Re-specification:

3.2.5.9 All sensitive computer-resident information shall have system access controls, consistent with the level of protection. (Reference *Sensitive Information,* Table 5.4.1 and *Level of Protection for Sensitive Information*, Table 5.4.2)

Example 5

Initial specification:

3.3.2.1 The system shall have no single point failures.

Critique:

- This is an ambiguous requirement. Needs identification of what components and/or functions the “no single point failures” applies to.
- As specified it cannot be implemented or tested.

Re-specification:

3.3.2.1 The following system components shall have no single point failures:

a. host servers,
b. networks,
c. network routers,
d. access servers,
e. hubs,
f. switches,
g. firewalls, and
h. storage devices.

Example 6

Initial specification:

3.2.7.1 The system shall purge state control records and files that are older than the operator or technical user-specified retention period.

Critique:

- Requirement is incomplete and vague without specifying the retention period or providing a reference as to where the information can be obtained.
- Requirement cannot be implemented or tested as stated.

Re-specification:

3.2.7.1 The system shall purge state control records and files that are older than the retention period input into the system by either the:

a. operator, or
b. technical user.

Example 7 1 OF 2

Initial specification:

3.2.6.3 The system shall receive and process state return data from the State Processing Subsystem. The system shall provide maintenance of the state data files and generate various reports.

Critique:

- Two "shalls" under one requirement number and multiple requirements in the specification.
- The word "process" in the first shall is vague. Need to define the processing required.
- The second "shall" does not provide for valid requirements; they cannot be implemented or tested as stated.
  - Needs identification of type/amount of maintenance required.
  - "various reports" is ambiguous.

Example 7 2 OF 2

Re-specification:

3.2.6.3 The system shall receive:

a. production data that contains data from multiple states, and
b. state total amount for one or more states,

extracted by the Returns Processing Subsystem.

3.2.6.4 The system shall parse multi-state data to respective state files.

3.2.6.5 The system shall display a summary screen reporting the results of processing for each state containing:

a. state totals,
b. state generic totals, and
c. state unformatted totals.

Example 8

Initial specification:

3.2.7.1 The system shall not prevent the individuals from entering the year for which they intend the payment, but shall provide a check-point for them to ensure that they are not making a mistake in entering the correct year.

Critique:

- This is a negative requirement, negative requirements should not be specified. They cannot be implemented.
- A requirement should have all conditions that are required. If conditions are not required they will not be implemented.
- Two “shalls” under one requirement number.
- Suggest that this requirement be structured in a positive fashion.

Re-specification:

3.2.7.1 The system shall:

a. allow individuals to enter the payment year, and
b. provide a check-point to ensure that individuals enter the correct payment year.

Example 9 1 OF 2

Initial specification:

After the system receives the Validation file, the system shall:

- notify the individual about acceptance or rejection.
- the acceptance file must contain the name and ZIP code of the individual.
- rejected validation request must include the Reason Code.

Critique:

- The second and third bullets don't make sense, try to read them as such:
  - the system shall the acceptance file must...
  - the system shall rejected Validation…
- Use of both "shall" and "must".
- No unique identifier, use of bullets. Bullets cannot be traced.
- This requirement is ambiguous and cannot be implemented or tested.

Example 9 2 OF 2

Re-specification:

3.2.7.3 When the system receives a validation file, the system shall:

a. reject the file if it does not contain the individuals:

1. name, or
2. ZIP code, and

b. notify the individual about acceptance or rejection with a reason code. (Reference *Reason Code*, Table 5.4.8)

Example 10

Initial specification:

3.2.8.2 The enrollment process shall take from one to ten calendar days to complete for all payment types.

3.2.8.3 The enrollment process shall take no more than three days to complete for:

a. credit payment, and/or
b. note payment.

Critique:

These requirements are inconsistent and in conflict with each other.

Re-specification:

3.2.8.2 The enrollment process shall take:

a. one to three calendar days to complete for:
    1. credit payment, and
    2. note payment, and
b. one to ten calendar days to complete for all other payment types.

Example 11

Initial specification:

3.2.9.1 When doing calculations the software shall produce correct results.

Critique:

- Really? This is not a requirement.
- This type of requirements should not be specified!
- It should be deleted.

Re-specification:

Requirement deleted.

Summary

- The teams identified over 1000 requirements.
- The issues with their initial specification represented the entire spectrum of the following critical attributes:

  - completeness
  - traceability
  - testability
  - consistency
  - feasibility
  - unique identification
  - design free
  - use of shalls
- The teams were receptive to the critique, resolved issues and implemented the recommendations willingly.
- The requirements resulting from this effort were:
  - reviewed with senior management
  - accepted as specified
  - baselined, and
  - allocated to development teams for implementation.

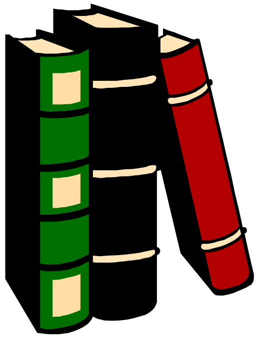
Conclusion

- If sufficient time and proper effort is taken to validate requirements against critical attributes during their definition and specification, software projects will improve their probability of success considerably.

- If this is not done, projects pay the consequences during implementation, integration and test – not to mention during operation.

But you *knew* that, didn't you?
(I hope!)

References & Suggested Readings



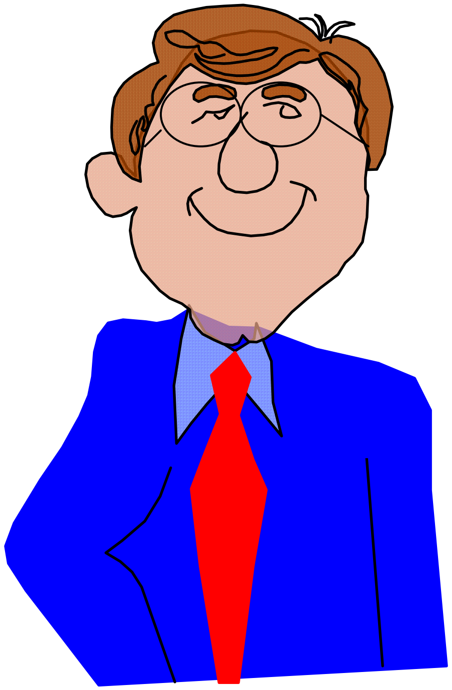
References

1. Florence, Al, April 2002, *Reducing Risk with the Proper Specification of Software Requirements,* Cross*Talk*, The Journal of Defense Software Engineering.
2. June 4, 1985, *MIL-STD-490A, Military Standard Specification Practices,* Department of Defense, USA.

Suggested Readings

- October 20, 1998, *IEEE Std 830-1998, IEEE Recommended Practices for Software Requirements Specifications*, IEEE Computer Society.
- Cook, David A.; Dupaix, Les, March 2001, *The Requirements for Good Requirements*, Software Technology Conference Proceedings.
- Florence, Al; Sanders, Steve, March 2002, *Software Requirements Validation/Verification*, PSQT/PSTT 2002 Conference Proceedings.

Contact Information



Alfred (Al) W. Florence

florence@mitre.org

(703) 983-7476

Using MIL-STD-882D to Integrate ESOH into SE

NDIA SE Conference
San Diego, CA
25 October 2005

Mr. Sherman G. Forbes
Office of the Deputy Assistant Secretary
(Science, Technology and Engineering)

U.S. AIR FORCE

Purpose

- **Discuss the deliberate, decade-long DoD-wide effort to integrate Environment, Safety, and Occupational Health (ESOH) Considerations into Systems Engineering (SE) using the System Safety risk management principles, with emphasis on**
  - **The benefits and challenges of institutionalizing System Safety within SE and the larger Acquisition System**
  - **Why DoD chose System Safety to be the methodology for integrating ESOH**
  - **The continuing focus on institutionalizing the “D” version of MIL-STD-882**

Overview

- Acquisition Context for System Safety
- Initial System Safety-ESOH-SE Breakthrough
- Adapting MIL-STD-882 to Support the DoD Acquisition System and SE
- Institutionalizing System Safety-ESOH-SE Integration
- Way Ahead

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Acquisition Context

- **Defense Acquisition System -- provides effective, affordable, and timely systems to meet warfighting capability needs**
- **Systems Engineering (SE)**
  - **Translates capabilities into technical specifications**
    - **Optimizes total system performance**
    - **Minimizes total ownership cost**
  - **Employs interdisciplinary approach throughout life-cycle**
  - **Utilizes _Risk Management_ to balance**
    - **External limitations, e.g,. technology, budget, *ESOH requirements***
    - **Design considerations & constraints, e.g., *ESOH***

Acquisition Context

- DoD chose System Safety as the methodology for effectively and efficiently integrating ESOH considerations into SE
  - Compatible with other SE risk management activities
  - Can consolidate and translate E, S, and OH requirements into manageable program risks
- System Safety process
  - Provides common approach for the E, S, and OH areas to interact with each other and SE
  - Needs to provide specific risk management products at key points on the SE process
  - Needs to integrate these System Safety products into overall program risk management
- DoD efforts focused on connecting E, S, and OH and SE using the System Safety process

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Initial Breakthrough

- DoD 5000.2R (1996) integrated ESOH into Systems Engineering for the first time
  - Defined environmental compliance in risk management terms
  - Established System Safety hazard identification and risk assessment, mitigation, and acceptance requirements
  - Did not reference a standard of any kind
- PROBLEM: MIL-STD-882C (1993) was the only existing government-industry System Safety standard
  - DoD rejected it as too prescriptive
    - Defined "how to" in long list of System Safety tasks
    - Focused on multiple System Safety reports, not specific products that support program risk management
  - DoD would not allow Acquisition Programs to put MIL-STD-882C on contracts

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Adapting MIL-STD-882

- DoD directed conversion of 882 into a performance-based Standard Practice to meet Acquisition PM needs
- Government & Industry team rewrote MIL-STD-882C
  - GEIA G-48 System Safety Committee had representatives from
    - OSD, the Services, FAA, NASA, and Coast Guard
    - All major defense corporations
  - AF published MIL-STD-882D on 10 Feb 00
    - Defined WHAT required -- 8 actions to integrate ESOH into SE
    - Focused on the process of hazard identification and risk assessment, mitigation, and acceptance -- not reports
    - Added guidance on how to apply risk management to Environmental issues
    - Approved for use on all DoD contracts without restriction

Adapting MIL-STD-882

- **MIL-STD-882D System Safety Process – 8 Actions**
  - **Document System Safety Strategy**
  - **Identify Hazards**
  - **Assess Mishap Risk**
  - **Identify Mitigation Measures**
  - **Reduce Mishap Risk to Acceptable Level**
  - **Verify Mishap Risk Reduction**
  - **Formally Accept Residual Risks**
  - **Track Hazards & Mishaps**

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Adapting MIL-STD-882

Hazard Risk Index and Acceptance
DoDI 5000.2, E7.7 & MIL-STD-882D

FREQUENCY OF OCCURRENCE	HAZARD CATEGORIES			
	I CATASTROPHIC	II CRITICAL	III MARGINAL	IV NEGLIGIBLE
(A) Frequent	1	3	7	13
(B) Probable	2	5	9	16
(C) Occasional	4	6	11	18
(D) Remote	8	10	14	19
(E) Improbable	12	15	17	20

HIGH(CAE)

SERIOUS (PEO)

MEDIUM (PM)

LOW (PM)

Adapting MIL-STD-882

MIL-STD-882D Severity Categories expanded to include Environmental Risk

Description	Category	Environmental, Safety, and Health Result Criteria
Catastrophic	I	Could result in death, permanent total disability, loss exceeding $1M, or irreversible severe environmental damage that violates law or regulation.
Critical	II	Could result in permanent partial disability, injuries or occupational illness that may result in hospitalization of at least three personnel, loss exceeding $200K but less than $1M, or reversible environmental damage causing a violation of law or regulation.
Marginal	III	Could result in injury or occupational illness resulting in one or more lost work days(s), loss exceeding $10K but less than $200K, or mitigatible environmental damage without violation of law or regulation where restoration activities can be accomplished.
Negligible	IV	Could result in injury or illness not resulting in a lost work day, loss exceeding $2K but less than $10K, or minimal environmental damage not violating law or regulation.

Adapting MIL-STD-882

- **Risk acceptance levels defined IAW DoD Acquisition Policy**

Mishap Risk Assessment Value	Mishap Risk Category	Mishap Risk Acceptance Level
1 – 5	High	Component Acquisition Executive
6 – 9	Serious	Program Executive Officer
10 – 17	Medium	Program Manager
18 – 20	Low	As directed

- **PM puts 882D on contract to define WHAT required**
- **Contractor provides detailed plan of HOW to implement**
  - **Flexible implementation by contractor**
  - **Tailored to program size and complexity**

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Adapting MIL-STD-882

- Barriers to institutionalization of MIL-STD-882D
  - System Safety community resisted leaving 882C
  - G-48 Committee did not provide planned training for
    - System Safety Engineers and PMs
  - DoD lack of explicit emphasis or guidance on
    - Using 882D System Safety process for ESOH in SE
    - Connection between traditional Safety reporting and the Programmatic Environment, Safety, and Occupational Health Evaluation (PESHE) document
  - DoD focused on PESHE as only DoD required ESOH report – issue of where to document ESOH risk data
  - Lack of Senior Leadership attention

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Institutionalizing System Safety

- **12 May 03 DoDI 5000.2, E7 laid groundwork for greater institutionalization and guidance**
  - **Carried over requirements from 1996 DoD 5000.2-R**
  - **Applies to ESOH risks identified by an Acquisition Program**
    - **Regardless of ACAT**
    - **Regardless of life cycle phase**
  - **Relies upon "industry standard for system safety"**
- **Oct 04 Defense Acquisition Guidebook (DAG)**
  - **ESOH discussion in Chapter 4, Systems Engineering**
  - **Detailed description of ESOH risk management process**
  - **Defines MIL-STD-882D to be the "industry standard"**

Institutionalizing System Safety

- May 2003 SECDEF Memo focused Senior Leadership attention on Safety
  - Established goal of 50% reduction in mishap rates
  - Led to creation of Defense Safety Oversight Council (DSOC)
    - Joint Chiefs of Staff & Undersecretaries of the Services
    - Eight supporting Task Forces (TF)
- DSOC Acquisition and Technology Programs (ATP) TF focused on System Safety
  - Chair: Mr. Mark Schaeffer, USD (AT&L) Director of Systems Engineering (SE)
  - ATP TF linked efforts to increase emphasis on System Safety to revitalization of Systems Engineering (SE)

Institutionalizing System Safety

- **23 Sep 04 USD (AT&L) Defense Acquisition System Safety memo requires ALL DoD PMs to:**
  - **Integrate ESOH into SE using System Safety**
  - **Use MIL-STD-882D as the System Safety methodology**
    - **Extended debate on whether to refer to “D” exclusively**
    - **Firm decision by OSD and Services that “D” was most compatible with the overall Acquisition System approach**
  - **Incorporate ESOH integration strategy into the new Systems Engineering Plan (SEP)**
  - **Address ESOH risk acceptance decisions in technical and program reviews**

Institutionalizing System Safety

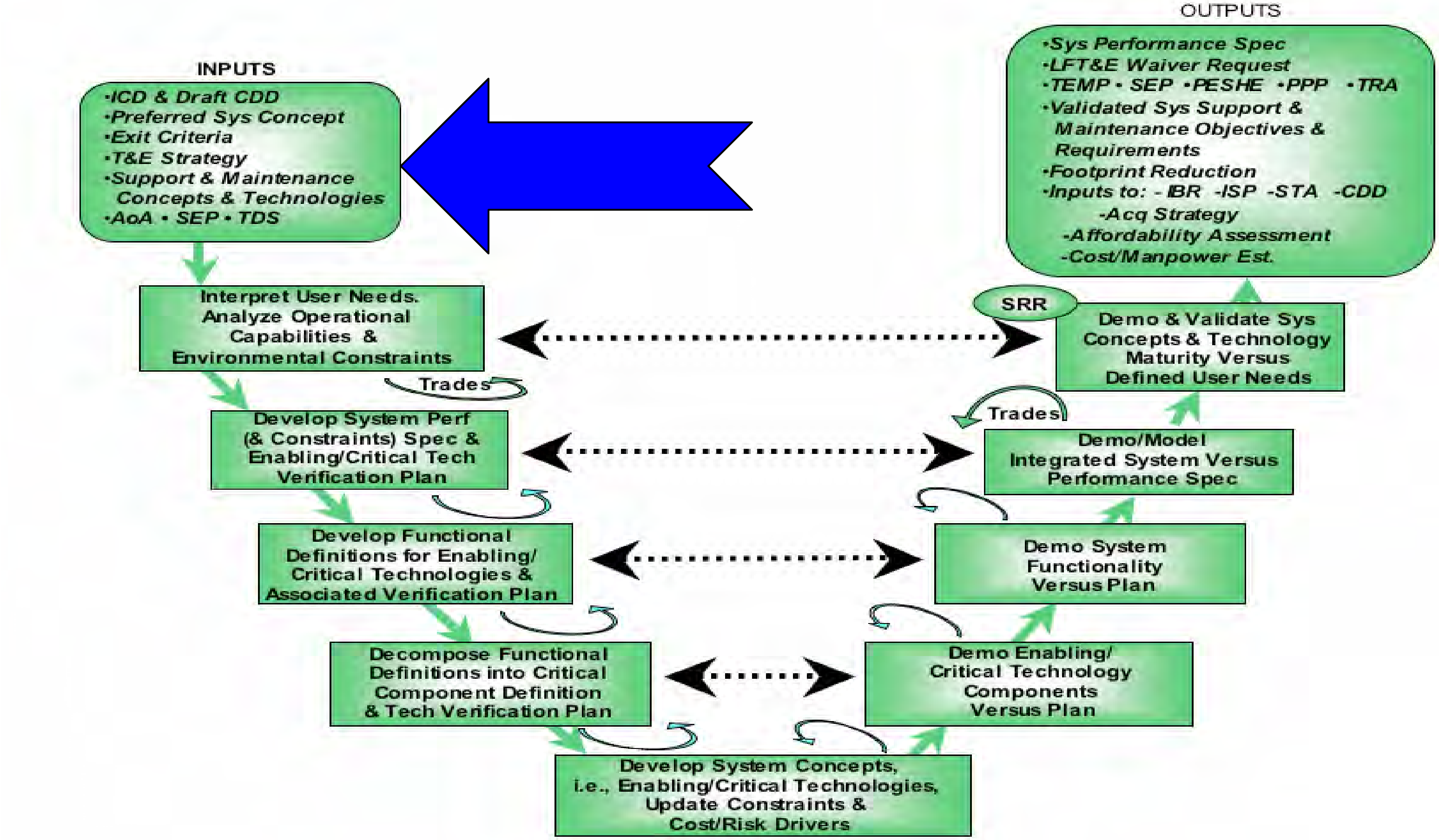
- **Connecting SE and System Safety Disciplines a key DSOC ATP TF effort**
  - **Oct 04 NDIA SE Conference Government & Industry Senior Level Panel on System Safety**
  - **Nov 04 PEO/SYSCOM Conference Senior Government Panel on System Safety**
  - **NDIA SE Division creation of System Safety Committee**
    - **Focus on implementation of 23 Sep 04 USD (AT&L) memo**
    - **Industry & Government Co-Chairs**
  - **Outreach to System Safety Society and G-48 Committee**
    - **Mark Schaeffer one of 4 Distinguished Speakers at the August 2005 International System Safety Conference**

Institutionalizing System Safety

- **Defense Acquisition University (DAU) Continuous Learning Module (CLM) -- System Safety in Systems Engineering (SSSE)**
  - **Based on MIL-STD-882D**
  - **Subject Matter Experts (SMEs) from each service & industry worked together beginning in 2004**
  - **Feb 05: peer review of by government & industry practioners of SE, System Safety, Environmental Engineering, & Occupational Health**
  - **Apr 05: available to both industry & government**
  - **Maps System Safety activities into the SE V-Model**
  - **Maps government and industry relationships**

Institutionalizing System Safety

SSSE CLM Course Material - Technology Development Phase



Institutionalizing System Safety

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SSSE CLM Course Material - Technology Development Phase

Inputs	System Safety Should:
Initial Capabilities Document (ICD) and Draft Capability Development Document (CDD)	Develop system safety criteria and requirements
Preferred System Concept	Evaluate system concept against identified system safety criteria
Exit Criteria	Provide the following exit criteria: 1. Update Preliminary Hazard List (PHL) 2. Update strategy for integrating Environment, Safety, and Occupational Health (ESOH) risk management into systems engineering (SE)
Test and Evaluation (T&E) Strategy	1. Incorporate hazard risk mitigation test and verification methodologies 2. Provide approach toward obtaining safety release(s)
Support and Maintenance Concepts and Technologies	Provide inputs as requested
Analysis of Alternatives (AoA)	Characterize ESOH footprints or risks for AoA development
Systems Engineering Plan (SEP)	Update strategy for integrating ESOH risk management into SE
Technology Development Strategy (TDS)	1. Include strategy to identify hazards 2. Identify needed ESOH technology development

Institutionalizing System Safety

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- 29 Jul 05 Air Force Instruction 63-101
  - Includes key System Safety (ESOH in SE) requirements from
    - 10 Feb 00 MIL-STD-882D
    - 12 May 03 DoDI 5000.2
    - 23 Sep 04 USD(AT&L) policy memo
    - 17 Oct 04 DoD Acquisition Guidebook
  - Key requirements include
    - Use of MIL-STD-882D to integrate ESOH into SE
    - ESOH documentation requirements
      - Acquisition Strategy
      - SEP
      - Risk Management Plan
      - Programmatic Environment, Safety, and Occupational Health Evaluation (PESHE)

Institutionalizing System Safety

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- **29 Jul 05 AFI 63-101 Key Requirements (cont'd)**
  - **ESOH risk management data included in**
    - **Annual Expectation Management Reviews**
    - **Technical Reviews**
    - **Programmatic Reviews**
  - **Defines three types of ESOH risks (from DAG) due to**
    - **Routine operations and maintenance**
    - **System or subsystem failures (mishaps)**
    - **ESOH compliance on cost, schedule, & performance**
  - **Risk acceptance responsibilities**

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Way Ahead

- Need to convert to a more traditional risk management 5X5 matrix of High-Medium-Low risks
  - Alignment with the rest of the Risk Management approaches in DoD Acquisition
  - Provide transparent communication about ESOH risks during technical and program reviews
  - More effective support to the customer – the PM
- Need to avoid going back to prescriptive 882
  - Drives unnecessary costs
  - Limits flexibility and innovation
  - Alternative ways to document traditional System Safety “tasks” to support System Safety engineers

Way Ahead

- ESOH Risk Acceptance role for Operational Commands -- not just Acquisition community decision
  - Needs greater definition & emphasis on existing guidance
  - Especially for Systems in Sustainment
- Improved clarification on relationships between PESHE & traditional System Safety documentation
- Standardized System Safety effectiveness evaluation criteria -- in work by the DSOC ATP TF
  - Already adopted in Defense Acquisition Executive Summary (DAES) for systems in Sustainment
  - Help clarify expectations for System Safety ESOH management as an integral part of SE process

Summary

- **Institutionalizing System Safety within SE and the Acquisition System**
  - **Benefit - Makes System Safety directly useful and necessary to a DoD core business area**
  - **Challenge - Requires System Safety professionals to adapt their discipline to SE and Acquisition System expectations**
- **System Safety is <u>the</u> methodology for integrating ESOH because it can consolidate and translate E, S, and OH requirements into manageable program risks**
- **DoD will continue to focus on institutionalizing 882D**
  - **Compatible with prevailing Acquisition System approach**
  - **Hard-won policy and training infrastructure built around it**

[redacted]

BACK UP CHARTS

Risk Acceptance Authority

Hazard Risk Index and Acceptance
DoDI 5000.2, E7.7 & MIL-STD-882D

FREQUENCY OF OCCURRENCE	HAZARD CATEGORIES			
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Institutionalizing System Safety

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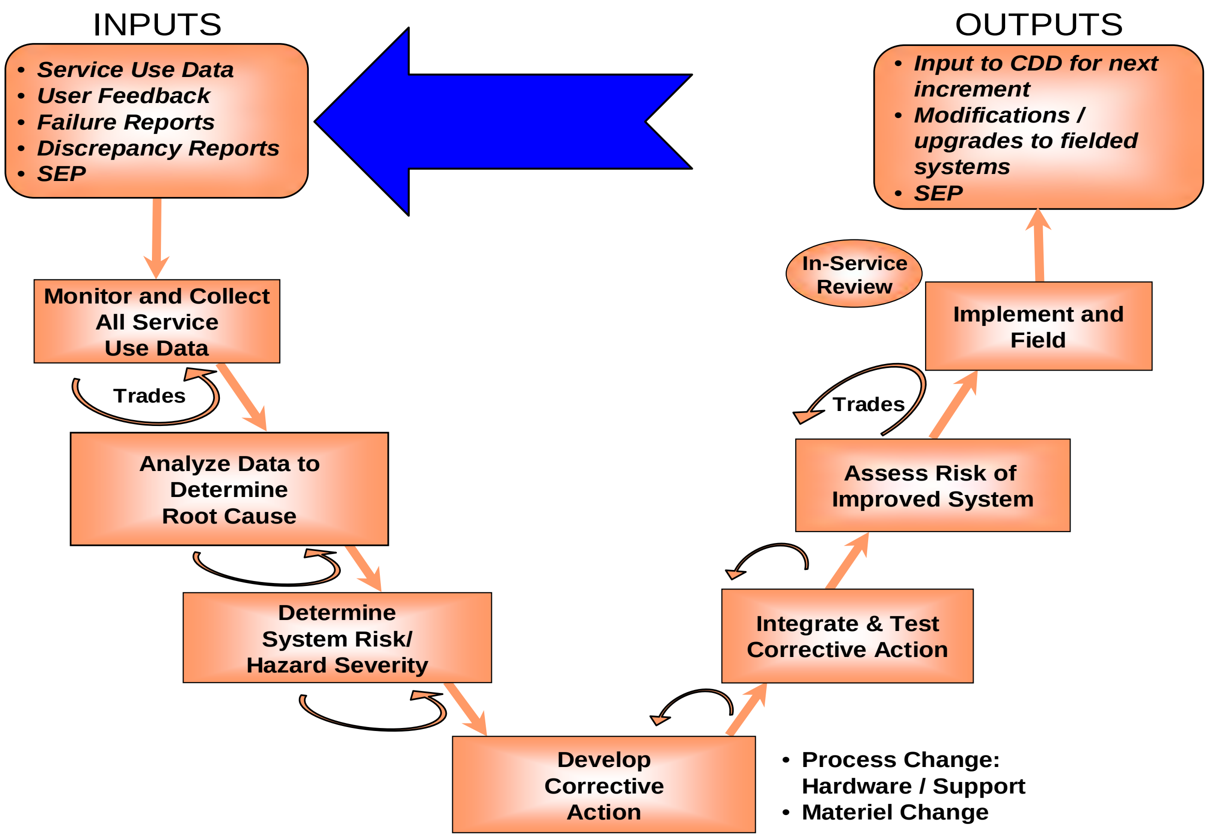
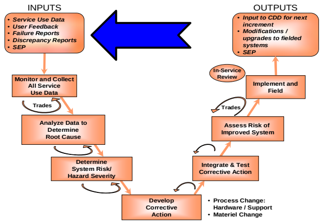
OPERATIONS AND SUPPORT PHASE



Institutionalizing System Safety

OPERATIONS AND SUPPORT PHASE



Inputs	System Safety Should:
Service Use Data	Review for system safety implications
User Feedback	Review for system safety implications
Failure Reports	1. Review Follow-On Operational Test & Evaluation (FOT&E) results for system safety implications 2. Review failure/mishap reports for causal factors or mitigation failures and recommend alternative mitigation measures 3. Assist in mishap investigations as requested
Discrepancy Reports	Review discrepancy reports for system safety implications
Systems Engineering Plan (SEP)	1. Update strategy for integrating ESOH risk management into SE 2. Identify applicable safety boards and process for concurrence/approval

ESOH Risk Management Keys

- **Develop mitigation measures using System Safety Order of Precedence based on assessed risks**
  - **Higher the risk -- higher up the Order of Precedence**
  - **High & Serious Risks -- require more effective measures**
    - **Design or material changes to eliminate or reduce the risk**
    - **Control systems to prevent mishaps**
  - **Medium & Low Risks -- allow use of less effective and less expensive solutions to reduce the risk, if even necessary**
    - **Warning devices**
    - **Procedural changes and training**

Risk-Based ESOH Management

- Three types of ESOH risk to be identified and assessed
  - Potential for adverse impacts to ESOH from routine system use
  - Potential for adverse impacts to ESOH and mission readiness from system failures or mishaps
  - Potential for adverse impacts to program cost, schedule, and performance from ESOH compliance requirements
- Purpose of risk-based ESOH management approach
  - To determine what ESOH laws/regulations apply to the system
  - To prioritize Acquisition Program Office efforts to comply
  - To determine how Acquisition Program Office will comply

A Taxonomy of Operational Risks

Brian Gallagher

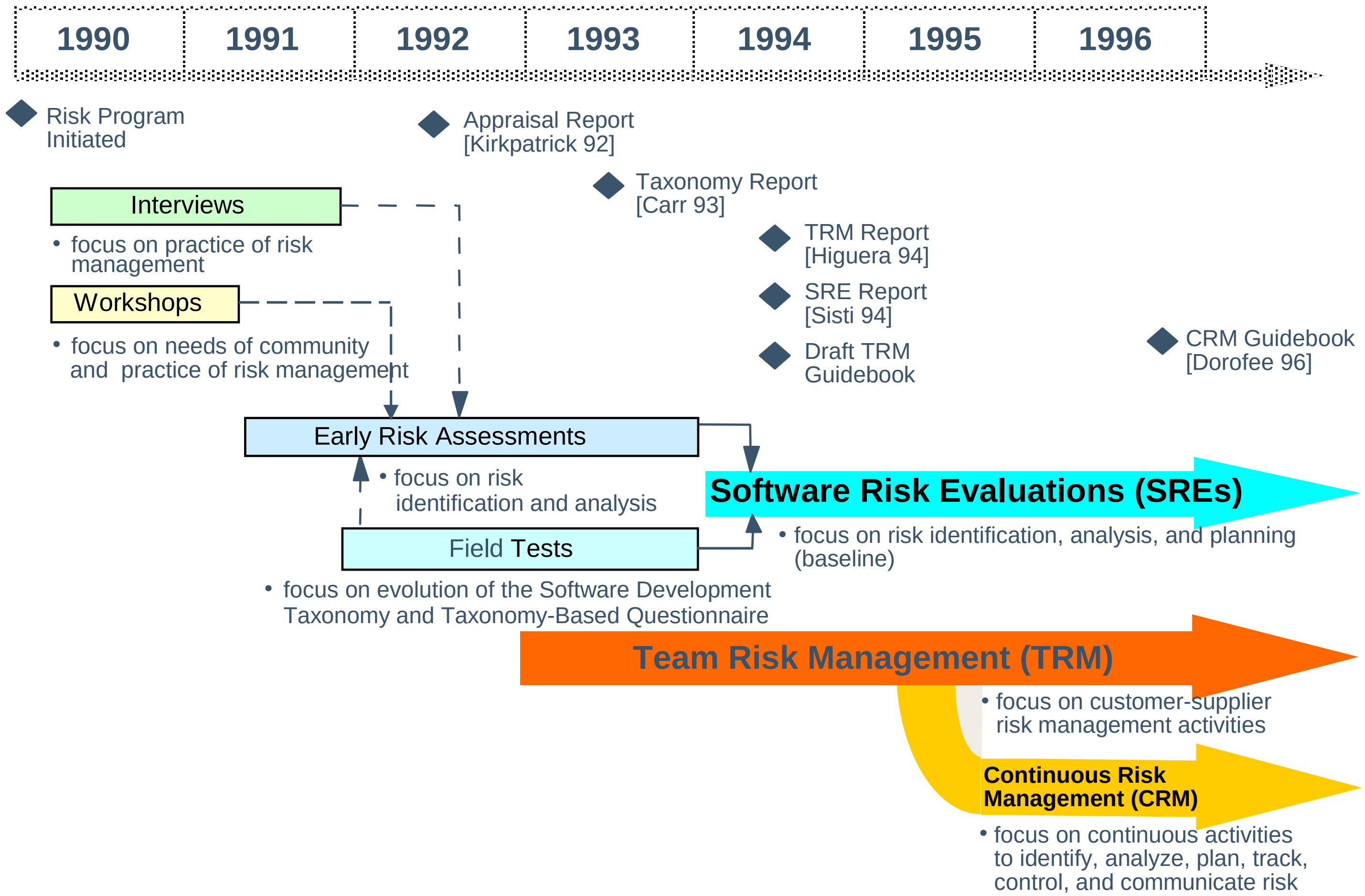
Director, Acquisition Support

Operational Risk

"By its nature, the uncertainty of war invariably involves the acceptance of risk...Because risk is often related to gain, leaders weigh risks against the benefits to be gained from an operation."

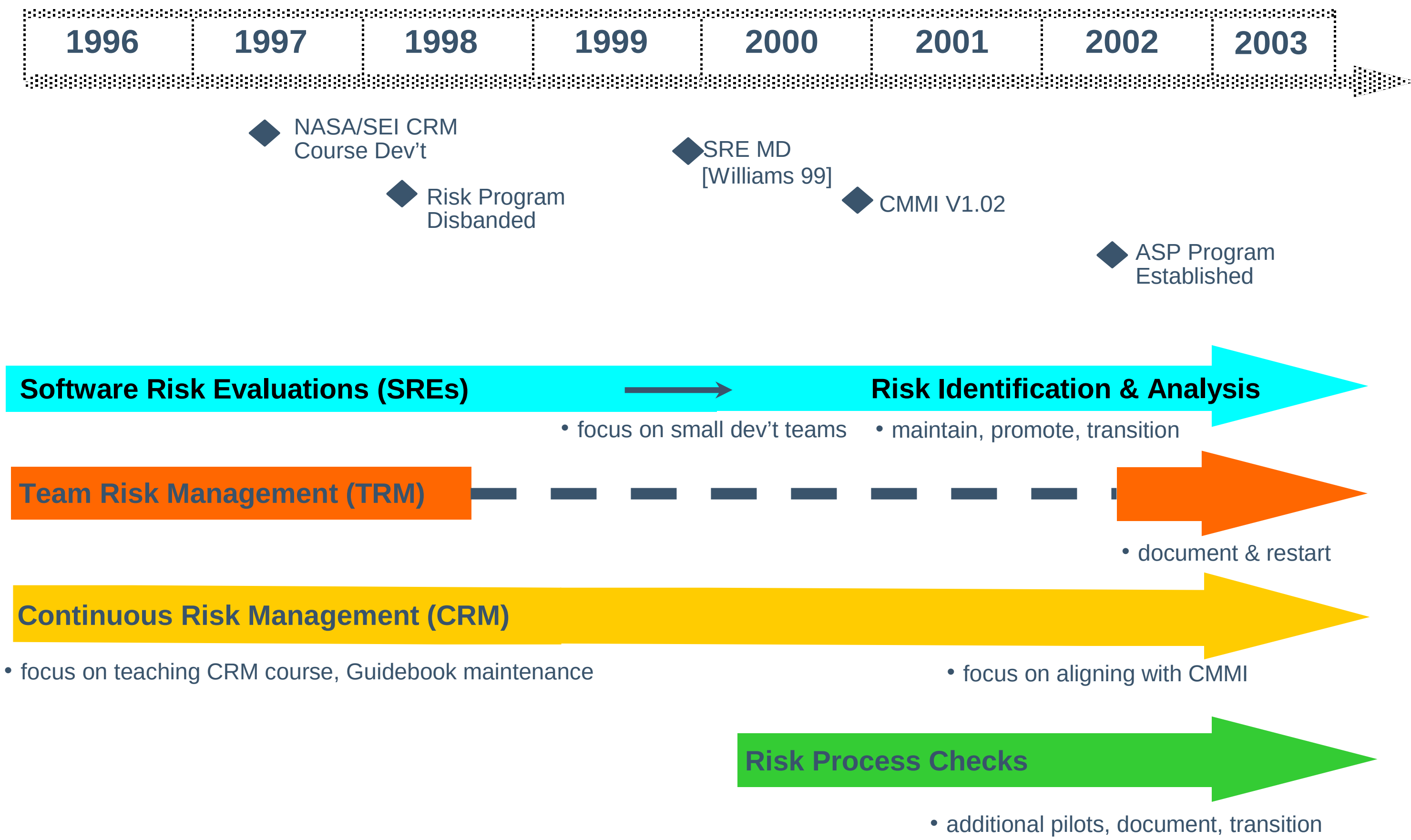
NDP-1 (Naval Warfare)

History of SEI Risk Management$_1$



Carnegie Mellon
Software Engineering Institute

History of SEI Risk Management$_2$



Key Aspects of Continuous Risk Management

Identify – Continually asking, “what could go wrong?”

Analyze – Continually asking, “which risks are most critical to mitigate?”

Plan – Developing mitigation approaches for the most critical risks

Track – Tracking the mitigation plan and the risk

Control – Making decisions based on data

Communicate – Ensuring a free-flow of information throughout the project

SEI's Risk Taxonomy

Developed in 1993 to help software-intensive system developers systematically identify risks

Used with the SEI's Software Risk Evaluation process or other risk identification techniques

Used as a "checklist" or expanded "radar screen" to ensure a greater number of potential risks are identified when doing on-going risk identification

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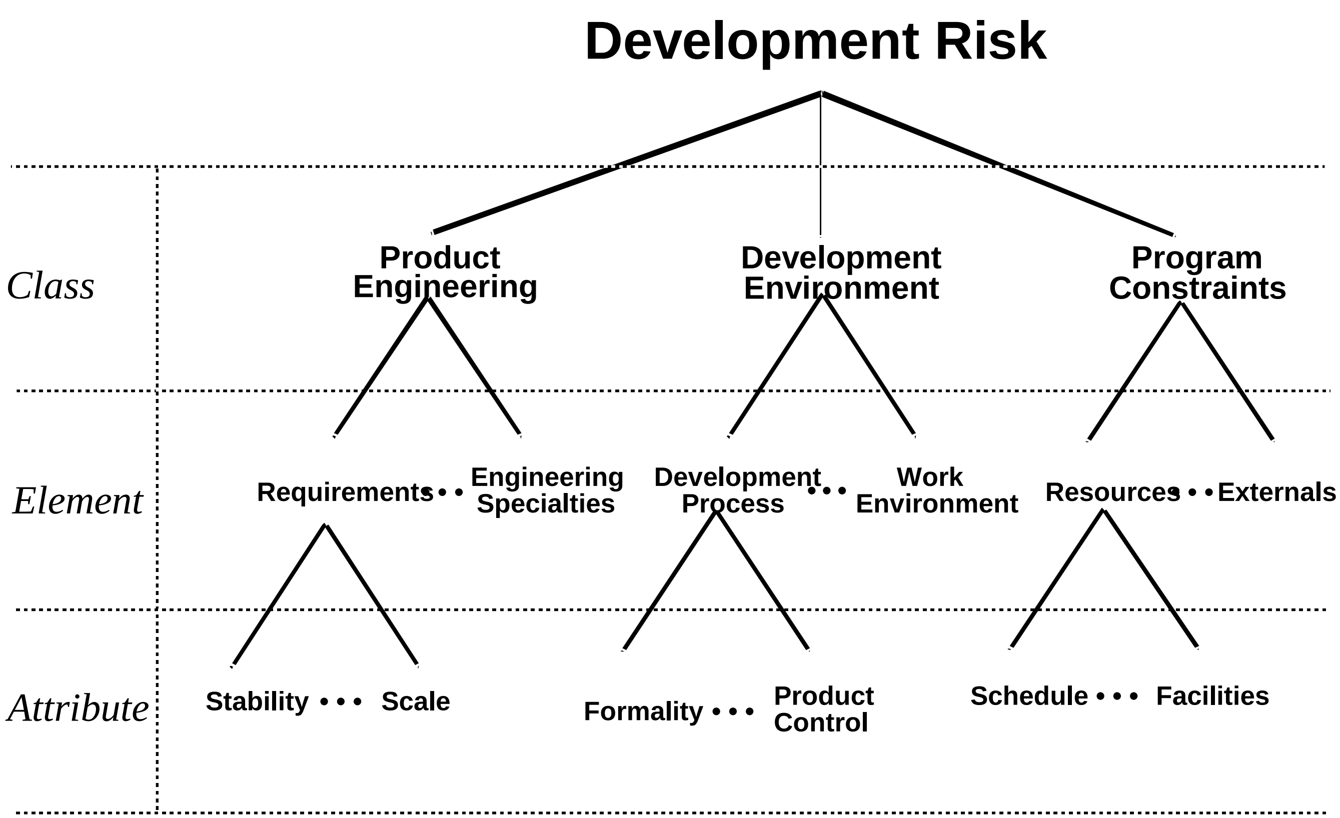
Taxonomy Structure



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Development Taxonomy

A. Product Engineering

1. Requirements
   - a. Stability
   - b. Completeness
   - c. Clarity
   - d. Validity
   - e. Feasibility
   - f. Precedent
   - g. Scale
2. Design
   - a. Functionality
   - b. Difficulty
   - c. Interfaces
   - d. Performance
   - e. Testability
   - f. Hardware Constraints
   - g. Non-Developmental Software
3. Code and Unit Test
   - a. Feasibility
   - b. Testing
   - c. Coding/Implementation
4. Integration and Test
   - a. Environment
   - b. Product
   - c. System
5. Engineering Specialties
   - a. Maintainability
   - b. Reliability
   - c. Safety
   - d. Security
   - e. Human Factors
   - f. Specifications

B. Development Environment

1. Development Process
   - a. Formality
   - b. Suitability
   - c. Process Control
   - d. Familiarity
   - e. Product Control
2. Development System
   - a. Capacity
   - b. Suitability
   - c. Usability
   - d. Familiarity
   - e. Reliability
   - f. System Support
   - g. Deliverability
3. Management Process
   - a. Planning
   - b. Project Organization
   - c. Management Experience
   - d. Program Interfaces
4. Management Methods
   - a. Monitoring
   - b. Personnel Management
   - c. Quality Assurance
   - d. Configuration Management
5. Work Environment
   - a. Quality Attitude
   - b. Cooperation
   - c. Communication
   - d. Morale

C. Program Constraints

1. Resources
   - a. Schedule
   - b. Staff
   - c. Budget
   - d. Facilities
2. Contract
   - a. Type of Contract
   - b. Restrictions
   - c. Dependencies
3. Program Interfaces
   - a. Customer
   - b. Associate Contractors
   - c. Subcontractors
   - d. Prime Contractor
   - e. Corporate Management
   - f. Vendors
   - g. Politics

Operational Organizations

An Operational organization is any group of individuals teamed together to carry out a mission.

Operational organizations consists of mission elements or teams that carry out mission requirements or subsets of requirements.

Requirements could come from external customers or from internal sources.

Examples

Examples of Operational organizations:

- military units
- educational institutions
- health care facilities
- fire and police units
- non-profit organizations

Task Defined

Operational organizations perform tasks to satisfy mission requirements.

Mission-essential tasks: A mission-essential task is any task that directly accomplishes mission requirements.

examples: flight operations, satellite control, mission management, etc.

Mission-support tasks: A mission-support task is any task that supports the accomplishment of mission requirements.

examples: spares replenishment, mission planning, new employee orientation, etc.

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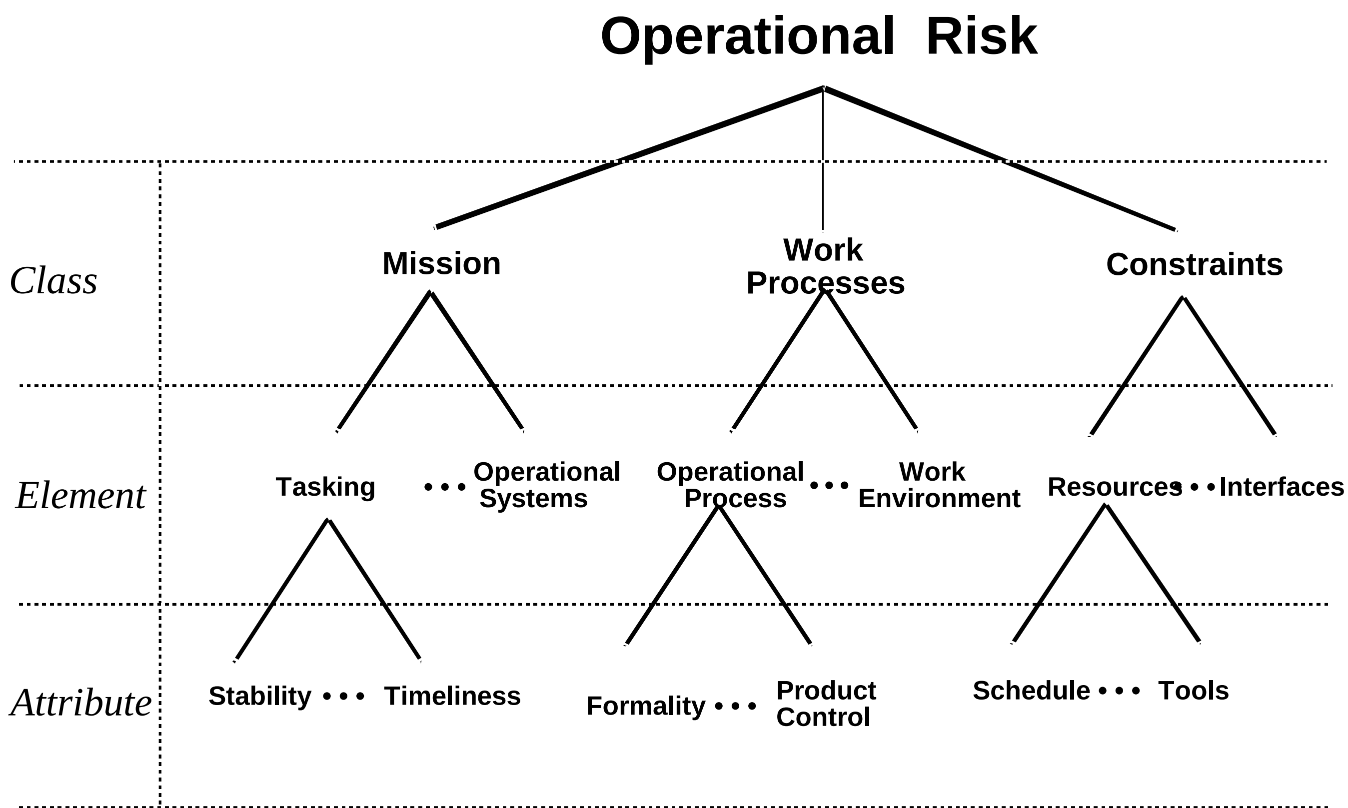
Identifying Operational Risks

When identifying risks in an operational environment, the Development Taxonomy doesn’t work well

- Operational personnel don’t do development per se
- Operational personnel don’t feel comfortable with the definitions in the original Taxonomy
- Operational personnel need systematic tools to help identify mission-related risks

Constructing an Operational Taxonomy



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Taxonomy of Operational Risks

A. Mission

1. Tasking, Orders and Plans
   - a. Stability
   - b. Completeness
   - c. Clarity
   - d. Validity
   - e. Feasibility
   - f. Precedent
   - g. Timeliness
2. Mission Execution
   - a. Efficiency
   - b. Effectiveness
   - c. Complexity
   - d. Timeliness
   - e. Safety
3. Product
   - a. Usability
   - b. Effectiveness
   - c. Timeliness
   - d. Accuracy
   - e. Correctness
4. Operational Systems
   - a. Throughput
   - b. Suitability
   - c. Usability
   - d. Familiarity
   - e. Reliability
   - f. Security
   - g. Inventory
   - h. Installations
   - i. System Support

B. Work Processes

1. Operational Processes
   - a. Formality
   - b. Suitability
   - c. Process Control
   - d. Familiarity
   - e. Product Quality
2. Maintenance Processes
   - a. Formality
   - b. Suitability
   - c. Process Control
   - d. Familiarity
   - e. Service Quality
3. Management Process
   - a. Planning
   - b. Organization
   - c. Management Experience
   - d. Program Interfaces
4. Management Methods
   - a. Monitoring
   - b. Personnel Management
   - c. Quality Assurance
   - d. Configuration Management
5. Work Environment
   - a. Quality Attitude
   - b. Cooperation
   - c. Communication
   - d. Morale

C. Constraints

1. Resources
   - a. Schedule
   - b. Staff
   - c. Budget
   - d. Facilities
   - e. Tools
2. Policies
   - a. Laws and Regulations
   - b. Restrictions
   - c. Contractual Constraints
3. Program Interfaces
   - a. Customers/User Community
   - b. Associate Agencies
   - c. Contractors
   - d. Senior Leadership
   - e. Vendors
   - f. Politics

http://www.sei.cmu.edu/publications/documents/05.reports/05tn036.html

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Example Class/Element/Attribute: Mission

A. Mission
In an operational environment, a *mission* is considered to be the primary reason for the existence of the operational organization. The mission consists of a set of defined tasks that produce a product or service for a customer. The mission could be defense intelligence operations, banking, retail sales, manufacturing, or a variety of other missions, including those performed by civil agencies.

The elements of the Mission class of operational risks cover traditional aspects of the mission, including planning, execution, and the products and services provided. Mission elements include attributes of the operational systems and the organizations that operate those systems.

1. Tasking, Orders, and Plans
The Tasking, Orders, and Plans element contains attributes that are used to characterize aspects of the information contained in the tasks, orders, and plans of an operational organization. These attributes also describe the ability of an operational system and the organization that operates it to respond to requests. The following attributes characterize the Tasking, Orders, and Plans element.

a. Stability
The Stability attribute refers to the frequency with which tasks, orders, or plans change and the effect this has on the operational organization. It can also refer to the organizations that submit tasks or orders to an organization for execution. This attribute also addresses the flexibility of the operational entity in responding to changing tasks, orders, and plans and to handling multiple sources of tasks, orders, and plans.

A “Short” Taxonomy-based Questionnaire

A. Mission

Consider risks to the operation that can arise because of the nature of the mission that your organization is trying to accomplish.

1. **Tasking, Orders, and Plans**

Question: Are there risks that could arise from the way the mission is tasked, orders are provided, or operational plans developed? Examples:

a. Stability
b. Completeness
c. Clarity
d. Validity
e. Feasibility
f. Precedent
g. Timeliness

Using the Taxonomy of Operational Risks

The Taxonomy can be used:

- to establish a baseline set of operational risks
- to perform ongoing operational risk identification
- to help identify weaknesses in current operational capabilities and to help establish new statements of operational need
- when working with acquisition or development organizations to identify the operational risks associated with accepting new systems into operational use
- to participate with acquisition or development organizations using Team Risk Management techniques

Example: System Acceptance Risks

Context:

A military unit is responsible for operating satellite systems. An acquisition organization is acquiring a replacement system to consolidate operations at one location and upgrade the hardware and software to prepare for future acceptance of new satellite systems.

The program was late, and tension between the operators, the acquirers, and the developers was high.

The SEI participated in a risk assessment using the SRE process and the Taxonomy of Operational Risks at the operational facility to help identify risks of accepting the new system and to uncover any root causes of the program delays.

During the two-day risk identification and analysis activities, stakeholders from the operational squadron, operational test personnel, Contractor Logistics Support (CLS), and site management wrote seventy (70) risk statements over the course of four interview sessions.

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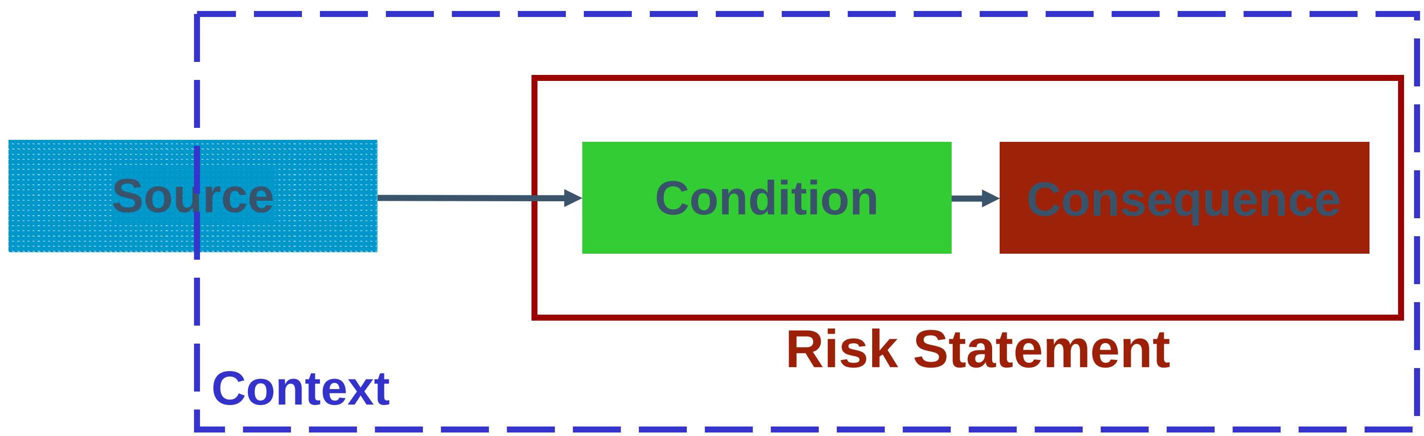
The Risk Statement

A “standard” format for risk statements provides:
- clarity
- consistency
- a basis for future risk processing



A good Risk Statement is
- ✓ fact-based
- ✓ actionable
- ✓ brief

Example Risk Statements

ORD does not levy requirements at the level of capability of legacy systems; system will be less capable, loss is visible at general officer level

Loss of key technical experts (significant attribution); loss of continuity

Positive "spin" put on info going up the chain; expectation mismatch

Roles and responsibilities not defined under this implementation of TSPR. (Insight vs. Oversight); Confusion, delays, who's responsible, who's leading

There is no official program schedule; Can't plan. Can't determine when to move personnel (out-year O&M and personnel costs)

Test resources at the factory are currently insufficient; Late discovery of problems

Training suite is sub-optimal, does not meet expectations or requirements, cannot perform integrated crew training; Will force training and evaluation on OPS floor

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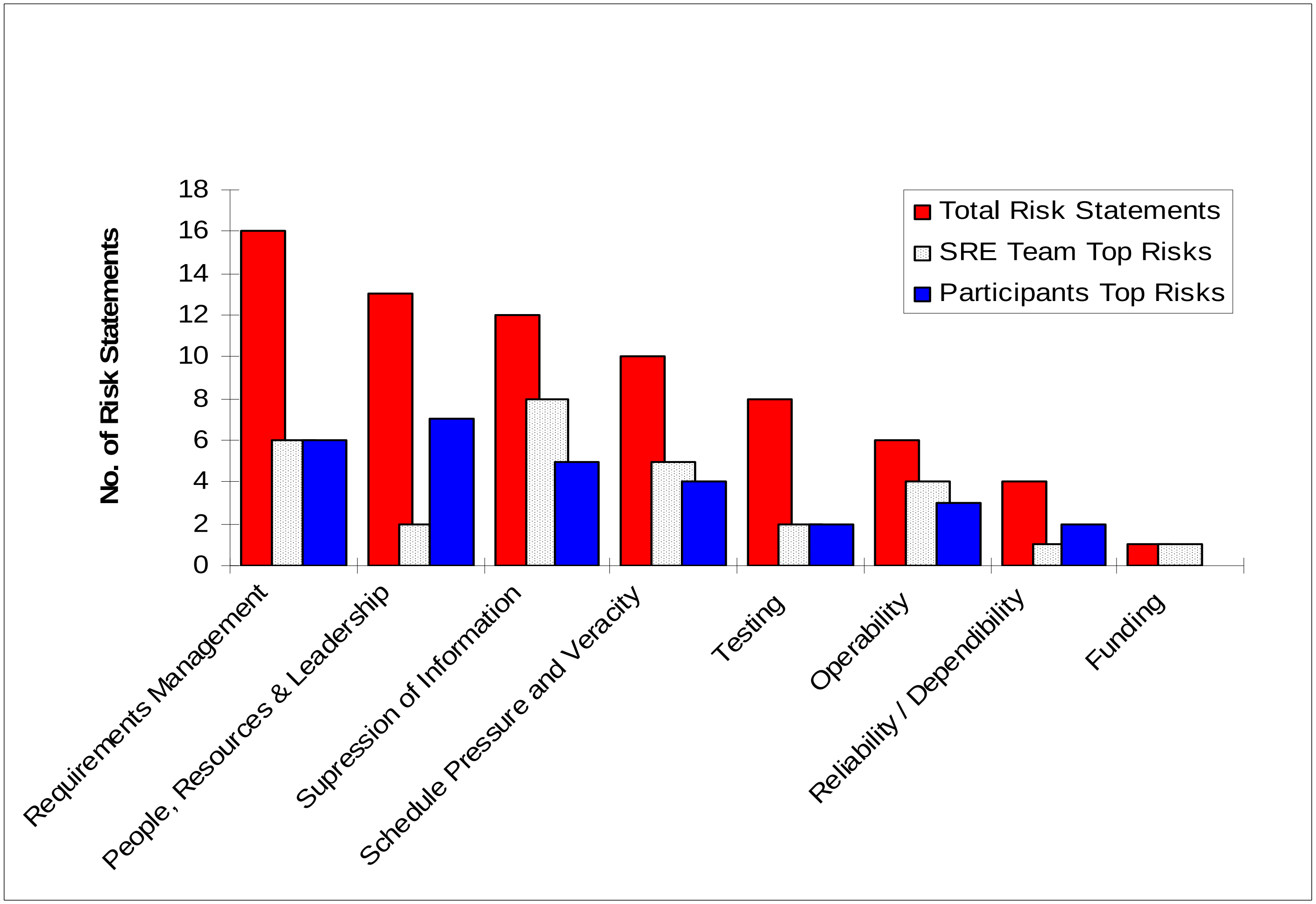
Risk Areas Identified



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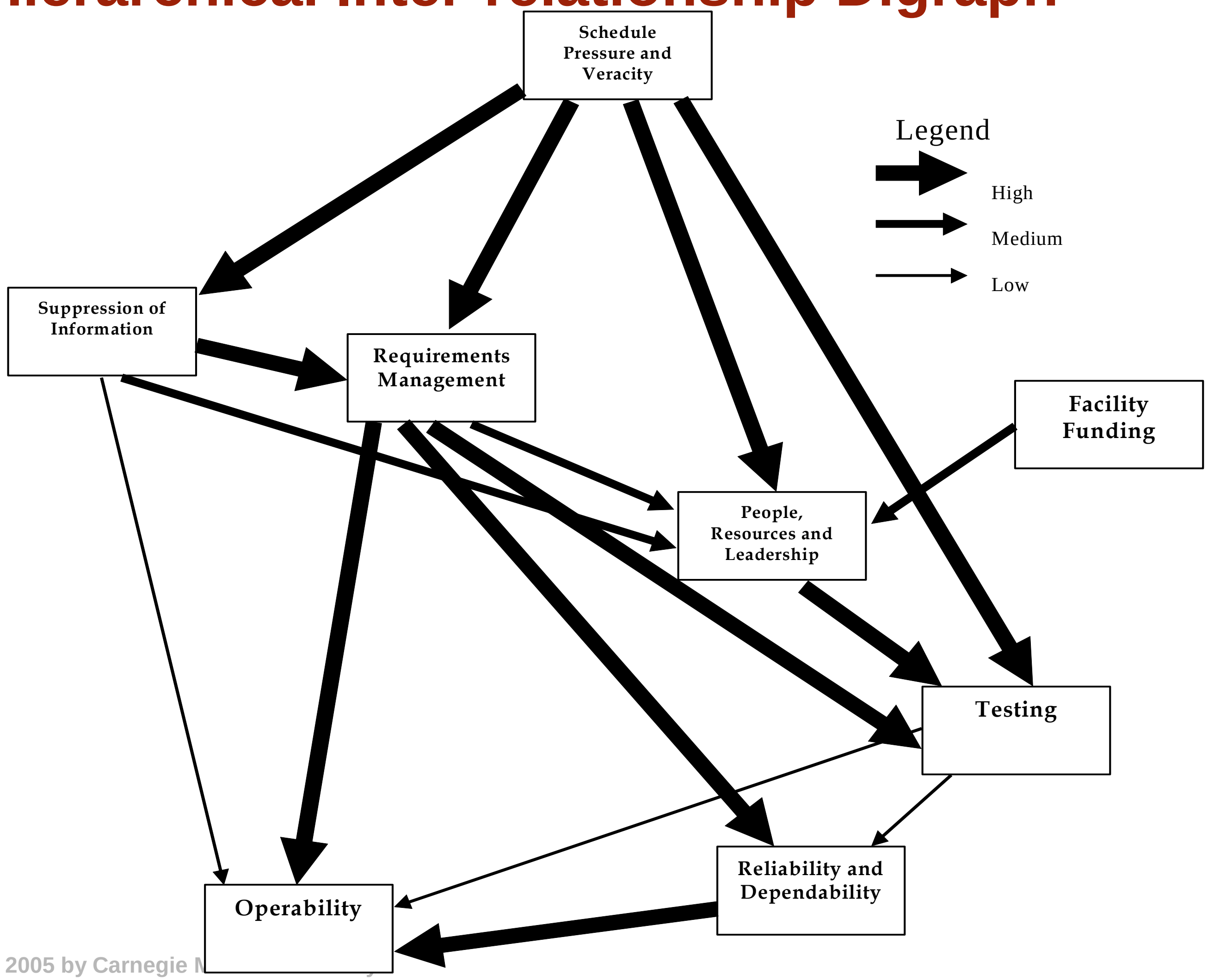
Hierarchical Inter-relationship Digraph



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Outcome

Risk assessments were also done at the developer's location using the development taxonomy and at acquirer's location using the SA-CMM as a "taxonomy" to get their unique perspectives

With all three perspectives, the team was able to make informed recommendations back to the PEO

Program was restructured

Team Risk Management

Team Risk Management (TRM) builds on healthy and active risk practices within diverse organizations, or organizational entities, teamed together for a common purpose.

TRM works to aid decision making in supplier-acquirer relationships.

Adding the end-user, or operator, TRM is the ideal method of managing risk during new system development.

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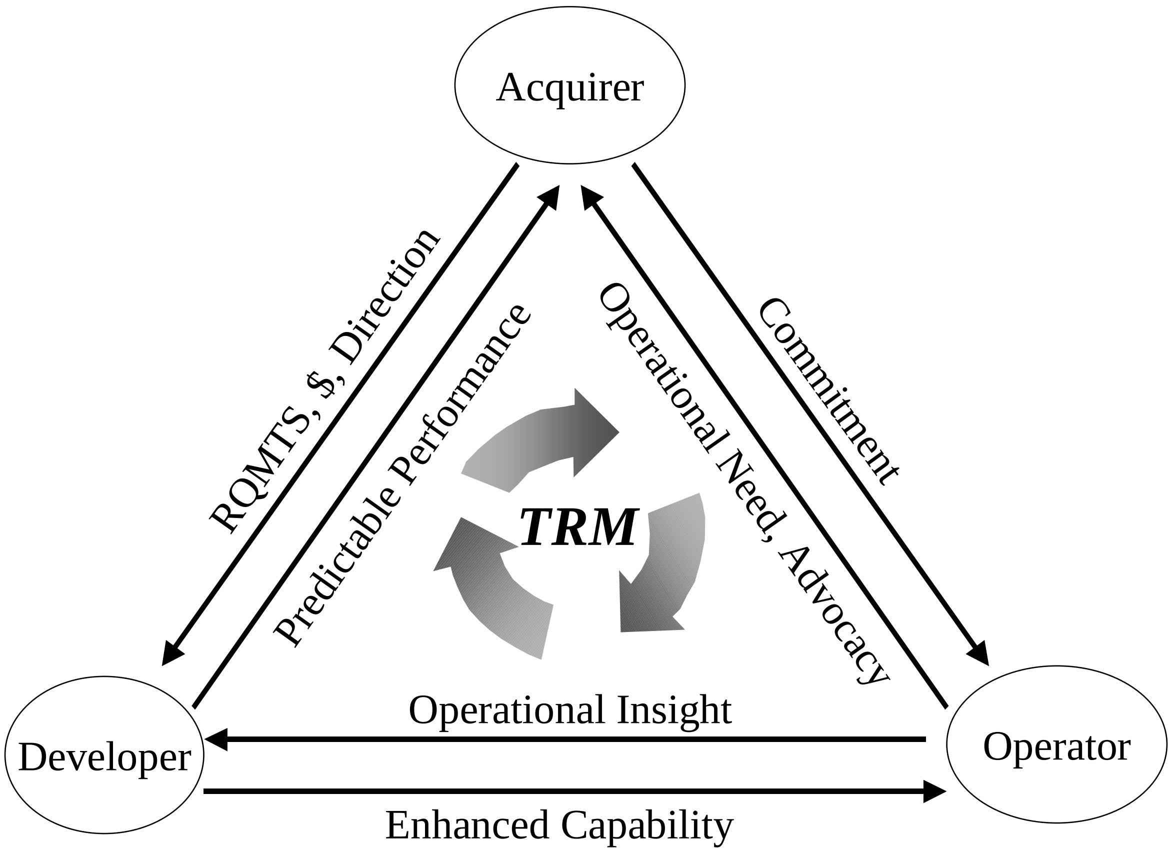
TRM “Vision”



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Conclusions

New systems or capabilities delivered to operational forces should mitigate operational risk.

Using a structured Taxonomy to help identify operational risk increases the likelihood of delivering usable systems or capabilities into operational use.

Contact Information

Brian Gallagher
Director, Acquisition Support Program
412-268-7157
bg@sei.cmu.edu

Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213-3890

References

A Taxonomy of Operational Risks (CMU/SEI-2005-TN-36). Gallagher, Brian P.; Case, Pamela J.; Creel, Rita C.; Kushner, Susan; Williams, Ray C. Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University, 2005.
http://www.sei.cmu.edu/publications/documents/05.reports/05tn036.html

Taxonomy-Based Risk Identification (CMU/SEI-93-TR-006, ADA266992). Carr, Marvin J.; Konda, Surish L.; Monarch, Ira; Ulrich, F. Carol; & Walker, Clay F. Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University, 1993.
http://www.sei.cmu.edu/publications/documents/93.reports/93.tr.006.html

Continuous Risk Management Guidebook. Murphy, Richard L.; Alberts, Christopher J.; Williams, Ray C.;Higuera, Ronald P.; Dorofee, Audrey J.; Walker Julie A. Pittsburgh, PA: Carnegie Mellon University, 1996.
http://www.sei.cmu.edu/publications/books/other-books/crm.guidebk.html

Software Risk Evaluation (SRE) Method Description (Version 2.0) (CMU/SEI-99-TR-029, ADA001008). Williams, Ray C.; Pandelios, George J.; & Behrens, Sandra G. Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University, 1999.
http://www.sei.cmu.edu/publications/documents/99.reports/99tr029/99tr029abstract.html

WBS-Based Approach to Understanding and Predicting Program Risk

Presented By:

Bruce M. Heim
Program Integrator, DCMA

Agenda

- History
- Process Overview
- Data Analysis & Risk Inputs
- Documenting & Reporting
- Future Development

Defense Contract Management Agency

History

History

- Early 2003
  - ➢ Concept / Goal: Assess risk in language meaningful to customer.
  - ➢ Provide lower level visibility than Customer has into the program
  - ➢ Researched various Risk methodologies
- Sept - Dec 2003
  - ➢ Initial methodology presented to PST
  - ➢ PST jointly refined the process/methodology
  - ➢ Notional data used to test risk tool & determine feasibility of process
- Jan 2004 – Dec 2004
  - ➢ January - Process baseline established
  - ➢ Real data used
  - ➢ Established process is viable
  - ➢ Identified opportunities for improvement
- 2005
  - ➢ Break Cost/Technical/Schedule risk out separately
  - ➢ Incorporate consequence factor into ratings

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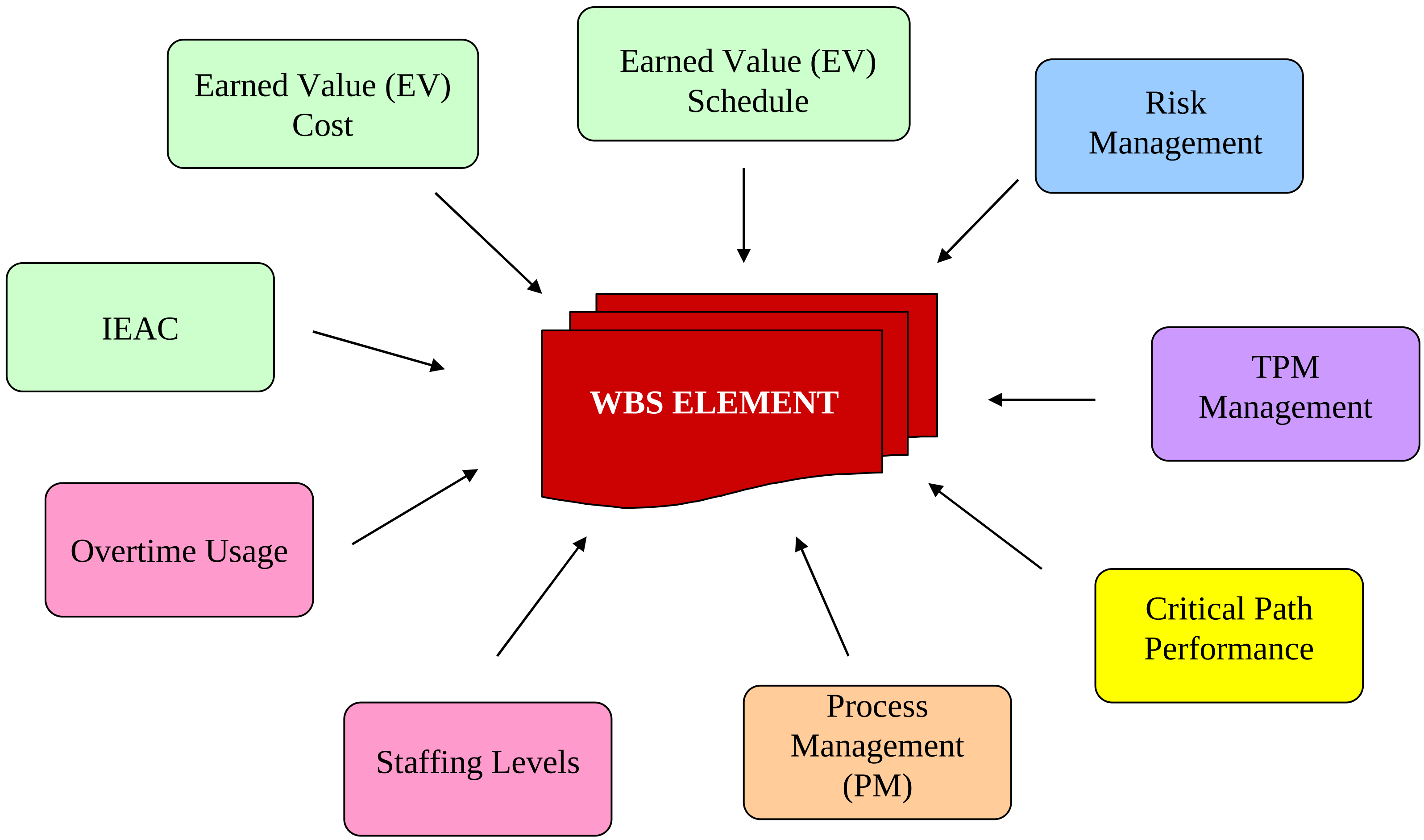
Process Overview

Process Overview

- Work Scope Centric
  - ➢ WBS Element is evaluated
- Risk is assessed at Level 4
  - ➢ Performance Based Evaluation
  - ➢ Provides insight to lower level activity
  - ➢ Increases fidelity when rolled up to higher levels
- Common Categories & Criteria used
- Goal of process is to determine the likelihood of the WBS element work scope being successfully completed
  - ➢ On Schedule
  - ➢ On cost
  - ➢ Meets technical requirements
  - ➢ Predict future performance / risk

Process Overview



Integrating data at the lower level

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Performance Factors / Criteria

FACTOR	DESCRIPTION	RATING CRITERIA
EVM-C	CPI performance	No variance = 1 Variance < 3% = 2 Variance 3 <7% = 3 Variance 7< 10% = 4 Variance > 10% = 5
EVM-S	SPI performance	No variance = 1 Variance < 3% = 2 Variance 3 <7% = 3 Variance 7 < 10% = 4 Variance > 10% = 5
EVM-EAC	BAC vs. DCMA IEAC	No variance = 1 Variance < 5% = 2 Variance 5 < 10% = 3 Variance 10 < 15% = 4 Variance > 15% = 5
CP	How well is the item performing relative to the Critical Path?	Not on Critical Path = 1 On Critical Path, able to meet key milestones = 2 Minor (< 1 wk) slip in key milestone = 3 Major (> 1 wk or multiple minor) slip in key milestone = 4 Cannot meet major milestone = 5
RK	How well is the contractor managing the identified risks?	All Mitigation events completed as planned = 1 Minor slip (< 1 wk) in mitigation event completion = 2 Major slip (> 1 wk) in mitigation event completion = 3 Multiple Minor or Major slips in mitigation event completion = 4 Risk events cannot be completed, or not planned = 5

Performance Factors / Criteria (cont.)

FACTOR	DESCRIPTION	RATING CRITERIA
PR	How are the processes performing?	Continues improvement / analysis of metrics used = 1 Processes are managed by metrics = 2 Defined process / Documented standards used = 3 Process management based on experience = 4 Lack of processes/processes uncontrolled = 5
TPM/PPM	How well are the measures performing relative to the Spec requirements or thresholds. ?	TPM will be met = 1 Acceptable with some reduction in margin = 2 Acceptable with significant reduction in margin = 3 Acceptable, no remaining margin = 4 Unacceptable = 5
ST	Staffing: Percent Under-manned	On plan = 1 Total < 3% = 2 Total 3 < 7% = 3 Total 7 < 10% = 4 Total > 10% = 5
OT	Amount of Overtime usage	No Overtime = 1 Total < 3% = 2 Total 3 < 7% = 3 Total 7 < 10% = 4 Total > 10% = 5

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Consequence Factors / Criteria

Performance	Schedule	Cost	Rating
Minimal or No Impact	Minimal or No Impact	Minimal or No Impact	1
Acceptable with some reduction in margin	Able to meet key dates	Budget increase or unit cost increase <5%	2
Acceptable with significant reduction in margin	Minor slip in key milestone; not able to meet key dates	Budget increase or unit cost increase 5-7%	3
Acceptable, no remaining margin	Major slip in key milestone or critical path impacted	Budget increase or unit cost increase >7-10%	4
Unacceptable	Cannot meet major milestone(s)	Budget increase or unit production cost increase >10%	5

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Risk Level Definitions

Risk Range	Risk of Failure	Definition
21 - 25	Near Certainty	➢WBS element will not be successfully completed. ➢Severe Cost overruns: CV >1 0% and/or ➢Severe Schedule slippage: SV > 10%. ➢Slip to Level I milestones ➢Will not meet technical requirements (SOW) ➢Completing QA Findings, Schedule & Corrective Actions ≥ 60 days
16 - 20	Highly Likely	➢WBS element will probably not be successful. ➢Cost overruns: 7% < CV > 10% and/or ➢Schedule slippages: 7% < CV > 10% ➢Slip to Level II Milestones ➢May not meet all technical requirements (SOW) ➢Completing QA Findings, Schedule & Corrective Actions Late < 60 days
11 - 15	Likely	➢WBS element may not be successful. ➢Cost overruns: 3% < CV > 7% and/or ➢Schedule slippages: 3% < CV > 7% ➢Slip to Level III Milestones ➢Will probably meet technical requirements. (SOW) ➢Completing QA Findings, Schedule & Corrective Actions Late < 45 days
6 - 10	Unlikely	➢WBS element will probably be successful. ➢Cost overruns: < 3% and/or ➢Schedule slippages: < 3% CV ➢Loss of more then one month schedule margin. ➢Technical requirements met. (SOW) ➢Completing QA Findings, Schedule & Corrective Actions Late < 30 days
1 - 5	Improbable	➢WBS element will be successful. ➢On cost, on schedule (no variance) ➢Meets all technical requirements. (SOW) ➢Completing QA Findings, Schedule & Corrective Actions on time

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Data Analysis and Risk Inputs

PST Assessment

- Assessment is done monthly
  - Each PST member is assigned specific WBS elements
  - PST member use the factors as an outline when writing monthly inputs
  - Provide an integrated picture of element performance
- Continuously monitor all WBS elements
  - Provide early warning of changing risk
  - Risk metrics tracked over a period of time (better, worse, staying the same)
- Predictive Analysis
  - Predict factor ratings for next 3 months
  - Track element performance over period of time
    - Is performance/risk improving, getting worse, or staying the same?
    - Relative to Milestone events
- Discuss cross-IPT impacts in PST Meetings

PST Assessment

- Top 10 risk elements are tracked
  - These items will warrant closer and/or additional surveillance
    - Resource Focus
  - PST helps mitigate the risk and ensure the program office/end user is fully aware of the impacts to the program and make recommendations to the customer for options they may use.
- Tool provides a Quick Look
  - Where the risk is on the program.
  - What are the factors driving the risk

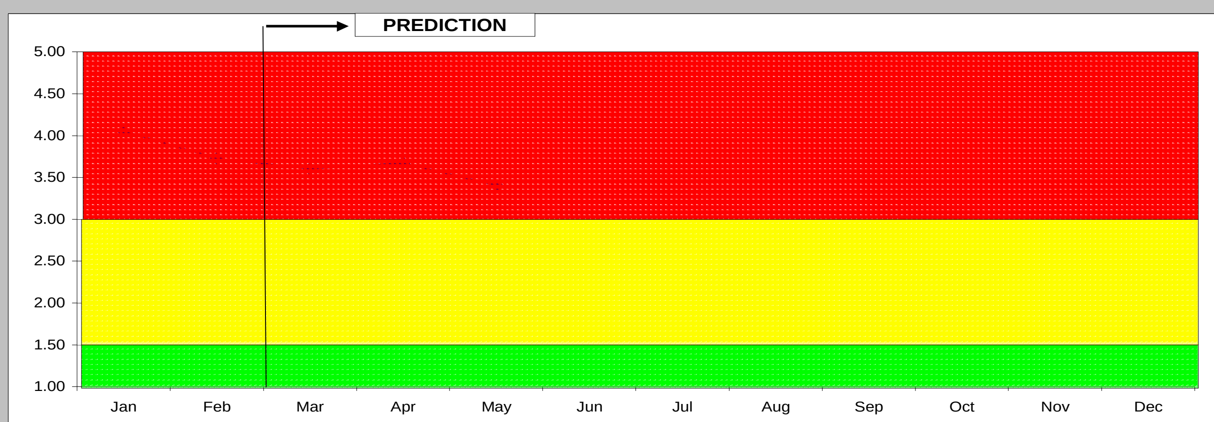
Old Process

- Process used up to May 2005.
- Consequence was not included in ratings. Consequence was interpreted via the PST members analysis.
- Attempted to incorporate Supplier Risk/Performance
  - Approach used (rating Suppliers separately) was not entirely successful.
- Roll up to program level done along WBS lines
  - Resulted in “masking” of lower level risks
  - Created a misconception of actual risk

Level 4 Risk Example (Old Process)

WBS Element: 1.1.2.4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EVM-C	3	3	3	3	4							
EVM-S	2	2	2	3	4							
CP	5	5	5	5	5							
RK	5	5	5	5	5							
PR	2	2	2	2	2							
TPM	3	3	3	3	3							
ST	2	3	3	3	3							
OT	3	3	3	3	3							
EVM-EAC	5	5	5	5	5							
WR	3	3	5	5	5							
Boeing	3.35	3.45	3.45	3.60	3.90							
Supplier 1	5.00	5.00	5.00	5.00	3.00							
Supplier 2	5.00	4.00	3.50	3.50	3.50							
Supplier 3	5.00	5.00	4.50	4.50	4.50							
Supplier 4	5.00	2.50	3.00	3.00	3.00							
Supplier 5	4.00	3.00	2.50	2.50	2.50							
Risk Factor	**4.06**	**3.73**	**3.60**	**3.67**	**3.41**							



Note: This is Notional data.

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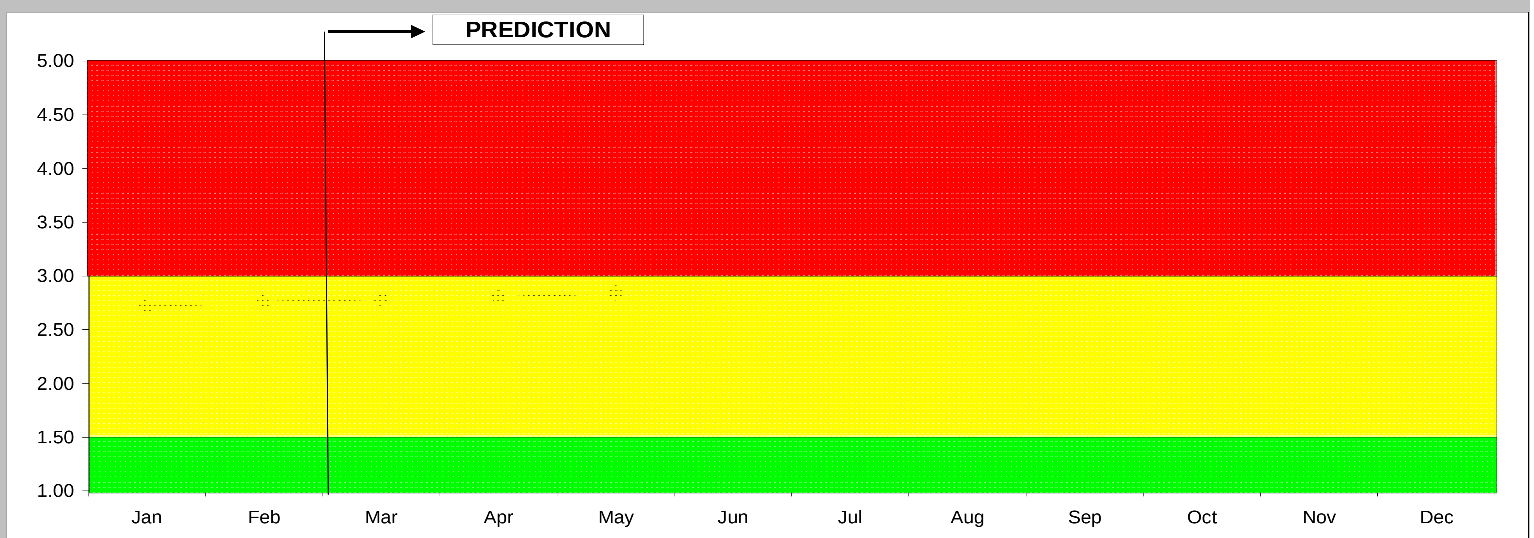
Risk Roll-up Example (old Process)

WBS Element: 1.0

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.1	2.70	2.84	2.95	2.96	3.04							
1.2	2.70	2.55	2.55	2.60	2.60							
1.3	1.79	1.76	1.74	1.76	1.83							
1.4	3.20	3.20	2.95	2.90	2.90							
Risk Factor	**2.71**	**2.76**	**2.79**	**2.80**	**2.84**							



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New Process

- Tool calculates Risk based on Performance inputs and consequence inputs
  - Cost is based on EVM-C, EVM-EAC and Staffing factors
  - Schedule is based on EVM-S, Critical Path, and Overtime factors
  - Technical is based on TPM, Risk Management, and Process Management
- Supplier performance is now assessed as an integral part of program level performance
- For each category, the tool takes the average of the 3 inputs and multiplies by the Consequence to arrive at the overall risk for each element.
  - Overall risk factor is rated against the Risk Level Ratings/Definitions
- Roll-up of Risk to the Program Level is now done relative to the End Product delivered to the Customer

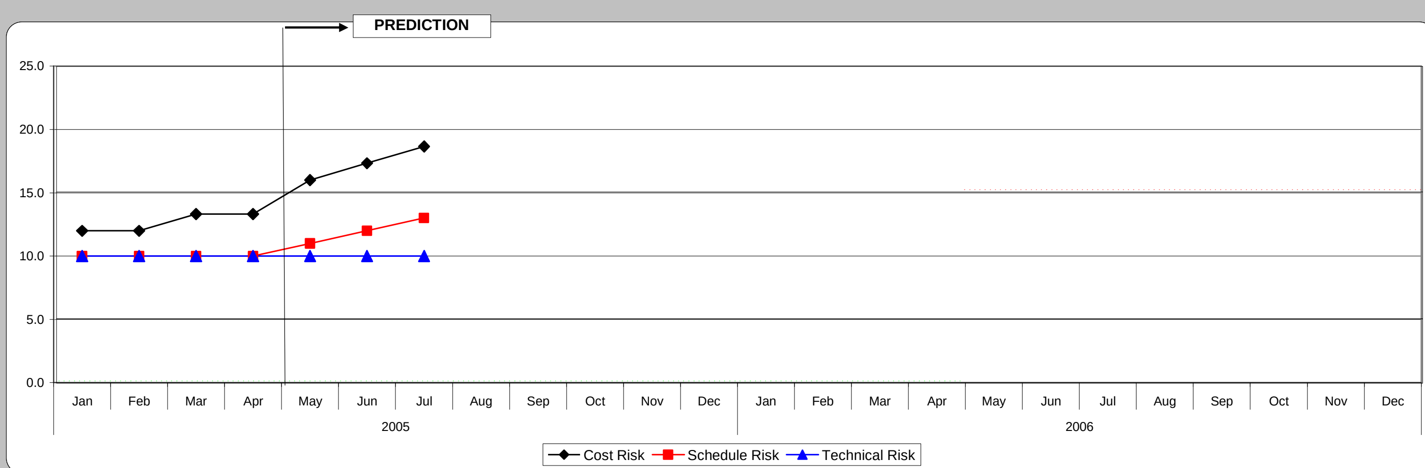
New Process (cont.)

- Roll-up is done relative to 8 groupings
  - Air Vehicle – Product
  - Air Vehicle – Non Product
  - Integration facilities
  - Program Management
  - Test & Eval
  - Production
  - Training
  - Logistics
- **Each group has a Cost, Schedule & Technical Category**
  - Each group is individually weighted (relative to 100%) in each category

Level 4 Risk Example (New Process)

WBS Element: 1.2.3.4

	2005												2006											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EVM-C	3	3	3	3	4	4	5																	
EVM-EAC	4	4	4	4	4	5	5																	
OT	2	2	3	3	4	4	4																	
Consequence	4	4	4	4	4	4	4																	
Cost Risk	**12.0**	**12.0**	**13.3**	**13.3**	**16.0**	**17.3**	**18.7**																	
EVM-S	4	4	4	4	4	4	5																	
CP	3	3	3	3	4	5	5																	
ST	3	3	3	3	3	3	3																	
Consequence	3	3	3	3	3	3	3																	
Schedule Risk	**10.0**	**10.0**	**10.0**	**10.0**	**11.0**	**12.0**	**13.0**																	
RK	2	2	2	2	2	2	2																	
PR	3	3	3	3	3	3	3																	
TPM	1	1	1	1	1	1	1																	
Consequence	5	5	5	5	5	5	5																	
Technical Risk	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**																	

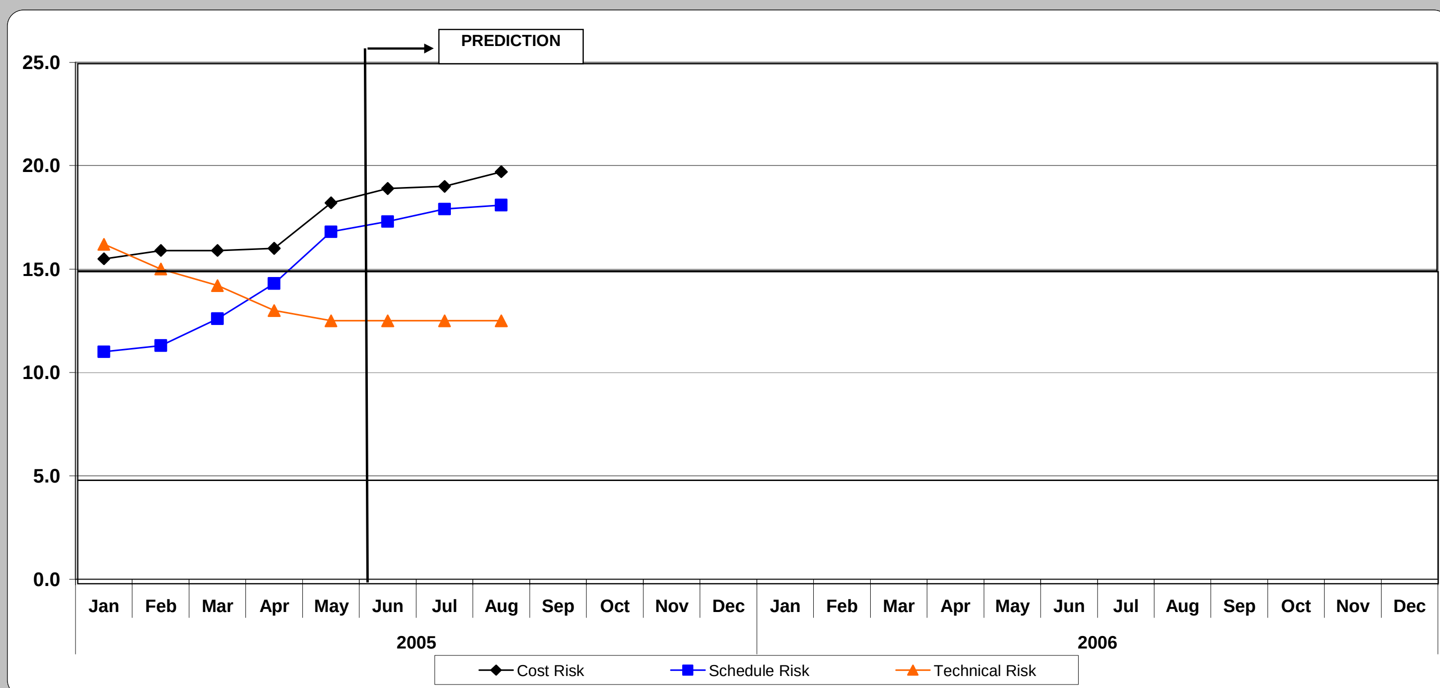


Note: This is Notional data.

Risk Roll-up Example (New Process)

Program "X"

	2005												2006											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cost Risk	15.5	15.9	15.9	16.0	18.2	18.9	19.0	19.7																
Schedule Risk	11.0	11.3	12.6	14.3	16.8	17.3	17.9	18.1																
Technical Risk	16.2	15.0	14.2	13.0	12.5	12.5	12.5	12.5																



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Documenting & Reporting

Documenting & Reporting

- Risk Tool provides a running metric on element risk
- Monthly Report
  - Narrative provided in Monthly Report to the customer
    - ❑ What are the factors driving risk in the WBS element
    - ❑ DCMA independent assessment of program performance
    - ❑ What are the real/potential impacts to the element
    - ❑ What actions are DCMA taking?
- DCMA Program Review (DPR)
  - WebEx session with all customers
  - Supporting DCMA offices/PSTs are tied in as well
  - Provide DCMA's independent assessment of program performance / risk
  - Forum for customer to ask questions pertaining to our assessment

DCMA
Defense Contract Management Agency

Future Development

Future Development

- Other factors under consideration
  - Technology Maturity Level
  - Complexity Factors
  - CMMI
  - Other Earned Value Metrics
  - Quality Measurements

Future Development (cont.)

- Alternative Risk Tool Formula
  - Are other calculations more appropriate?
    - Cost & Schedule relationship
    - Staffing & Overtime relationship
    - Example: (EVC*EVS)+CP+RK+PBM+TPM+(OT/ST)
- Develop additional risk metrics
- Continuously Refine Risk Definitions
- Convert Tool to Database Design

Headquarters U.S. Air Force

I n t e g r i t y - S e r v i c e - E x c e l l e n c e

USAF Systems Engineering Initiatives

NDIA 8th Annual
Systems Engineering Conference
San Diego, CA
25 October 2005

Mr. Terry Jaggers, SES
Deputy Assistant Secretary
(Science, Technology, and Engineering)

U.S. AIR FORCE

U.S. AIR FORCE

Technical Vision Framework

Air Force Technical Enterprise

SAF/AQR Focus Areas

Programs	Policy	Processes	People
• ASPs • MS Reviews • SSACs • TAG Teams	• SE AFI • SoS Engineer • System Safety • OSS&E • Acq Logistics • Architecture • HSI	• Tech Leaders' Roundtable • Value Models • TRAs • SEPs • MRAs	• Tech Asset Visibility • AFIT • SEAC • DTs • Recruitment & Retention

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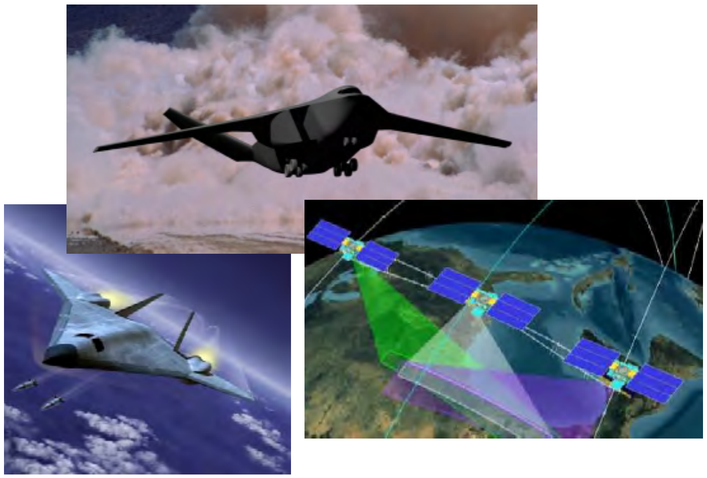
Technical Advisor to SAE



- ***Address credibility of AF acquisition***
- ***Provide distinct and separate technical voice at the table during SAE and Milestone reviews***
- ***Bring to bear the power of the larger AF technical community to identify and manage risk during acquisition***
- ***Connect practical program support to develop better technical policy***

- Created Tech Advisor Concept of Operations (CONOPS)
- Staffing and training new branch in SAF/AQRE to manage effort
- Created ties to EN and S&T communities to form high-performance "Technical Advisory Groups" to support major reviews
- Establishing career-broadening positions to grow tech workforce

Putting the "AQ" back into SAF/AQR

A Telling Statement?

"The only reason we in OSD are doing 'Deep Dive' technical reviews with your programs is because you [AF] aren't ..."

– OUSD (AT&L)

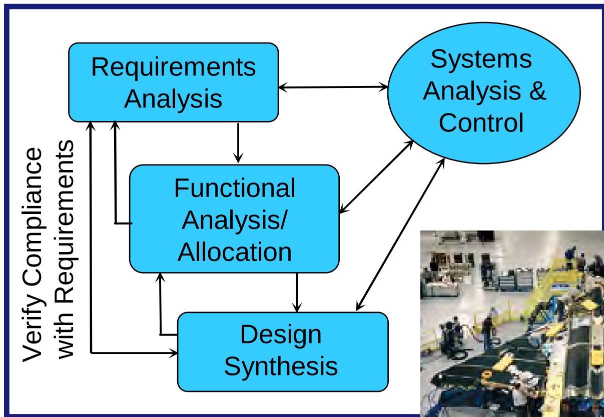
Restore USAF Credibility and Ensure Relevance

Technical Advisor Groups

- Augment in-house team as needed for additional expertise on specific technical issues to:
  - SAF/AQR S&T PEMs and engineering staff
  - AFMC Staff or Center ENs
  - AFRL Staff or Technical Directorates
  - Other organizations (*e.g.*, AFSTB, other Services)
- Appointed in consultation with AF Tech Leaders (AFMC/EN, AFRL/ST, etc.)
- May be called upon to support "Deep Dives" with programs, PEO reviews, and/or SAE reviews
  - Serve from appointment thru hot wash
  - Document lessons learned for feedback to AQR, PEO, SAE
- Use in conjunction with AQ Functional Management to broaden technical workforce and grow technical leaders

AF Engineering Vision & Leadership

U.S. AIR FORCE



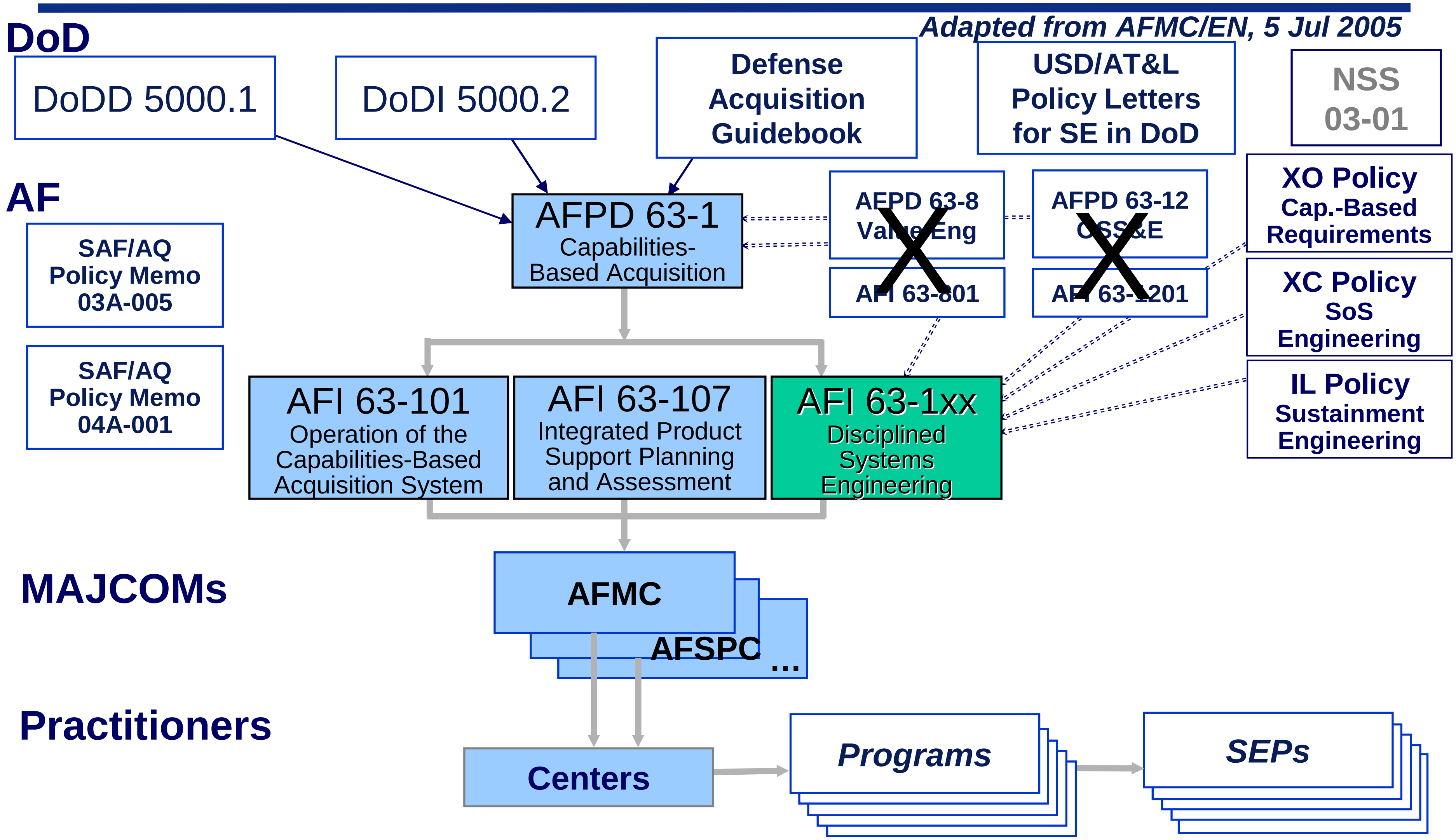
- *Provide a single AF voice to OSD on engineering and technical matters*
- *Unify proven AF engineering and technical methodologies across space and non-space efforts*
- *Resurrect systems engineering policy and re-institutionalize for AF*
- *Craft an achievable engineering vision to address architecture / systems-of-systems complexities*

- **Shifted roles and responsibilities for SE policy from SAF/ACE to SAF/AQR**
- **Established Technical Leaders' Roundtable for AF Technical Leaders to unite and caucus on engineering/technical vision**
- **Drafting new SE AFI to incorporate proven SE practices, new architecture/ SoSE vision, and space/non-space issues**
- **Leveraging experiences in Technical Advisor role to establish lessons learned from each acquisition review to roll into SE and technical policies**

Leading and Unifying AF Engineering Efforts

U.S. AIR FORCE

AF SE Policy Development



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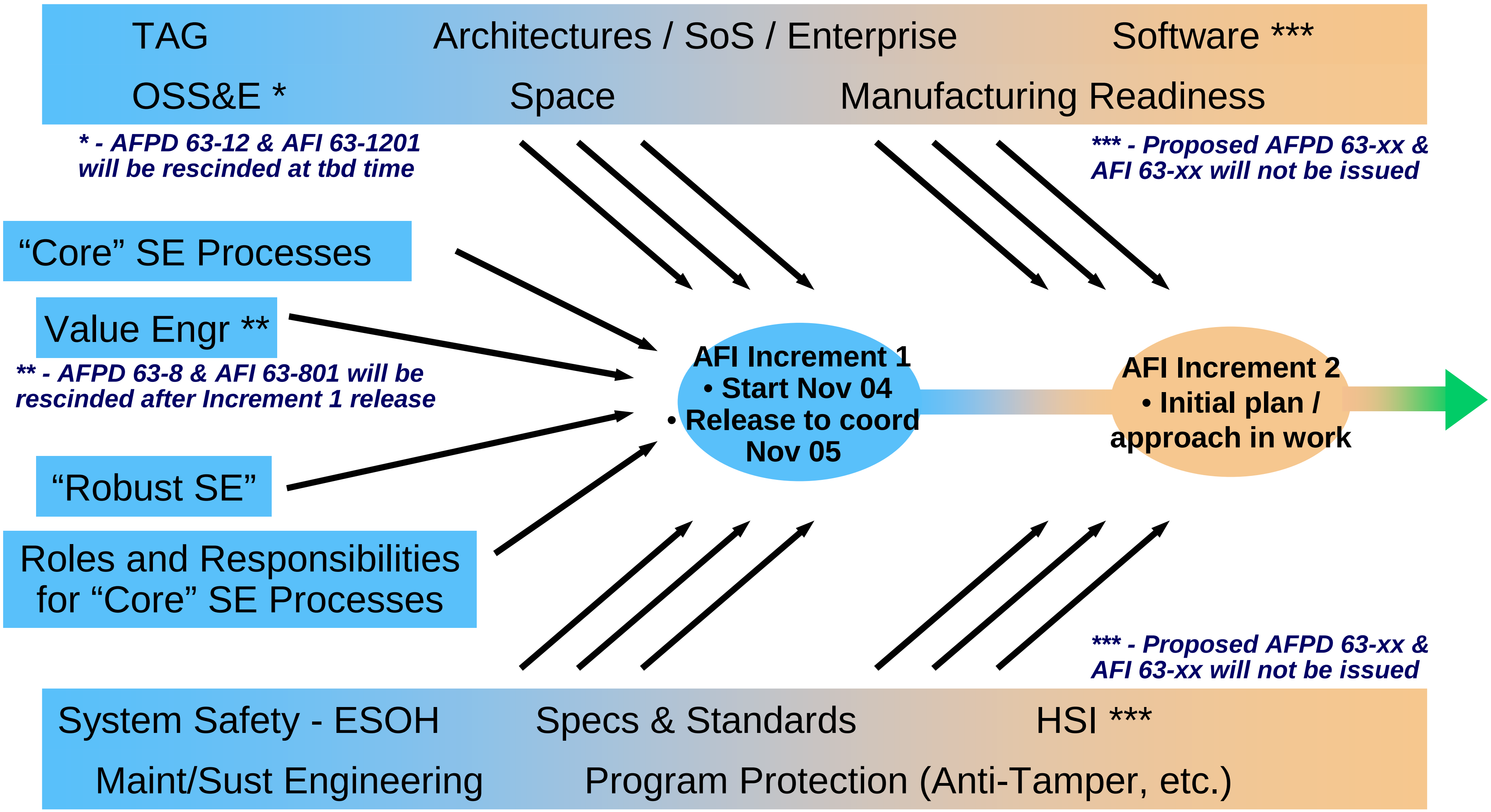
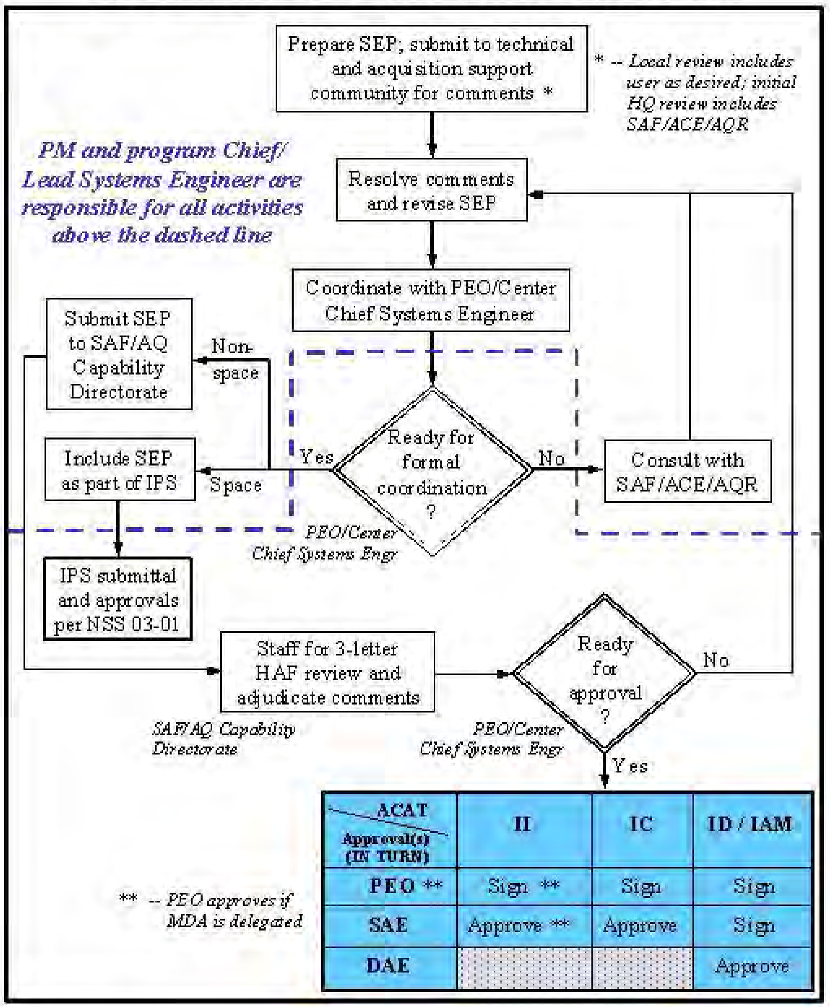
AF SE Policy Roadmap



As of: 5 Oct 05

AF SEP Approval Process

USAF SEP SUBMITTAL & APPROVAL
PROCESS FLOW FOR ACAT I/II PROGRAMS



ACAT / Approval(s) (IN TURN)	II	IC	ID / IAM
PEO **	Sign **	Sign	Sign
SAE	Approve **	Approve	Sign
DAE			Approve

- **MAJCOMs responsible for SEP preparation guides**
- **Program Executive Officers (PEO) Chief/Lead Systems Engineers responsible for SEP development/ review process**
- **Program Manager responsible for SEP content**
- **Reviewed and updated annually**
- **PEO's Chief/Lead Systems Engineer reviews SEPs for ACAT III programs before approval**

AF Systems Safety and SE

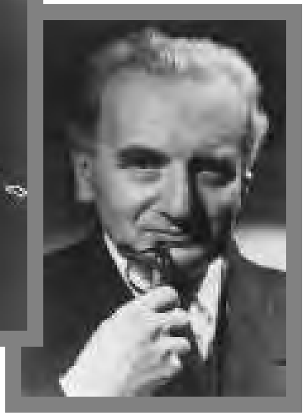
DoD goal of 75% reduction to FY02 mishap rates

- **OSD established Defense Safety Oversight Council (DSOC) to direct efforts to achieve goal**
- **Mr. Schaeffer chairs one of 8 DSOC task forces -- Acquisition and Technology Programs -- focused on revitalizing System Safety in SE**
- **AF developing AFI to guide revitalization of SE, with strong emphasis on System Safety and OSS&E**

FY02 -- 1 military death every 16 hours, 168 active duty injuries every hour, and 1 aircraft destroyed every 5.2 days ($1.8B loss)

Growing AF Technical Leaders

U.S. AIR FORCE



- *Value and respect the individual needs of every AF scientist and engineer (S&E)*
- *Ensure the S&E career field supports all diverse workforce demands of every one of our customers*
- *Provide smart buyers and competent engineers to the acquisition corps*
- *Unify the technical workforce to provide enhanced development opportunities*

- **Providing personalized development guidance with each S&E career field member through out development teams (DT) and career guides**
- **Identifying critical disciplines within S&E field, assessing state-of-health, and appointing a Technical Leader to take action, advocate and mentor**
- **Matrix support provided to SAF acquisition career field office to ensure S&E equities in SPO sizing models, acquisition commander boards, etc.**
- **Developing criteria to unify tech workers/leaders across all career fields**

Linking Technical Leadership to Our AF Future!

U.S. AIR FORCE

Summary

- Focusing SE policy to ensure strong technical planning and processes
- Leveraging Tech Advisor role to strengthen technical execution and credibility
- Growing technical leaders to ensure relevance in the future
- Synergizing technical people, programs, policy and processes to grow and strengthen the Air Force technical enterprise

Pursuing USAF Technical Excellence!

U.S. AIR FORCE

BACKUP

System Safety Revitalization Highlights

- **Apr 04 DoD Defense Safety Oversight Council Acquisition and Technology Programs Task Force**
- **Sep 04 USD (AT&L) System Safety policy memo**
- **Oct 04 NDIA SE Conference -- Senior Leader Panel**
- **Dec 04 NDIA SE Division System Safety Committee**
- **Mar 05 DSP Conf presentation on MIL-STD-882D**
- **Apr 05 DAU System Safety in SE course -- landmark**
- **Aug 05 Int'l System Safety Conference**
- **Oct 05 NDIA SE Conf -- first ever System Safety track**
- **Ongoing efforts include:**
  - **DAES Evaluation Criteria**
  - **Joint Programs Safety Board Certification Process**

Air Force Materiel Command

Developing, Fielding, and Sustaining America's Aerospace Force

U.S. AIR FORCE

Implementation of Policy Requiring Systems Engineering Plans for Air Force Programs – Results and Implications

Kevin Kemper
Senior System Engineer
Air Force Materiel Command

Objective

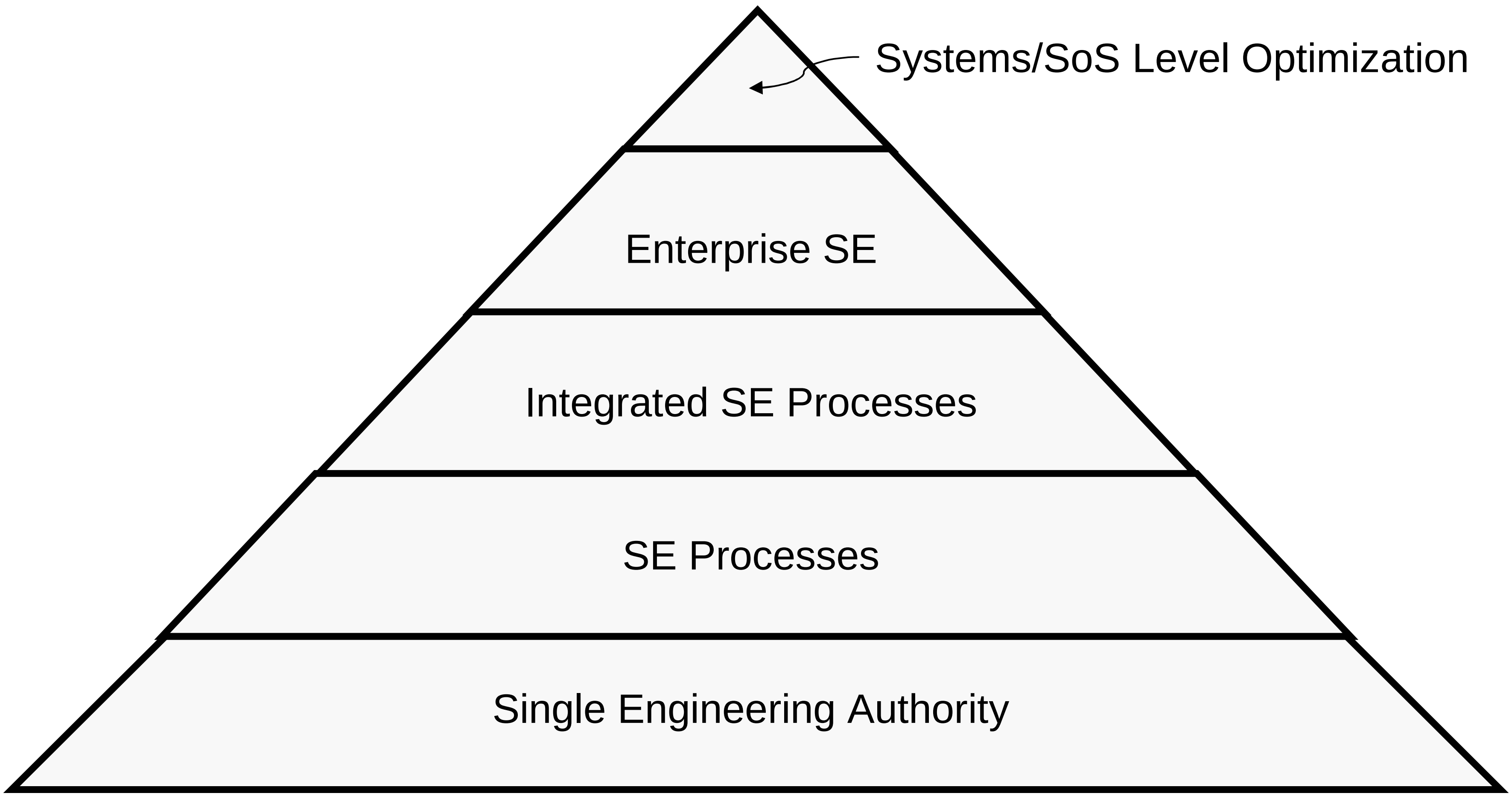
- Summarize and assess results of SEP reviews to date
  - SEP represents what is, not what should be
  - A measure of how well the revitalization of SE is going

State of the Practice vs State of the Art

Overview

- Background – policy, programs, reviewers
- Review results
- Implications
- Recommendations

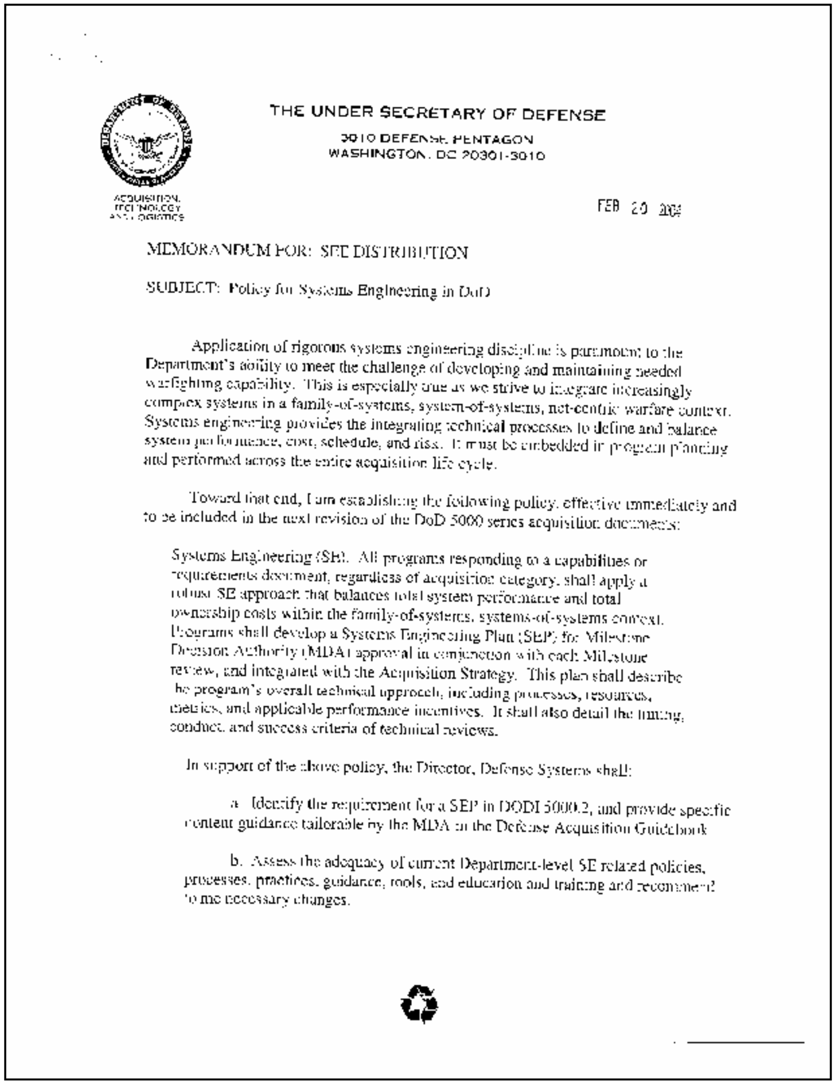
SE Implementation Hierarchy



Apologies to Maslow

Policy

- Policy Memo
  - Feb 04
- Draft AFI



THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

ACQUISITION, TECHNOLOGY AND LOGISTICS

FEB 20 2004

MEMORANDUM FOR: SEE DISTRIBUTION

SUBJECT: Policy for Systems Engineering in DoD

Application of rigorous systems engineering discipline is paramount to the Department's ability to meet the challenge of developing and maintaining needed warfighting capability. This is especially true as we strive to integrate increasingly complex systems in a family-of-systems, system-of-systems, net-centric warfare context. Systems engineering provides the integrating technical processes to define and balance system performance, cost, schedule, and risk. It must be embedded in program planning and performed across the entire acquisition life cycle.

Toward that end, I am establishing the following policy, effective immediately and to be included in the next revision of the DoD 5000 series acquisition documents:

Systems Engineering (SE). All programs responding to a capabilities or requirements document, regardless of acquisition category, shall apply a robust SE approach that balances total system performance and total ownership costs within the family-of-systems, systems-of-systems context. Programs shall develop a Systems Engineering Plan (SEP) for Milestone Decision Authority (MDA) approval in conjunction with each Milestone review, and integrated with the Acquisition Strategy. This plan shall describe the program's overall technical approach, including processes, resources, metrics, and applicable performance incentives. It shall also detail the timing, conduct, and success criteria of technical reviews.

In support of the above policy, the Director, Defense Systems shall:

a. Identify the requirement for a SEP in DODI 5000.2, and provide specific content guidance tailorable by the MDA in the Defense Acquisition Guidebook

b. Assess the adequacy of current Department-level SE related policies, processes, practices, guidance, tools, and education and training and recommend to me necessary changes.

About the Programs

- Non-Space AF programs at a milestone
  - Small # of programs
- Numerous other programs
  - Starting SEPs
  - Asking questions
  - Quick reviews

Air Force Reviewers

- SAF/ACE and AQR
- Extended Staff
  - AFMC/EN
  - AF Center for Systems Engineering

Areas Studied

- Requirements definition
- Processes
- Risk
- Key Performance Parameters
- Enterprise SE
- Multiple Reviews
- Authorship
- SEP Size

Requirement Definition

- 60% of programs adequately defined their requirements below the ICD/CDD
- Many programs can point to a “textbook” requirements analysis/decomposition process
- Few can point to a configuration controlled specification

Quotes

“We don’t have any requirements”

Processes

- 27% of programs described processes
- The rest either
  - Don’t have a process
  - Don’t know the process

Process 101

If you can’t document the process
You don’t have one

Risk

- 55% of programs defined their risks
- The rest
  - – Simply don't know what the risks are
  - – Not a integral part of the program

Quotes

"I can't list my risks in the SEP. They change daily"

"Why do you need to know what the program risks are to do SE planning"

Key Performance Parameters

- 73% of the programs list KPPs
  - KPPs are clearly stated as a SEP requirement

Quotes

"What have KPPs got to do with SE?"

"I can't list all of my program's KPPs in the SEP. We have hundreds"

"I don't have any KPPs"

Scheduled Design Reviews

- 55% of programs have entry and exit criteria for design reviews

Quotes

" We are not there yet"

Enterprise SE

- 10-20% of programs have fully integrated SE processes into program
  - Risk
  - EVMS
  - Design reviews
  - Manning

Multiple reviews

- Few programs approved without multiple iterations
- Approvals with comments

Authorship

- SEPs written by
  - Prime contractor
  - Task order contractor
  - Reserve Officer
  - Junior members of program

Big SEPs

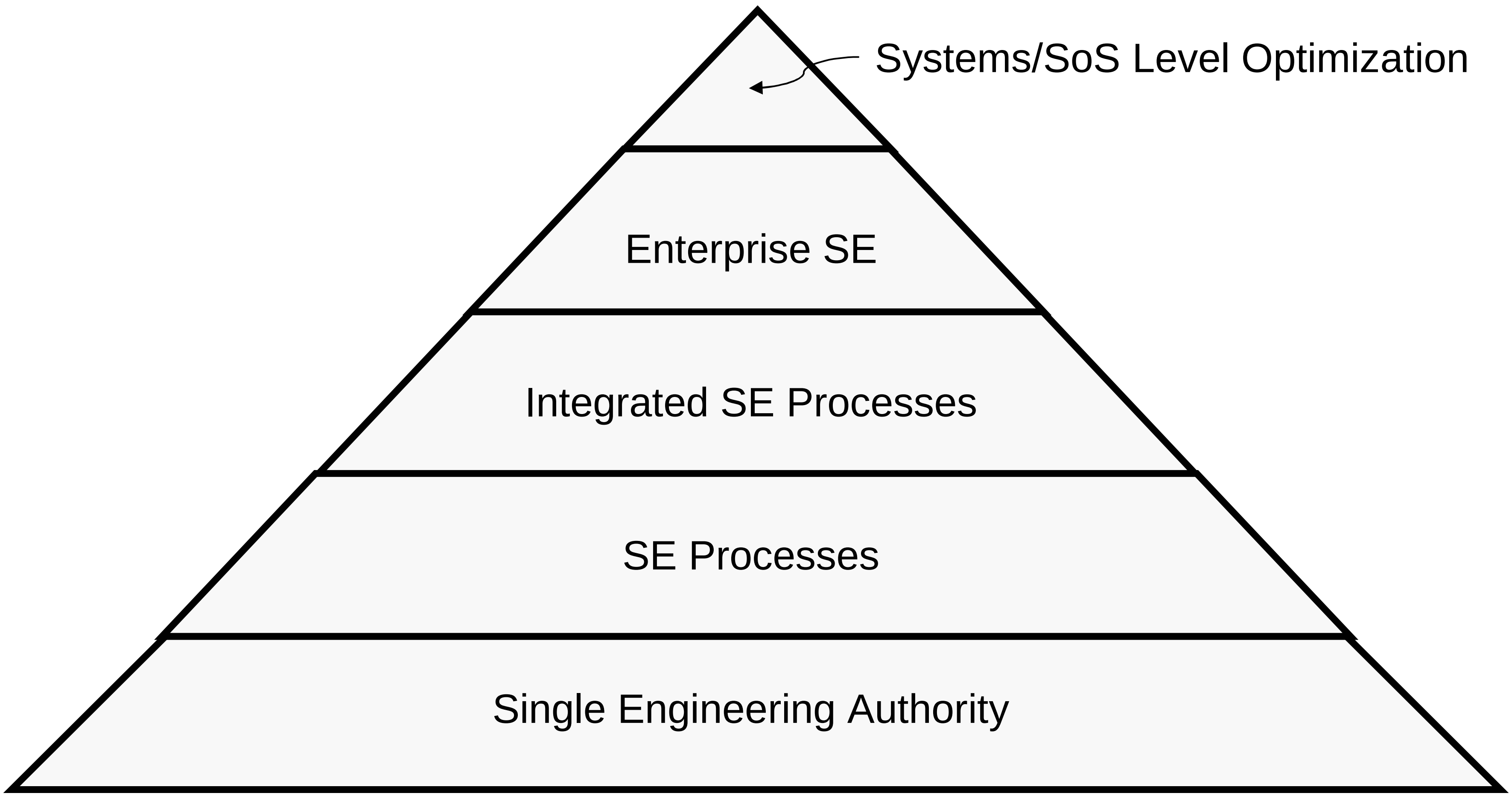
- Don’t know what “they” want
- Don’t know what my program is doing
- Give “them” lots of stuff and hope they stumble over what they want
- Tutorial

State of the Practice

- Not @ 100% in any of the areas reviewed
  - Requirements definition
  - Processes
  - Design reviews
- Shortfall is in SE fundamentals

State of the practice well below the state of the art

SE Implementation Hierarchy



Results - Possible Factors

- Requirement to document SE planning in a SEP is new
- Format confusion
  - What do they really want?
- Years of negative learning

Atrophied SE Talent

- AFMC has half the number of engineers as in the early 80s
- Engineers hired in the last decade+ were trained in a less disciplined SE environment
- SE talent still exists in AF/center
  – Generally at a higher level
- That limited talent is probably not working on the program

Consultants can only do so much

Implications - More Help

- SEPs indicate continuing, significant problems with the implementation of SE
- The powers that be will "Inspect in good SE"
  - Wing, Group, Squadron, PEO/Center, SAF/AQ

What gets inspected gets improved

Implications-SEP as Audit Tool

- More status will be required in SEPs
- Approval with comments
  - Update in 90 – 120 days

Recommendation

- Continue this type of analysis
  - Across programs and over time
- Develop PEO checklists
  - Start with OSD SEP checklist
  - Tailored/specific to product line
- Require just-in-time training
  - Event/milestone

AFMC

Questions

N65236-ENGOPS-BRIEF-0011-1.0

Systems Engineering Revitalization at SPAWAR Systems Center Charleston

Michael T. Kutch, Jr.

Chief Engineer Code 70 E
Intelligence & Information Warfare Systems Department
Director Engineering Operations Code 09 K
SSC Charleston

NDIA Systems Engineering Conference, October 25, 2005

Approved for release to the public - 23 Sept 2005

Presentation Outline

- Introduction
- Revitalization Effort
- Training
- Summary

Systems Center Charleston

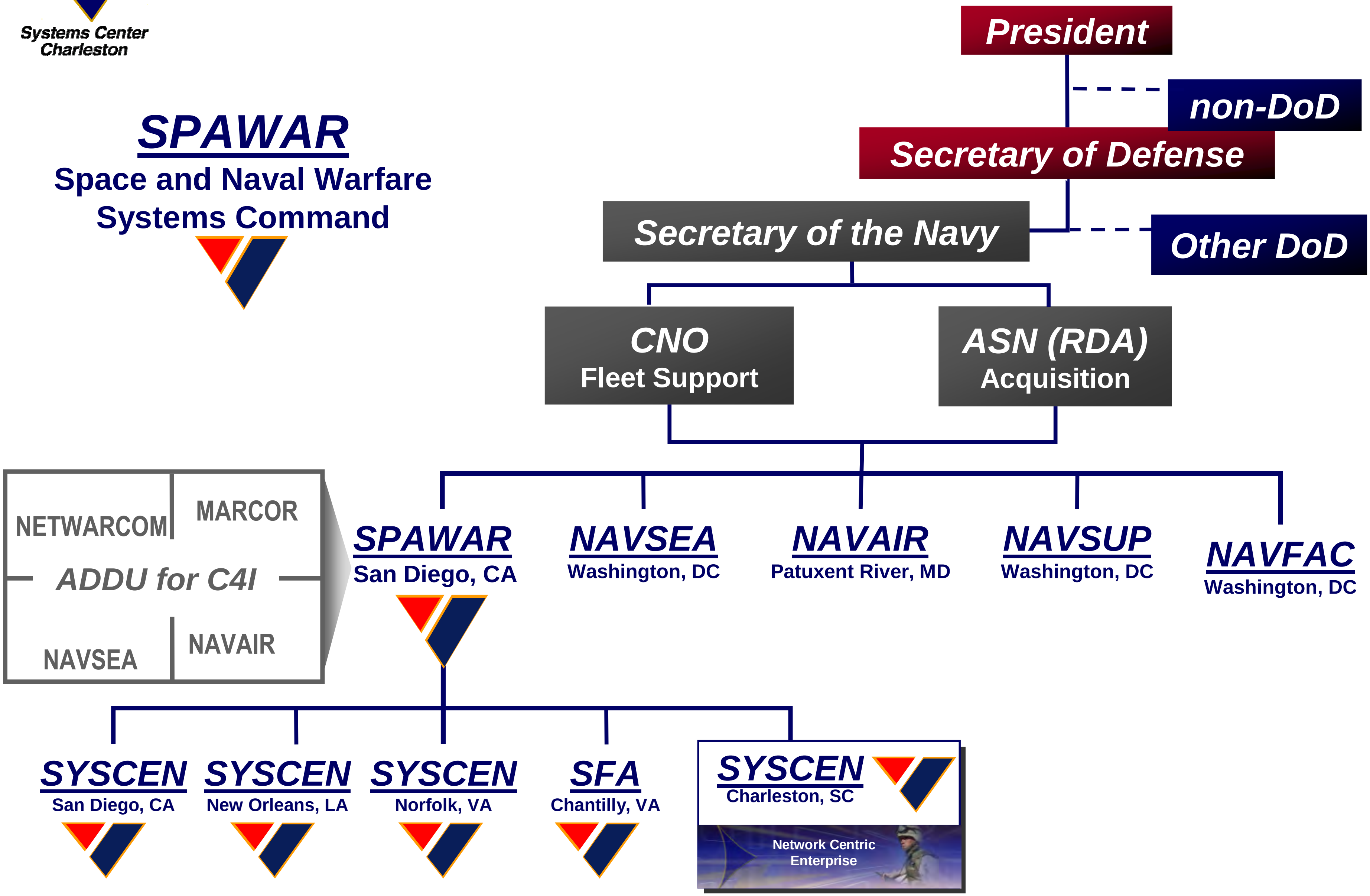
N65236-ENGOPS-BRIEF-0011-1.0

Introduction to SSC-Charleston

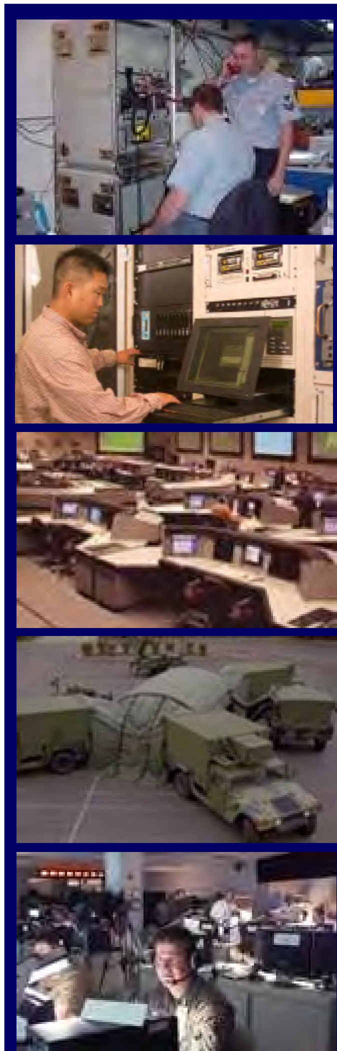
- Where we fit
- What we do
- What we are known for
- Who we are

Where We Fit

SPAWAR
Space and Naval Warfare Systems Command



What We Do



C^{4}ISR

- **C**ommand
- **C**ontrol
- **C**ommunications
- **C**omputers
- **I**ntelligence
- **S**urveillance &
- **R**econnaissance

- ***Modeling & Simulation***
- ***Command & Control***
- ***Navigation***
- ***Physical & Computer Security***
- ***Video Teleconferencing***
- ***Information Assurance***
- ***Sensors***
- ***Communications***
- ***Cryptologic & Intelligence***
- ***Image Processing***
- ***Meteorology***
- ***Air Traffic Control***

SPAWAR

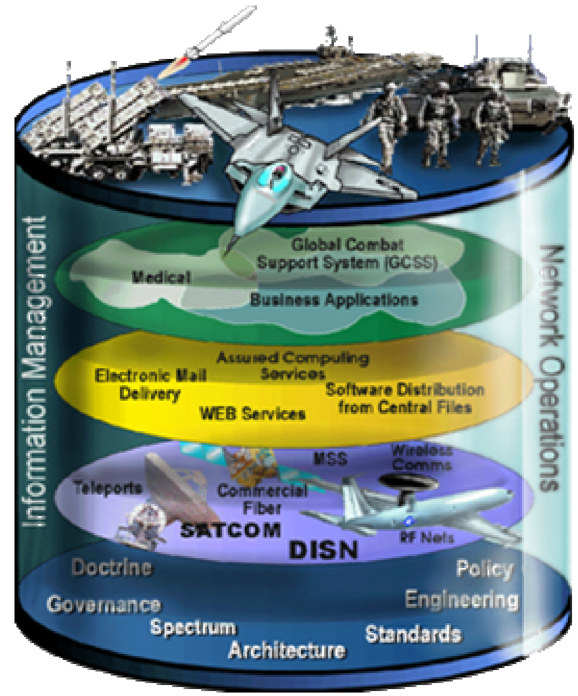
Systems Center
Charleston

What We're Known For

- **Developer of FORCEnet joint collaborative assessment tools** that promote netCentric interoperability and reduce system redundancy

- **Principal SPAWAR provider for Joint and Homeland Security** C4I solutions in a responsive manner.

- **Navy's most efficient provider of critical engineering** and acquisition expertise for Navy/Joint commands and other federal agencies



- **Rapid integrator and deployer of interoperable technologies** to the Navy, Federal Government, and Joint Warfighter

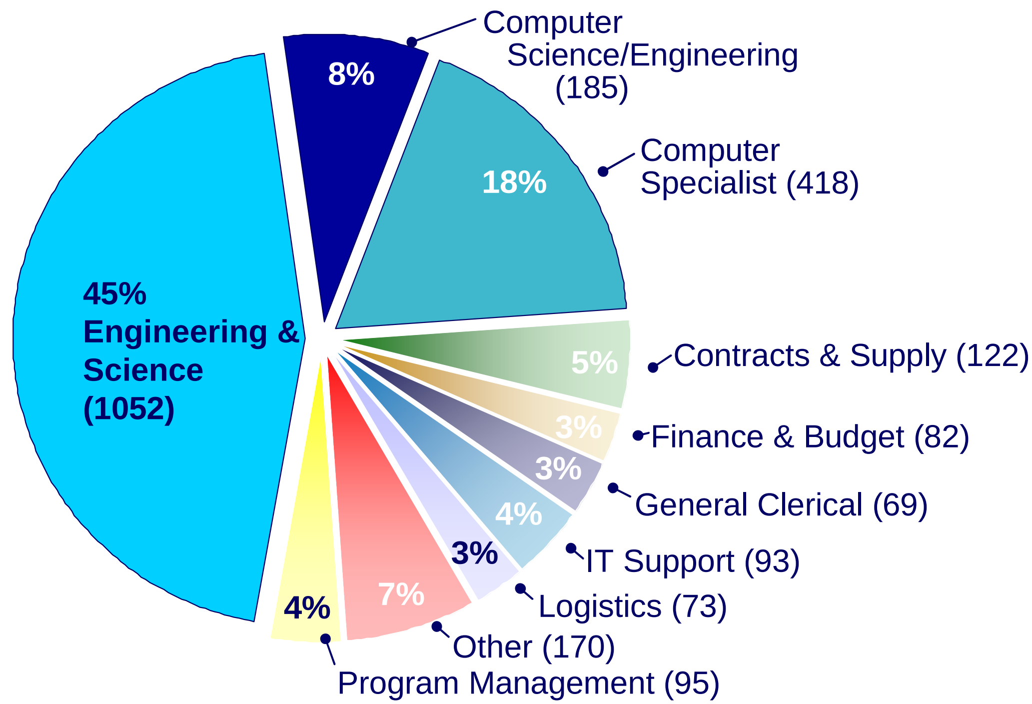
- **Developer and employer of life-cycle logistic support solutions** in a web-enabled portal environment

Who We Are

Systems Center Charleston

A Large Systems & Software Engineering Organization

Over 70% of workforce is in an engineering or computer-related discipline



- **The effective and efficient solutions to the global war on terror developed by SPAWAR result from good systems and software engineering.**
- **Systems engineering is our core competency.**
- **Total workforce of ~ 2300 employees.**

N65236-ENGOPS-BRIEF-0011-1.0

Systems Center Charleston

SE Revitalization Effort

- Vision
- Organization
- Plan
- Process
- EPB Tool

Approved for release to the public - 23 Sept 2005

Vision

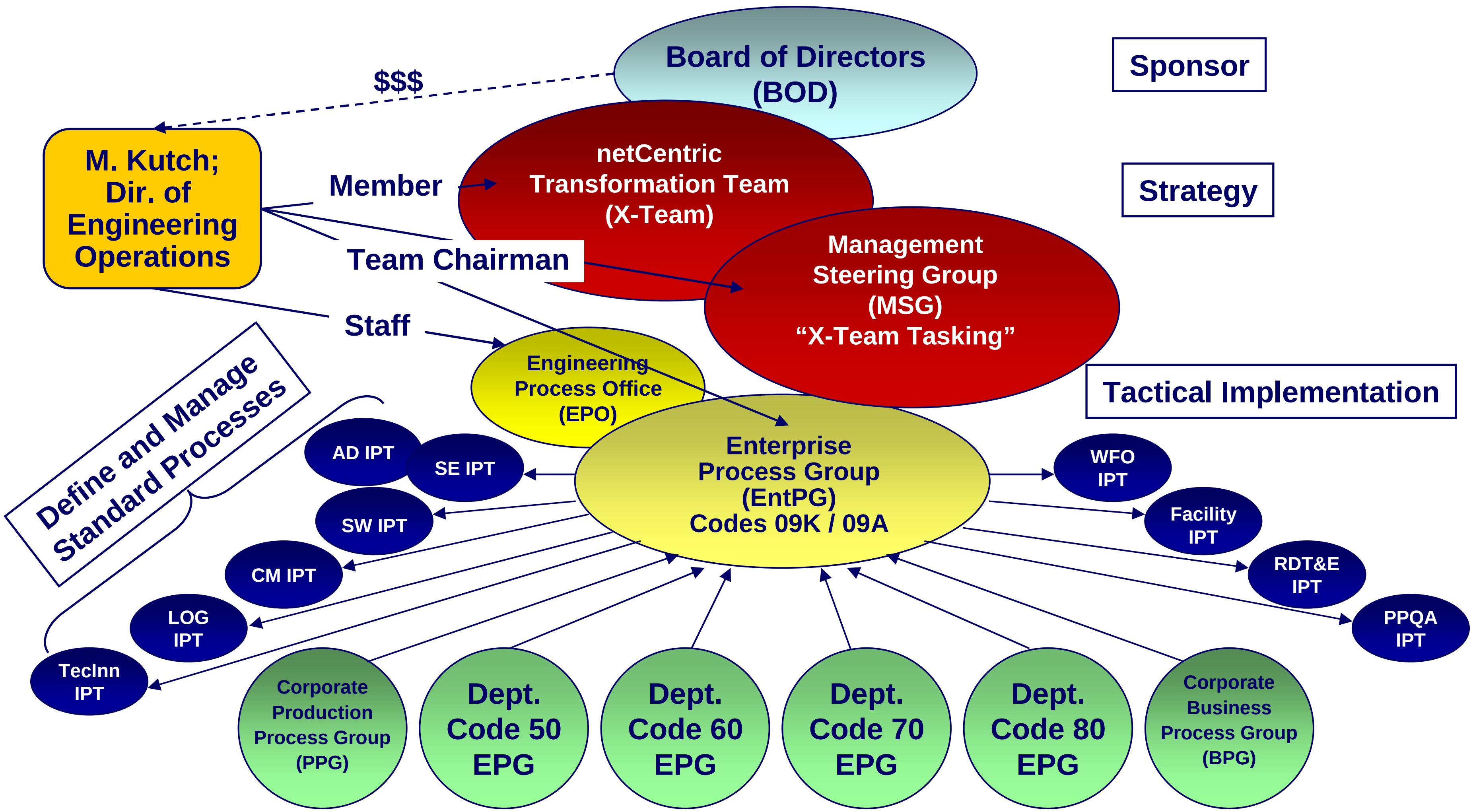
Systems Center Charleston

- **Vision**
  - Develop and maintain a World Class Systems Engineering Organization
- **Approach**
  - Achieve Command-wide operational consistency
  - Based on ISO 15288 – systems engineering
  - Based on ISO 12207 – software engineering
  - Measure using best practices of CMMI®
- **Benefits**
  - Facilitates sharing of tools, documentation, templates, and other artifacts needed by project engineers
  - Project Engineers will implement projects quicker; with improved monitoring, effectiveness, quality and efficiency

"Engineering is the key to our survival. Look to the future."

James Ward, Executive Director, SSC Charleston

Organization for Implementation



SPAWAR Systems Center Charleston

SSC-C SE Revitalization Plan

Elements of SSC-C SE Revitalization

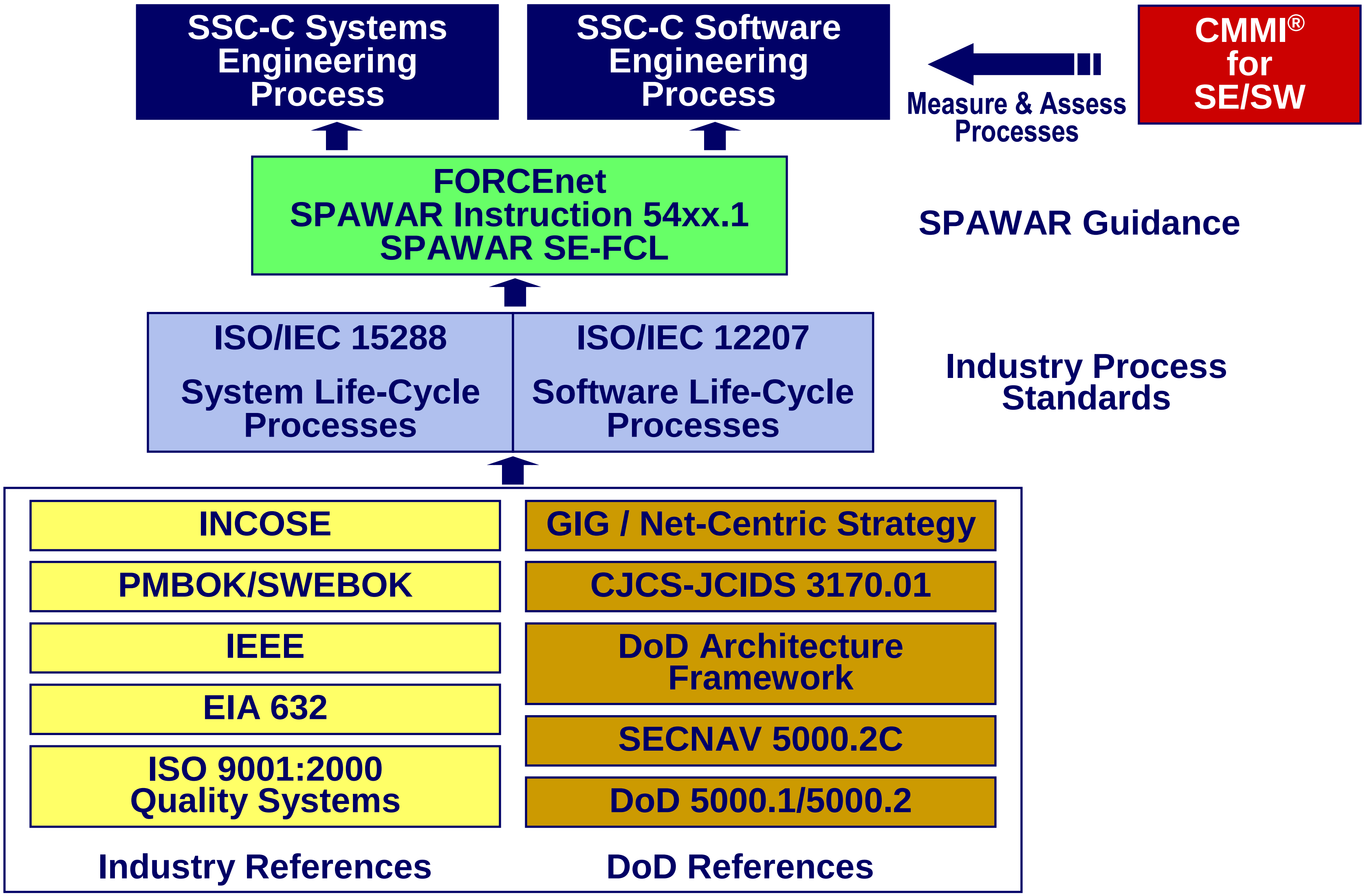
Policy / Guidance
- DoD SE Guidance & SE Instruction 54xx.1
- SSC-C SE Process Manual
- SSC-C SW Process Manual
- ePlan Builder

Training / Education
- Intro to PI WBT
- SE 101 WBT
- SE Fundamentals
- SW Fundamentals
- Certification Program

Assessment & Support
- CMMI® Level 2
- CMMI® Level 3
- Integrated Product Teams
- SITC - Tools
- Lean Six Sigma

Legend:
- Underway
- Completed/Ongoing

Basis for SSC-C SE Process



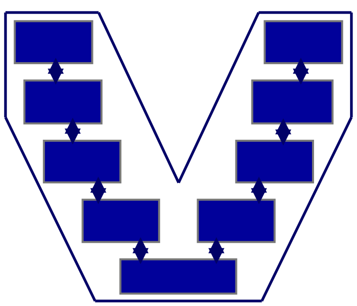
SPAWAR
Systems Center
Charleston

SSC-Charleston SE Process Steps

Process Implementation
Stakeholders Requirements Definition
System Requirements Analysis
System Architectural Design
Implementation
Integration
Verification
Transition
Validation

Key Milestones

System Requirements Review (SRR)
System Design Review (SDR)
Test Readiness Review (TRR)



Follows SE "Vee"

Each process step is defined by required inputs, controls, associated processes, and outputs.

Adapted from "SSC-C Systems Engineering Process Manual"

ePlan Builder Tool

- **ePlan Builder tool**
  - An interactive, web-based application that leads the user through a structured interview process (like TurboTax) to generate a CMMI®-compliant plan
  - Includes standard, consistent text
  - Generates a complete Project Management Plan, Configuration Management Plan, Quality Assurance Plan, and Requirements Management Plan
  - Future versions will build
    - Systems Engineering Plan
    - Measurement and Analysis Plan
    - Supplier Agreement Management Plan

Systems Center
Charleston

Training

- Systems/Software Engineering Classroom
- WBT
- Process Improvement and CMMI®

Systems Center Charleston

Systems Engineering Fundamentals Classes

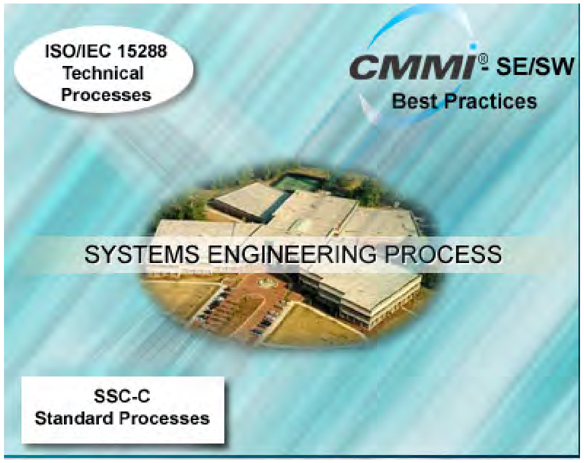
- **3-day on-site, classroom course**
  - Based on SMU SE Masters course
  - Customized to incorporate SSC-C SE process
  - 180 SSC-C engineers trained
  - Classes planned every 2 months
- **1-day *SE for Managers* course added**
- ***Intro to Software Engineering* planned**

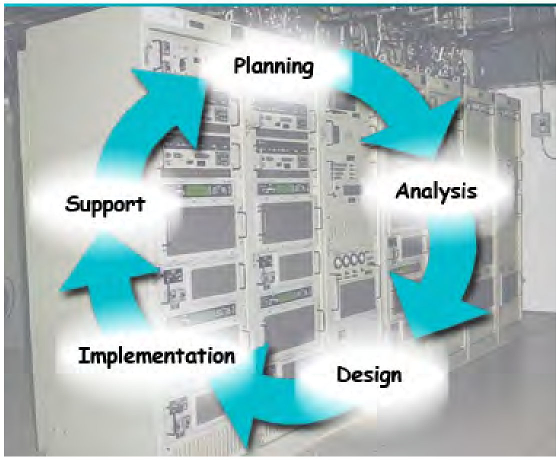
"The course was very educational. It helped me relate my current project to the overall system it was a part of, and how it fits in with the big picture."

"The course was well presented and accurately covered the Systems Engineering Design Process Fundamentals. Continued/additional training on this subject is critically needed for this command to continue to develop as a professional engineering organization."

Student Feedback

- **Introduction to Systems Engineering**
  - 10-module web based training
  - Closely aligned to SSC-C SE Process, SE Fundamentals Course, ISO/IEC 15288 and IEEE standards
  - Includes hotlinks to referenced documentation
    - Process manuals, policies, standards





Process Improvement Training

Systems Center Charleston

- **Intro to Process Improvement**
  - Over 800 people trained
  - Provided via WBT
  - Now Mandatory for all employees
- **CMMI®**
  - SEI Intro to CMMI®
  - SSC-C Level 2 Processes
  - 875 people trained
- **Project Management/Project Monitoring & Control**
  - 625 people trained
- **Process-specific Workshops (CM, QA, REQ, M&A)**
  - 375 people trained

Over 1300 Individuals Trained

Total attendance over 2800 *

**** This accounts for some employees attending more than one course***

Systems Center Charleston

Summary

- Accomplishments
- Results and Measures
- Lessons Learned
- Going Forward

What We Have Accomplished

Systems Center Charleston

- **Process Focus**
  - Defined Policies and Processes
  - Aligned with DoD and SPAWAR guidance
  - Aligned with industry standards and CMMI® model
  - Built organization structured around processes and process improvement
- **Training is Critical**
  - Providing Fundamentals of Engineering for new and old professionals
  - Developed web-based training for "self-paced" and refresher training
  - Defining a structured technical career development path for engineers
- **Tools for the Engineers**
  - Developed *ePlan Builder* application to generate planning documents
  - Developed templates, checklists, and web-based document repositories to link standards and DoD guidance to day-to-day tasks and processes

Early and persistent Systems and Software Engineering applied to programs and projects

Results and Measures

- **Formal process improvement policy issued in 2003**
  - Use CMMI to evaluate progress against best practices
- **Selected pilot projects**
  - Training of project teams
- **Informal Appraisals, Process Reviews, and Document Reviews to measure progress and identify gaps**
  - Class B/C appraisals of selected projects
  - Define/review project-specific plans and procedures
  - Ensure the processes and procedures were used
- **Project-level Formal SCAMPI Appraisals (Class A)**
  - Evaluated compliance with CMMI Maturity Level 2 requirements
  - 8 projects appraised between June 2004 and February 2005
- **Command-wide appraisal in April, 2005**

Major Milestone – Maturity Level 2

- The first SPAWAR Systems Center to achieve CMMI® Maturity Level 2 at the command level

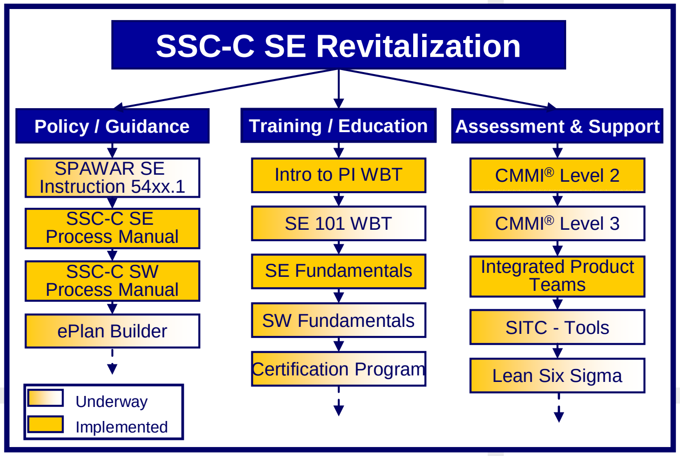
Lessons Learned

- **Senior Management support is critical to success**
- **Training**
  - Everyone needs to be engaged – "train the masses"
  - Specific training for process owners/subject matter experts
- **Utilize Teams (IPTs) as champions of specific processes**
  - Multi-department representation
  - Change agent mentality
  - Process focused charters
- **Resource Properly**
  - Implement with projects that want to improve, can benefit from efforts, and that recognize own weaknesses
  - EPO staff provided skilled coaching, resources, support, and tools
  - Project members learned by doing and maintaining
- **Goals and Publicity**
  - Keep goals to sizable bites (projects)
  - Publicize successes; Share best practices

Systems Center Charleston

Summary

- **Aggressive SE Program**
- **Industry Standards**
  - Systems Engineering (SE)
  - Software Engineering (SW)
- **Best Practices**
  - CMMI®
  - ISO 9001
  - Lean Six Sigma



- **Training – 1,300 people***
- **Systems Engineering Fundamentals - 180**
- **Intro to SSC-C PI**
  - CMMI® Level 2 Processes
  - CMMI® Level 3 Processes
  - SE/SW Engineering Workshops
  - Web-Based Training (WBT) for Process Improvement

*includes industry partners

- **Successes**
  - Command Achieved CMMI® Maturity Level 2 in April 2005
  - 1st SPAWAR Systems Center to Achieve CMMI® Maturity Level 2

- **Plans**
  - World Class Systems Engineering
  - Support Command Balanced Scorecard
  - April 2007 CMMI® Maturity Level 3

Going Forward

- **Develop more "how to …" guidance and tools**
  - ePlan Builder, an interactive web application, helps build required plans.
    - Currently builds PMP, QA, Configuration Mgmt, and Requirements Mgmt plan
    - Systems Engineering Plan, Measurement & Analysis Plan, and Supplier Agreement Management Plans under development
  - Institutionalize the SE/SW processes
    - Emphasize Formal Reviews
- **IPTs - expanding beyond CMMI® & Engineering areas**
  - Expecting more integration from teams
- **CMMI®**
  - SSC-Charleston standard process with Tailoring Guidelines for all projects
  - Projects progressing to ML3
  - Process Improvement tracked at department/project level using self assessment tool
  - 2 Balanced Scorecard measures directly related to CMMI®

SPAWAR Systems Center Charleston

Thank you !

Any Questions ?

Contact Information:

Michael T. Kutch, Jr
SPAWAR Systems Center Charleston
michael.kutch@navy.mil
(843) 218-5706

National Defense Industry Association (NDIA)
Conference and Expo
San Diego, California

Keynote Address

The Case for DoD Systems Engineering

Mr. John Landon
Deputy to the ASD(NII) for C3ISR and IT Acquisition
Office of the Secretary of Defense

October 25th, 2005

Agenda

• Investment Funding Trends & Challenges

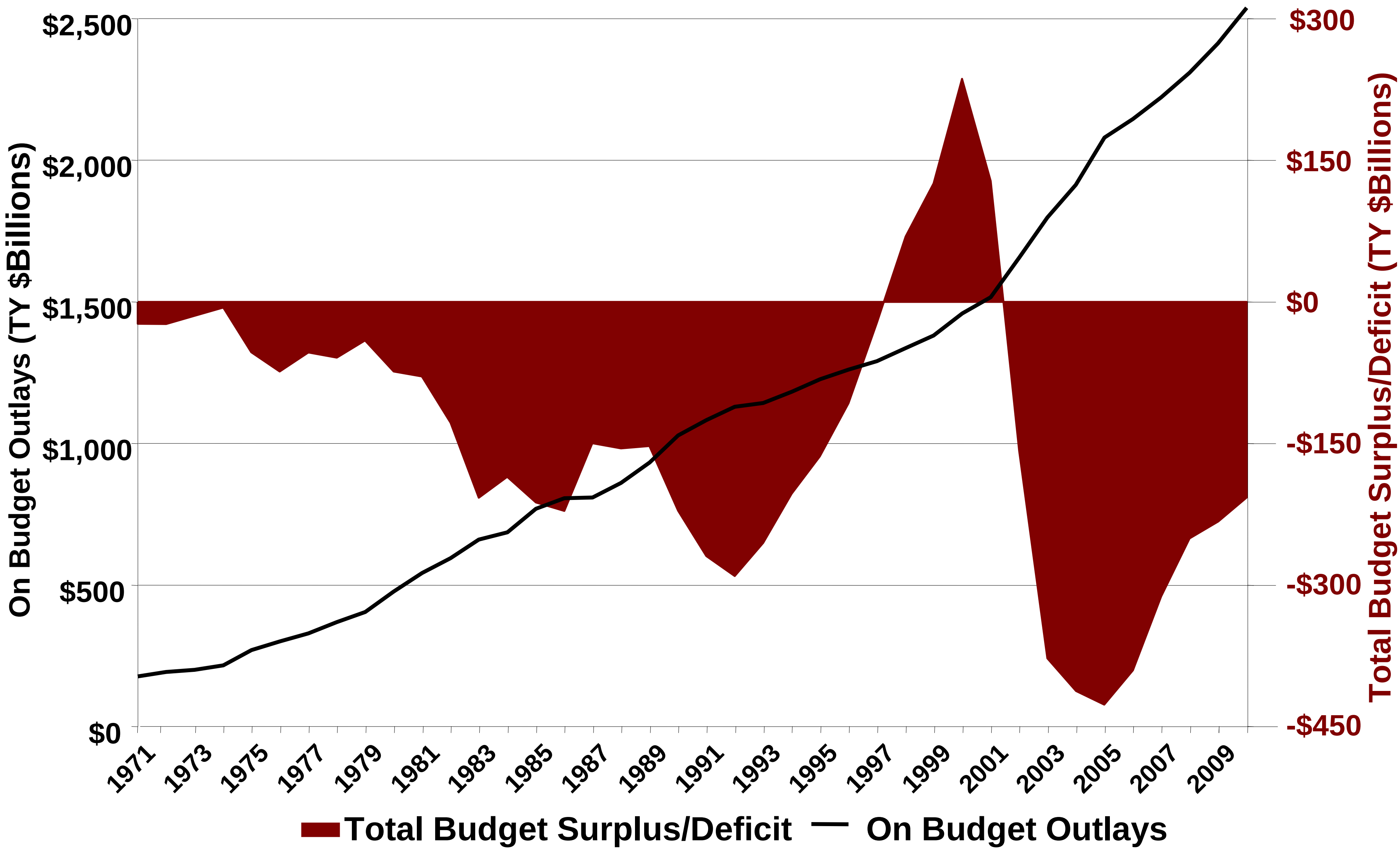
• Program Trends & Challenges

• Role of Systems Engineering in meeting these challenges

Investment Trends & Challenges

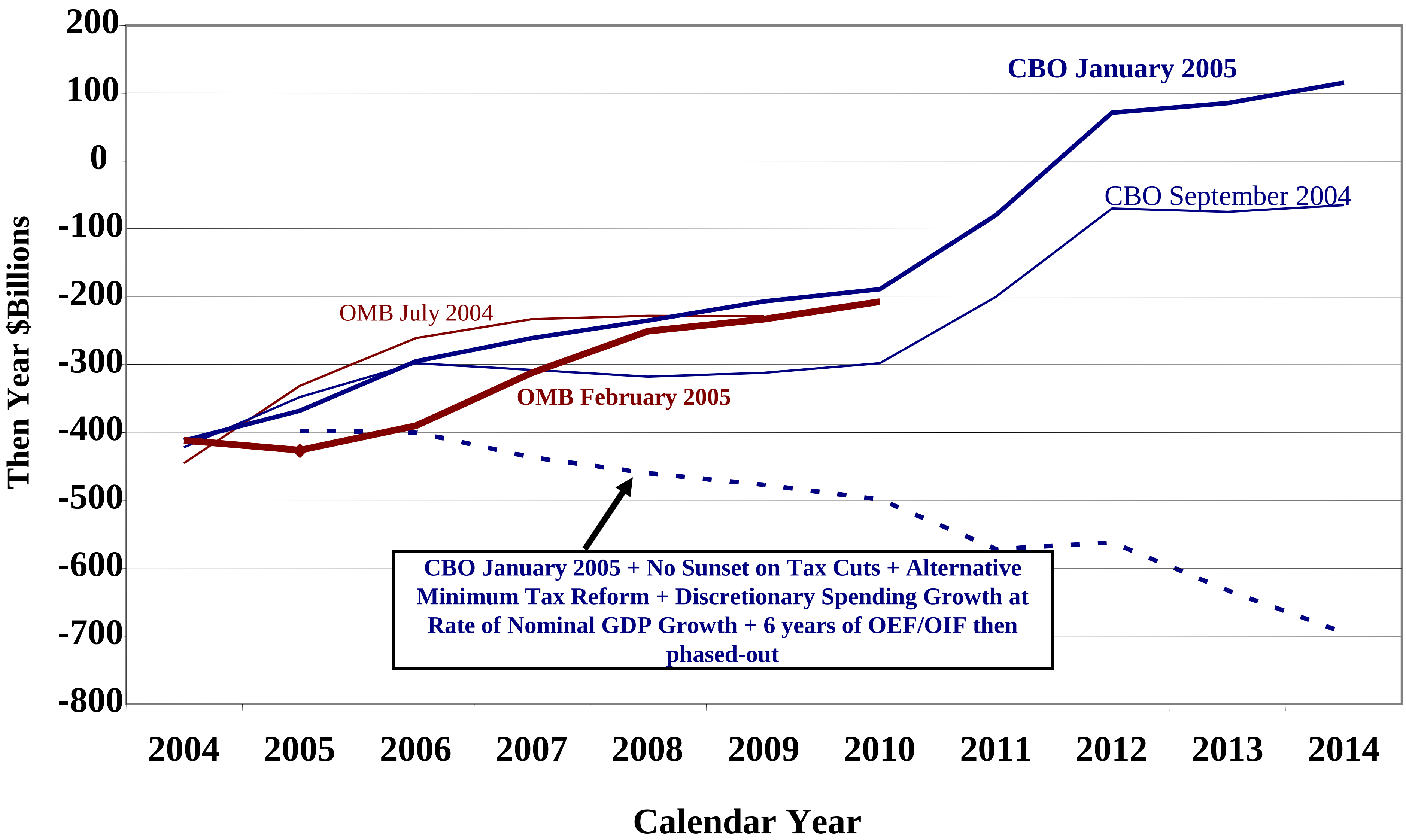
- **Federal Budget Deficit Pressures**
- **Discretionary vs. Non-Discretionary Spending**
- **Trends in Defense Topline**
- **Projected Investment Challenges**

Federal Expenditures and the Budget Deficit



Source: FY 2006 President's Budget

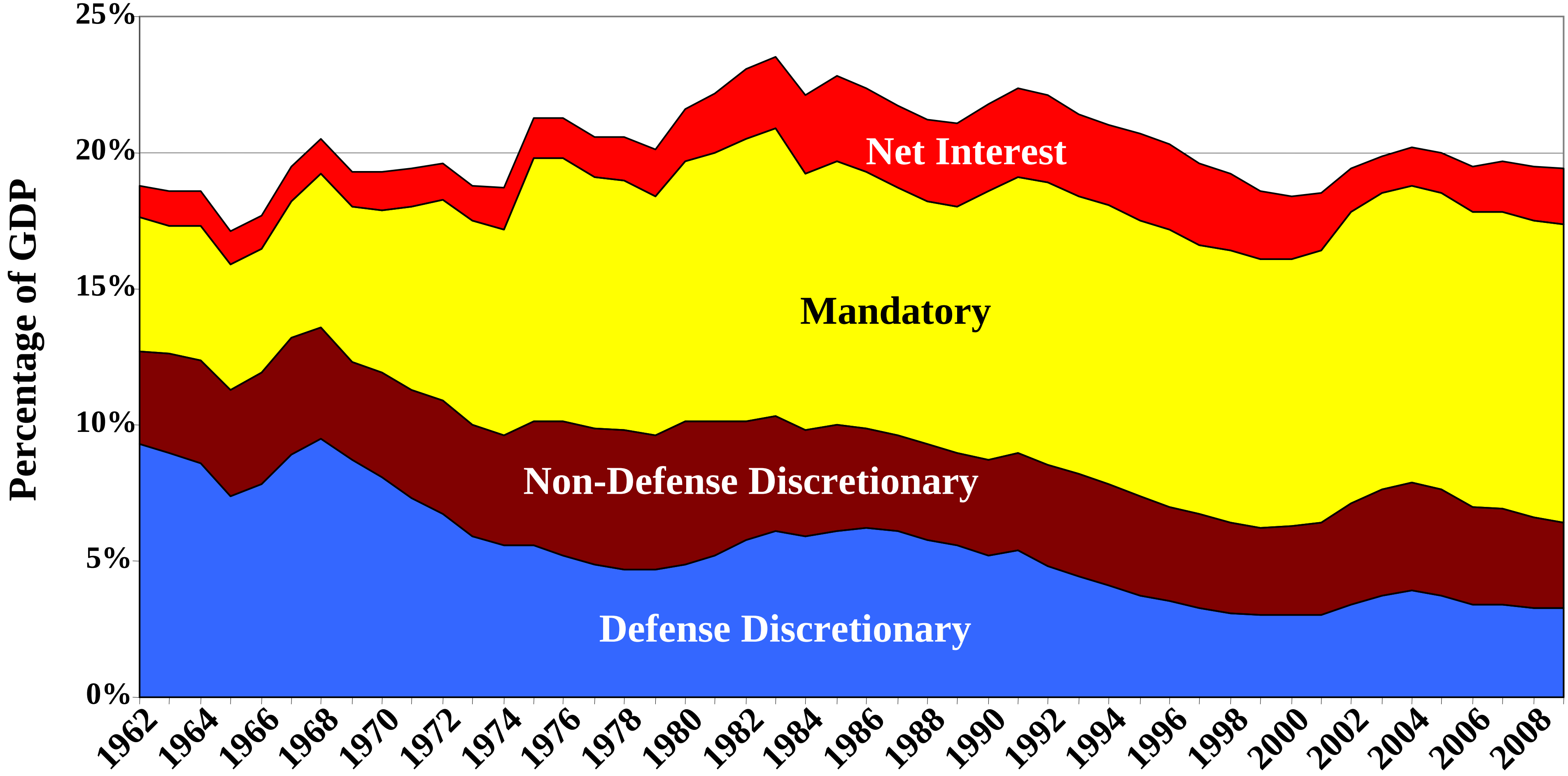
Recent Federal Budget Surplus/Deficit Projections



Source: FY 2006 President's Budget, CBO's Budget Outlook, OMB's Mid-Session Review, and White House Press Release

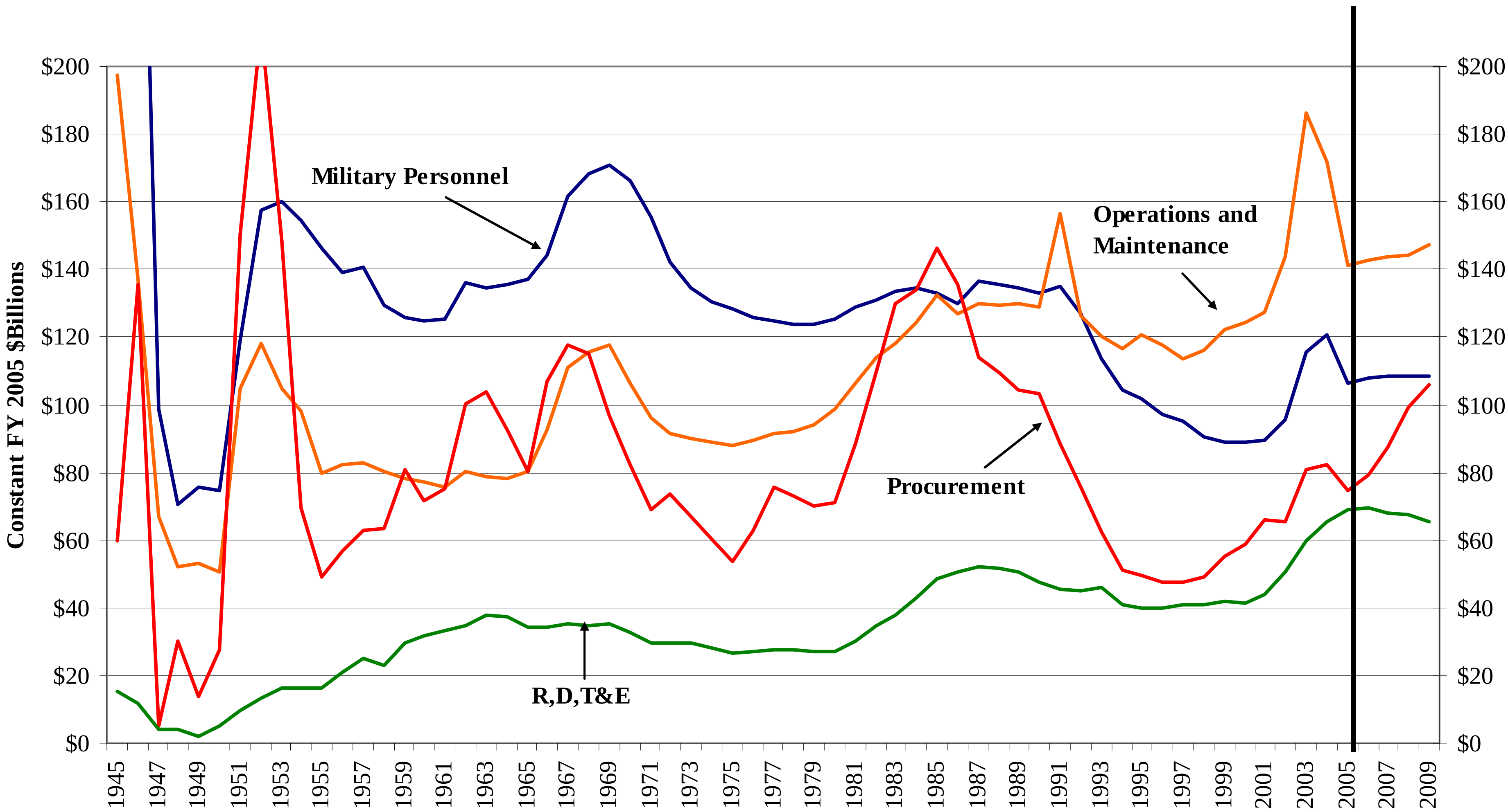
Federal Spending by Category as a Percentage of GDP

FY 1962 - FY 2009



Source: FY 2005 President's Budget

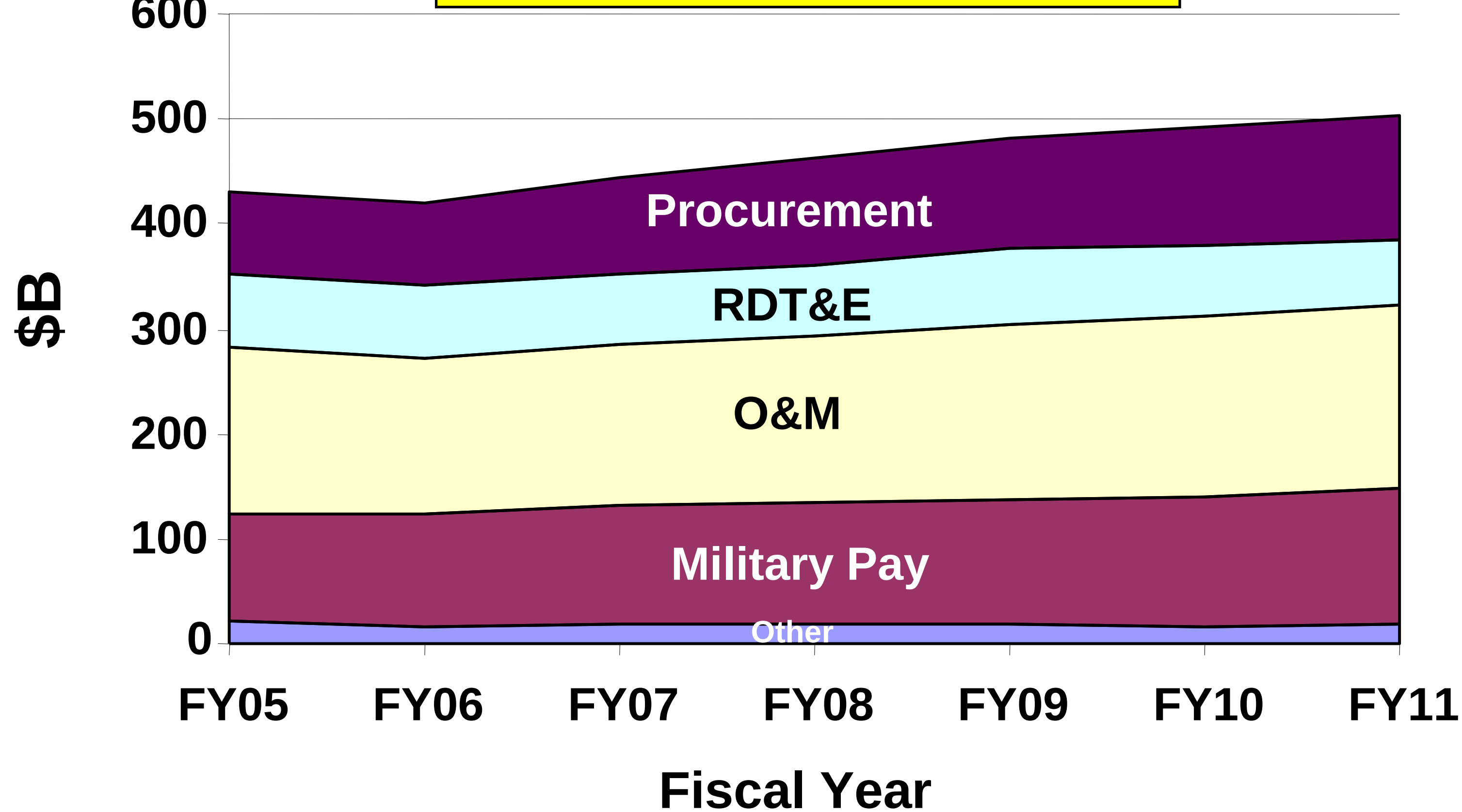
Department of Defense Budget Authority by Appropriation
FY 1945 – FY 2009 (Constant FY05 $)



Source: FY 2005 DoD Greenbook

Total DoD Topline
FY 2006 President's Budget

Approximately 5% Real Growth Programmed FY06-11

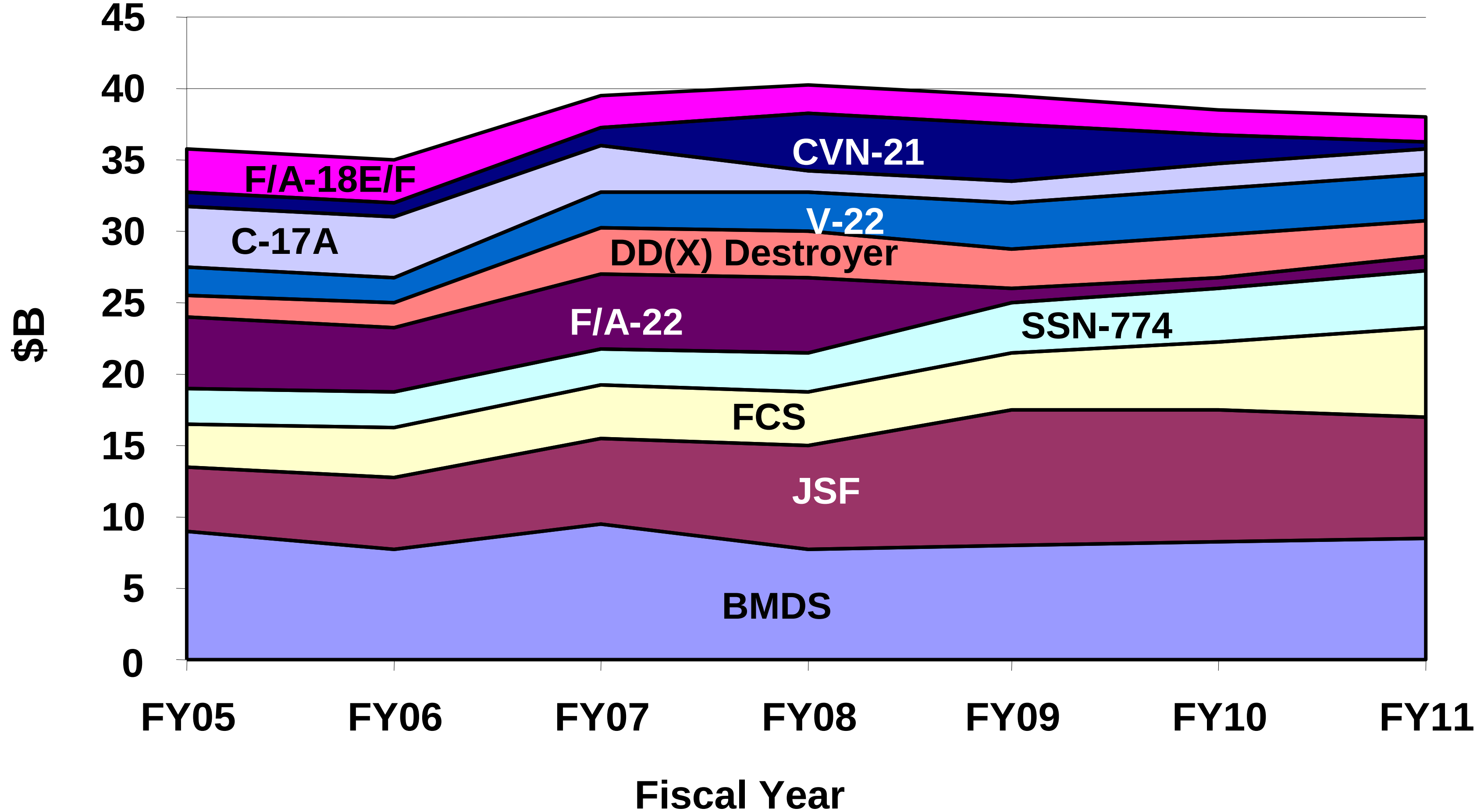


FY06-11 Investment Averages 36% of Topline

FY06-11 O&M Averages 35% of Topline

FY06-11 Military Pay Averages 25% of Topline

PB06 Top 10 Investment Programs



FY06-11 Cumulative Total = $231B
Approximately 23% of total Investment consumed by Top 10 Programs

Conclusion

- **Federal Budget seeks Equilibrium**

- **Mandatory Payments are Growing**

  …..But Federal Topline remains at 20% GDP

- **DoD Investment remains fairly stable**

DoD Program Trends & Challenges

- Frequent Program Rebaselining
- Increasing Cycle Time
- Increasing Cost
- Loss of "Buying Power"

DOD Programs Frequently Rebaseline

- GAO found that 49 of the 81 major defense programs (60 percent) reporting in 2003, rebaselined more than once during the life of the program.
- Programs with largest number of rebaselinings:

Program	Year of Program Start	Latest Rebaseline	Number of Rebaselinings
F/A-22	1992	April 2004	14
DDG 51	1988	August 2002	11
SM-2 Block V	1993	August 1999	11
SSN-21	1988	April 2000	10

Source: GAO Report 05-182, Defense Acquisition, March 2005

Based on Analysis of DOD SAR Data

GAO Analysis of 26 DoD Acquisition Programs

Cost and Cycle Time Growth for 26 Selected DoD Weapons Systems

FY05 $ Billions	First Full Estimate	Latest Full Estimate	Percent Change
Total Cost	$479.6	$548.9	14.5
RDT&E Cost	$102.0	$144.7	41.9
Simple Average Cycle Time	94.9 Months	114.7 Months	20.8
Weighted Average Cycle Time	146.6 Months	175.3 Months	19.6

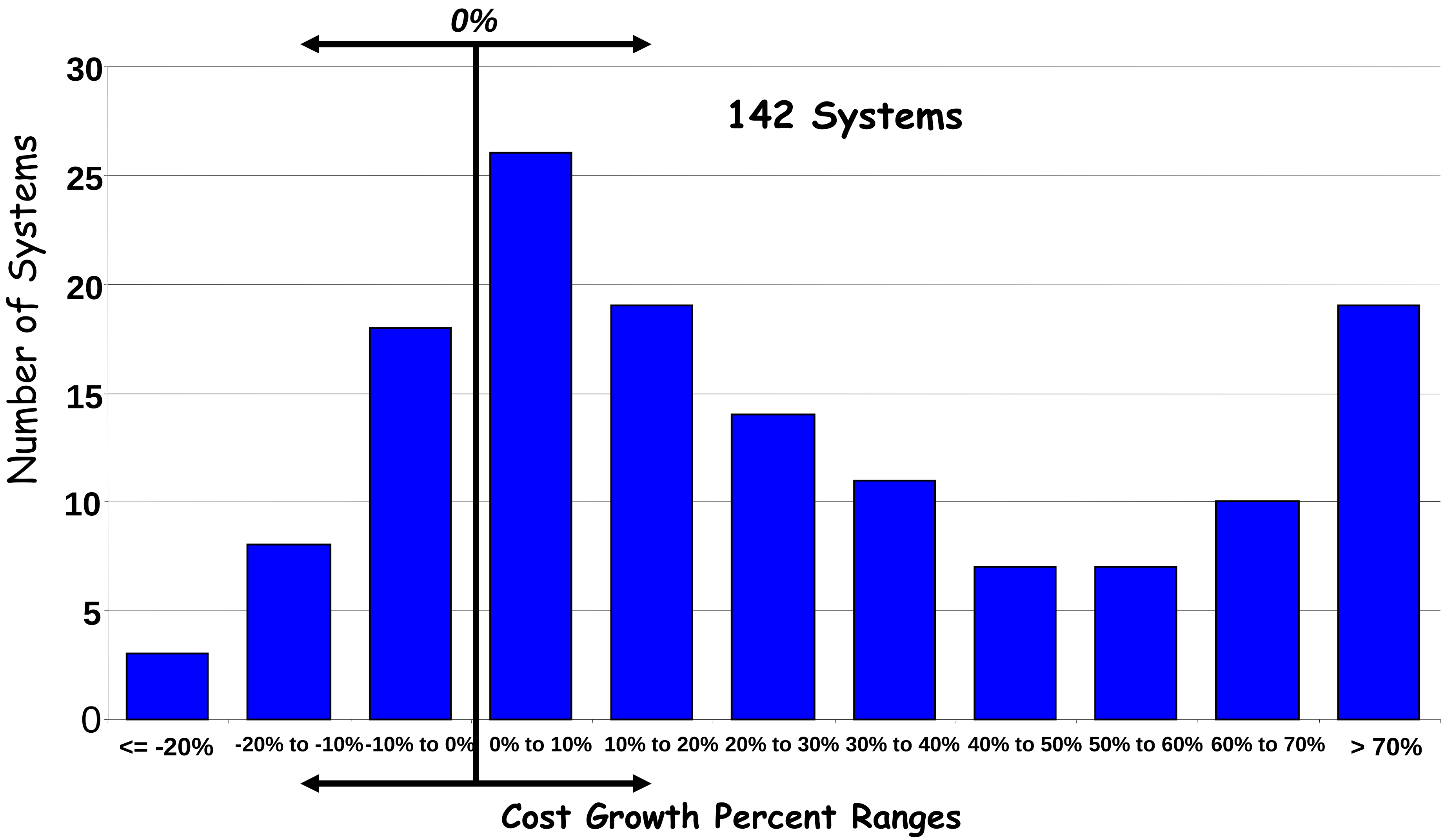
26 Programs Assessed: *AESA, AEHF, APKWS, C-5 AMP, C-5 RERP, CH-47F, CEC, E-2 AHE, EA-18G, Excalibur, EFV, ERGM, F/A-22, FCS, Global Hawk, JASSM, JSOW, JSF, JTRS Cluster 1, Land Warrior,NPOESS, Tomahawk, SDB, V-22, WIN-T, and WGS*

Weighted Average Cycle Time: weighted estimate of average acquisition cycle time for the 26 programs based on total program costs for first and latest estimates.

Source: *GAO Report 05-301, Assessments of Selected Major Weapons Systems, March 2005*

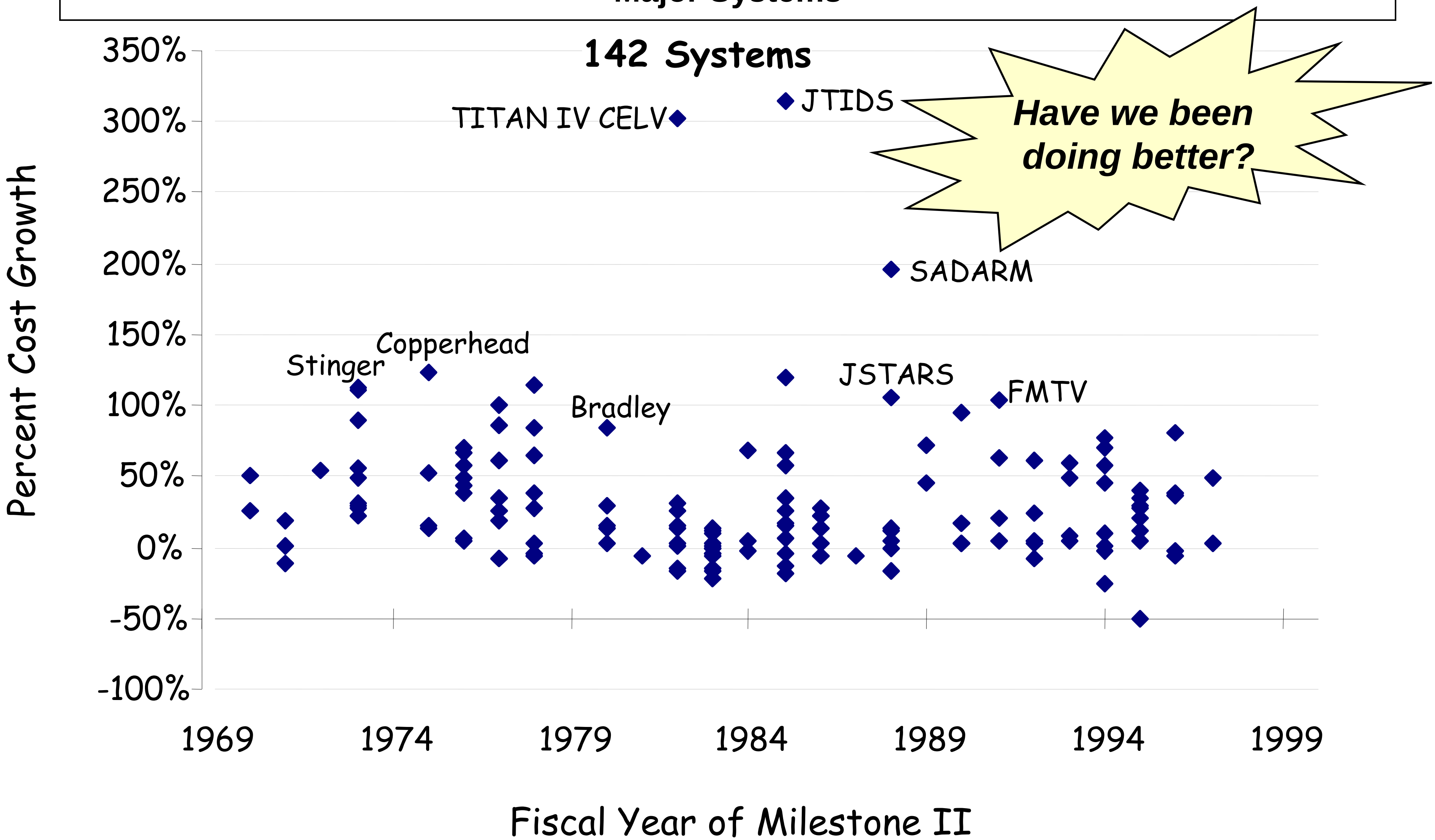
OSD CAIG Study January 2003
Cost Growth Summary

Source: OSD Cost Analysis Improvement Group (CAIG) Study: Cost Growth of Major Systems



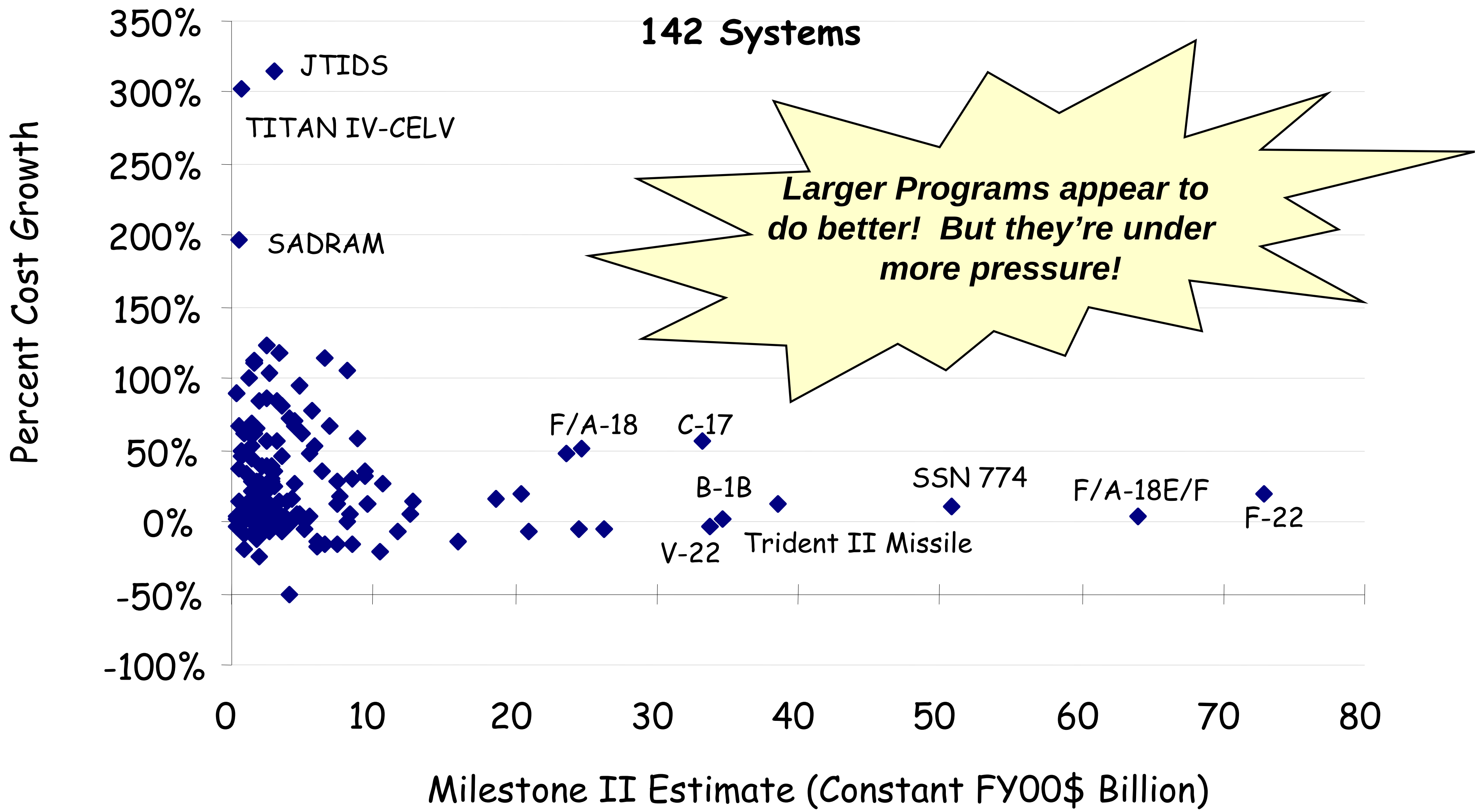
Total Cost Growth by Fiscal Year

Source: OSD Cost Analysis Improvement Group (CAIG) Study: Cost Growth of Major Systems

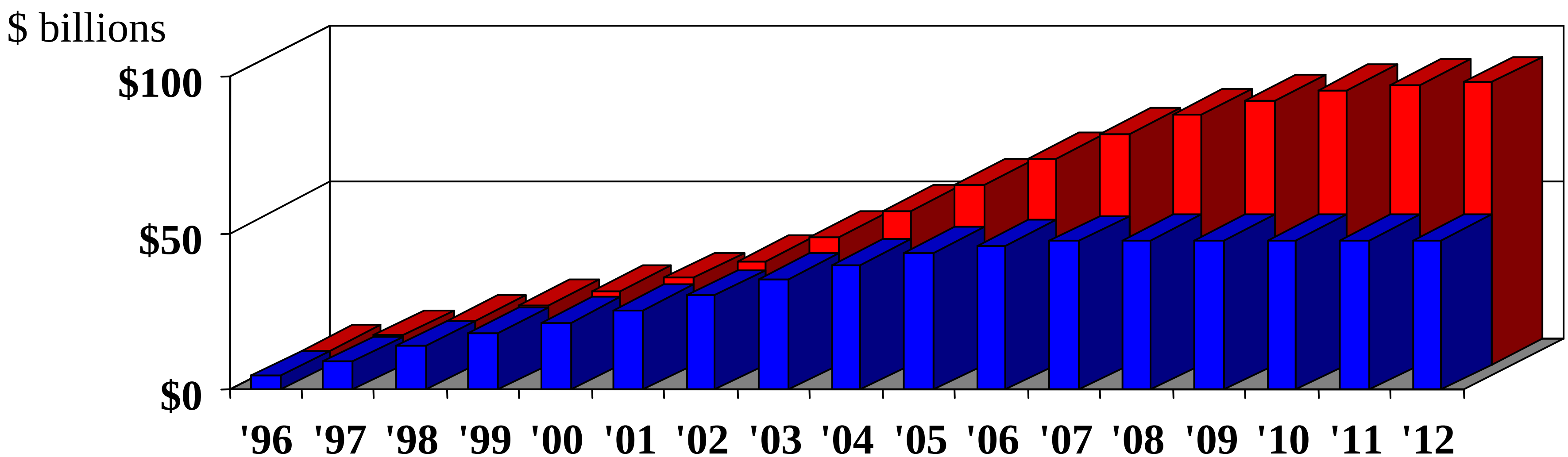


Total Cost Growth by Program Size

Source: OSD Cost Analysis Improvement Group (CAIG) Study: Cost Growth of Major Systems



Cumulative Effect of R&D Cost Growth on Developing Weapon Systems[1]

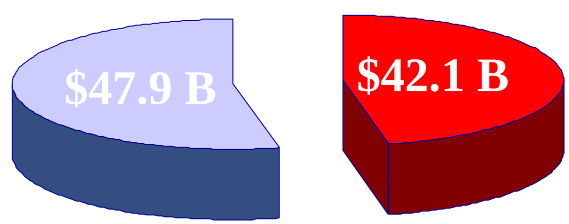


8 Programs: *JSF, Comanche, SBIRS-H, F/A-22, V-22, EFV, DDG-51, SSN-774*

FY 1998 Plan **FY 2005 Plan**

FY '05: $89.95 billion total

FY 1998 plan for completing development of 8 programs



Additional investment needed under FY 2005 plan for completing the 8 programs

Source: GAO Analysis of SAR data (12/31/96 and 12/31/03) on the 8 weapon systems among the highest R&D budget requests for FY 2003.
Note: All dollars are in constant FY 2005 dollars.

Importance of Systems Engineering

Causes of Program Cost and Schedule Growth

- Technology Maturity
- Design Stability
- Production Readiness
- Funding Stability
- Workforce Experience
- Requirements Stability
- Contractor Performance
- Parts Reliability
- Supporting System Readiness
- Configuration Control

The System Engineering Process Adds Value

- **The Systems Engineering process is crucial to DoD Acquisition Programs for meeting challenges "head-on"**
  - **Competition for Resources**
  - **Increasing Cycle Time**
  - **Cost Growth**
  - ***Restoring our "Buying Power"***
- **By providing technical rigor via a disciplined and proven process that helps us:**
  - ***Avoid those "mistakes"* that drive cost/schedule growth**
  - ***Inform "decisions"* that contribute to cost/schedule growth**

The Defense Acquisition Executive's 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 practices back into the way we do business."**

Mr. Michael Wynne
February 2004

Summary

- **While Investment Funding is projected to grow, historic trends suggest that it actually might be reduced**

- **Programs are taking longer and costing more**
  - **Completing for Available Funds**
  - **Reducing the Department's Flexibility**
  - **Reducing the Number of New Initiatives**
  - **Reducing our Buying Power**

- **Systems Engineering is a major tool for mitigating these effects**
  - **Restoring Technical Rigor to Programs**
  - **Avoiding Mistakes and Informing Decisions that affect Programs**
  - **Tracking Progress from Planning to Execution**

Services, Agencies, and Industry must take ownership of SE and institutionalize it

Next Generation Enterprise Information Management Appliances

Michael Lindow

25 October 2005

mlindow@mitre.org

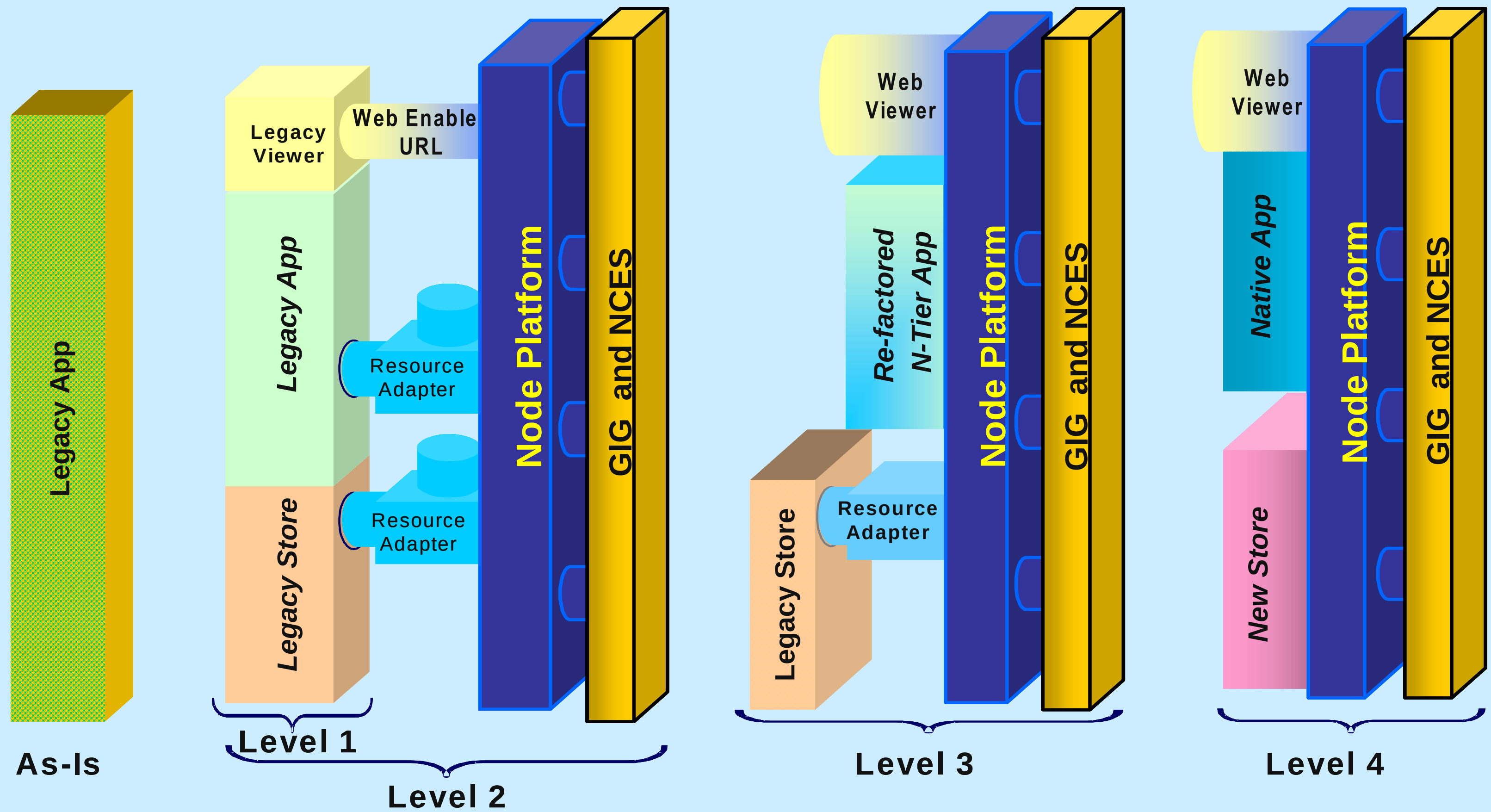
781-377-9117

Problem

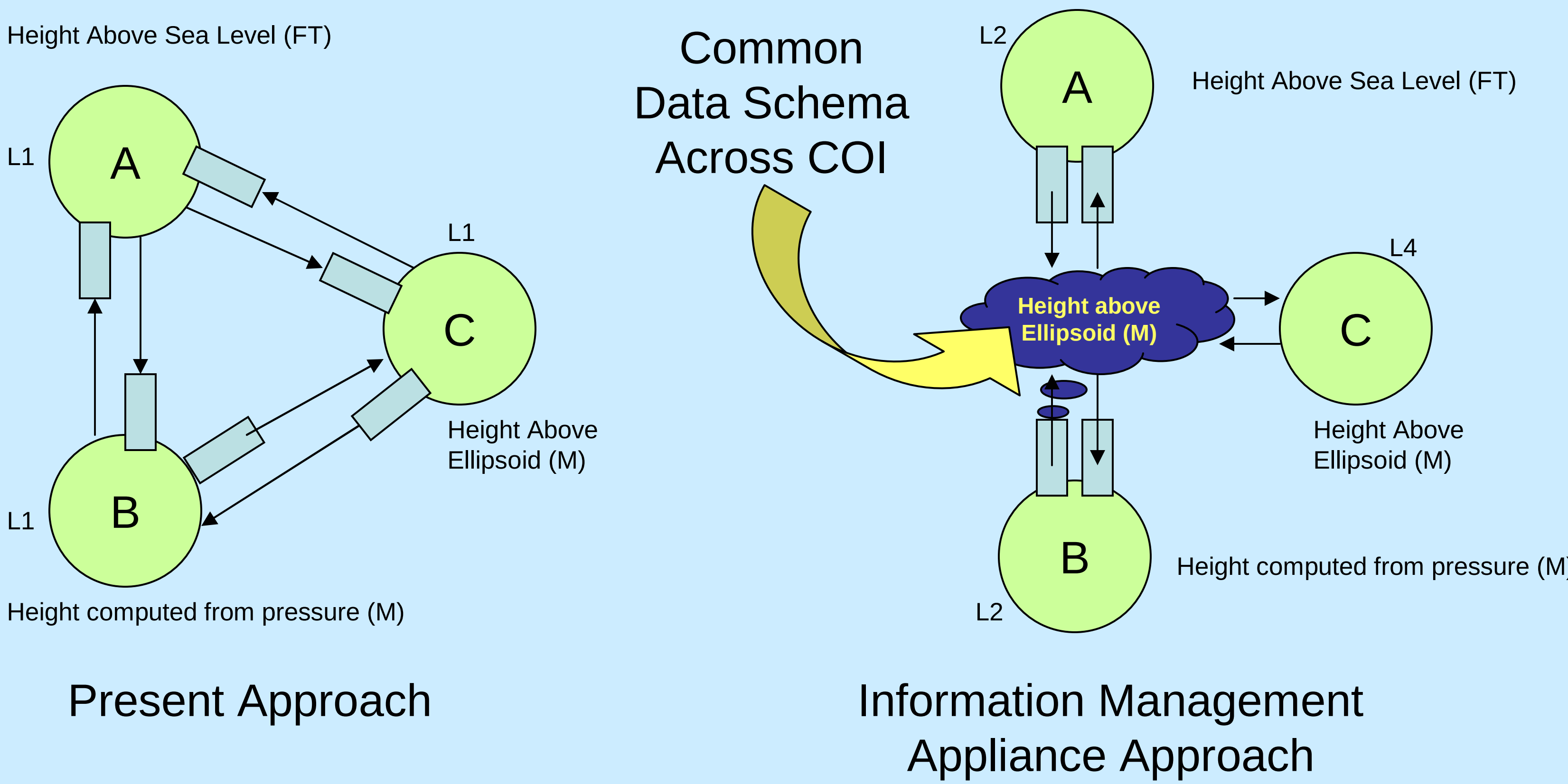
- A roadblock to integration is disparate data types across the same community of interest.
- Net-Centric technologies promise to deliver a deluge of information to consumers. (Which one's right?)
  - We need to avoid providing decision makers conflicting information
  - Information sources could be in the tens or hundreds on any discrete data point.
- Net-Centric technologies will place an increased load on information producers with time sensitive information.
  - If an information producer is the only data source then everyone will come to it for the information.
  - Current brokering approaches do not take into account best source of information and could provide consumers conflicting information.
  - UDDI is not dynamic and does not address the problem of service names and schemas being the same but the data content being different (Service Discovery)

NESI Architecture Diagram

Provide Flexibility through Multiple Levels of Migration

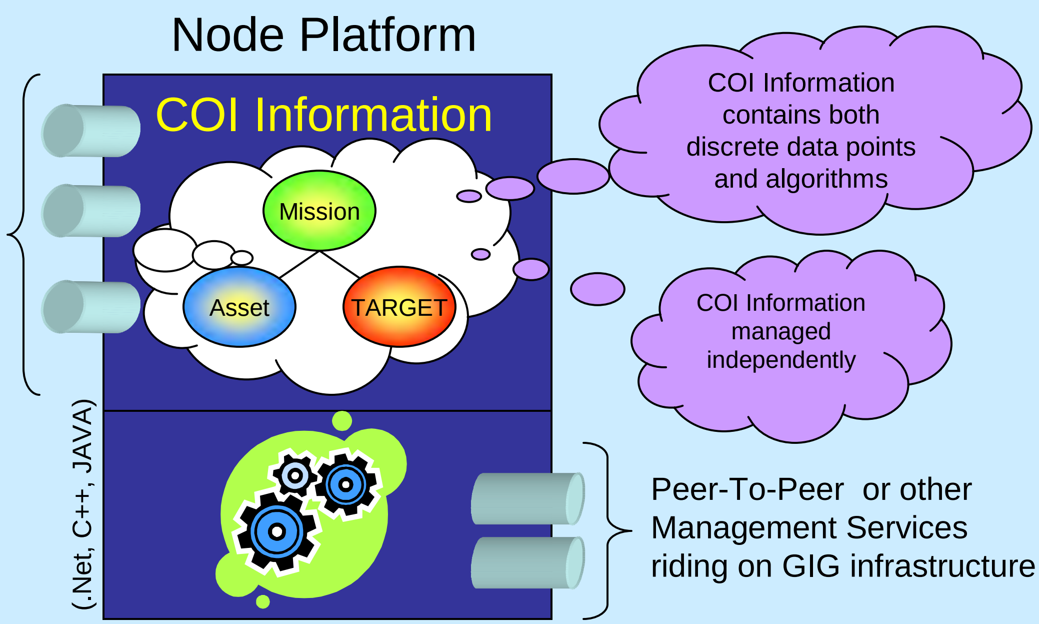


Disparate data types across the same community of interest.



Information Object Management Specification (IOMS) Fundamentals

• Information Adaptors provide interfaces to host system applications and data stores.
• Information Adaptors translate information from native system form to the common schema.



Provide a specification containing a collection of standards that are implementable across multiple *software platforms* (C++, JAVA, .Net) by multiple contractors independently.

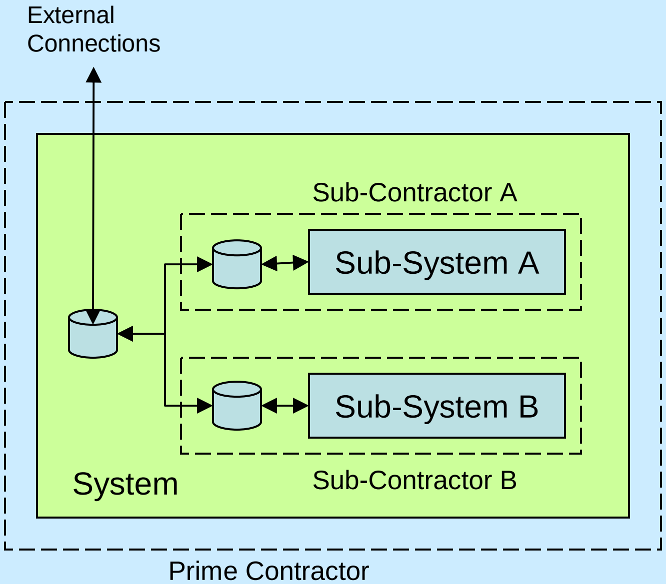
*COI = Community Of Interest

Specification Goals

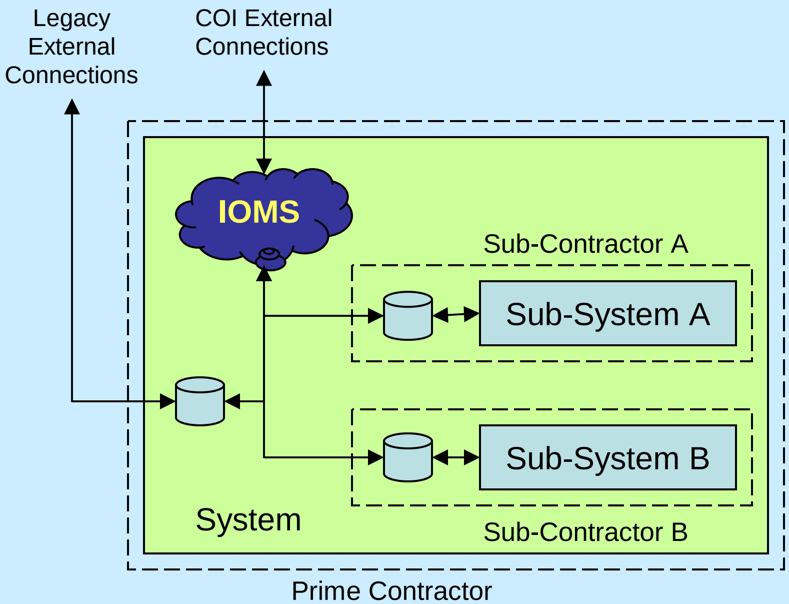
• A specification for the description of **independently managed COI data**

• A **specification for the interfaces** that would operate on the COI data and provide interfaces to and from the COI data that is implementable across multiple software platforms by multiple contractors independently

• A specification to **non-deterministically form networks** and share information across COI

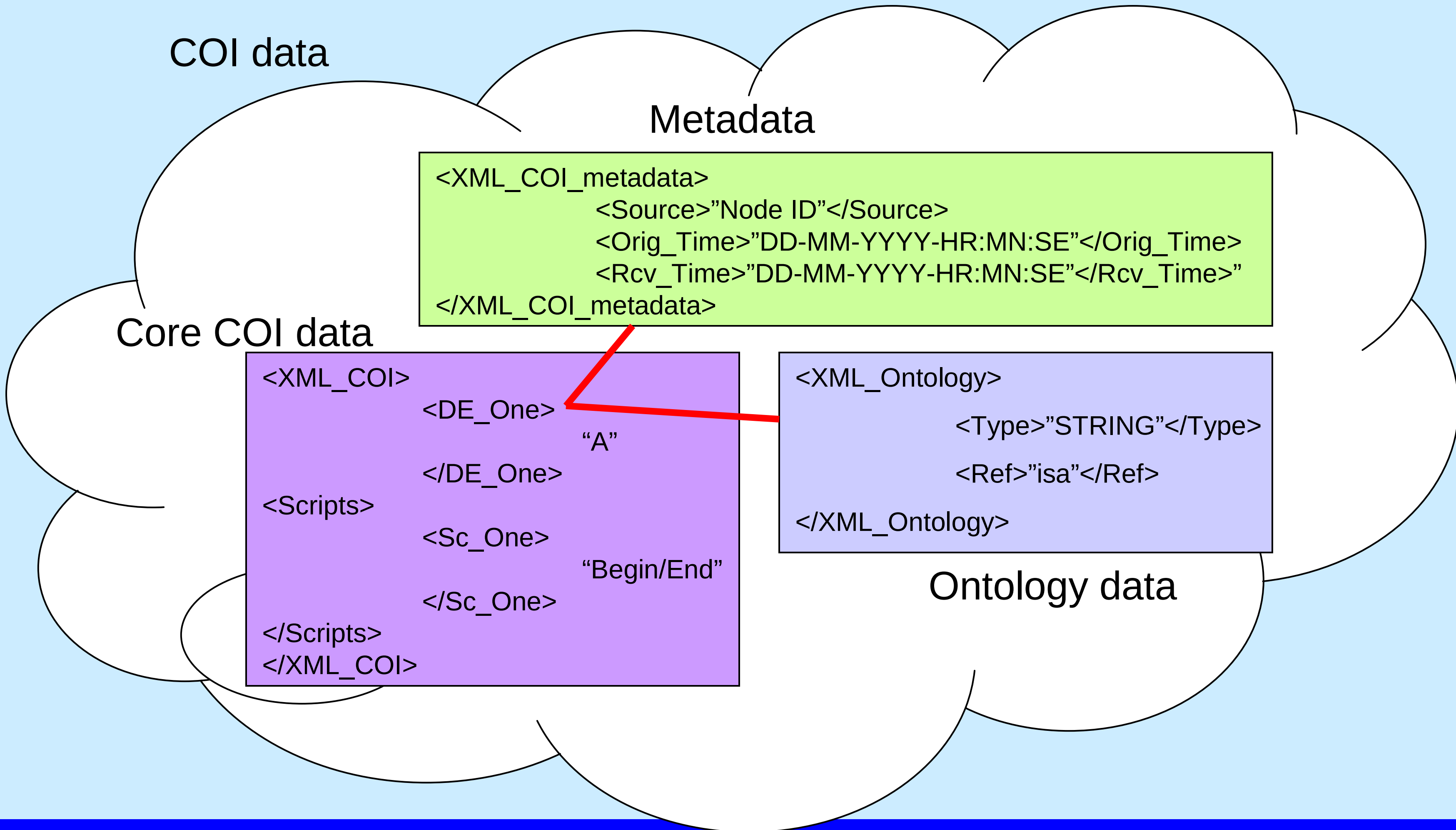


Present Approach



Information Management Appliance Approach

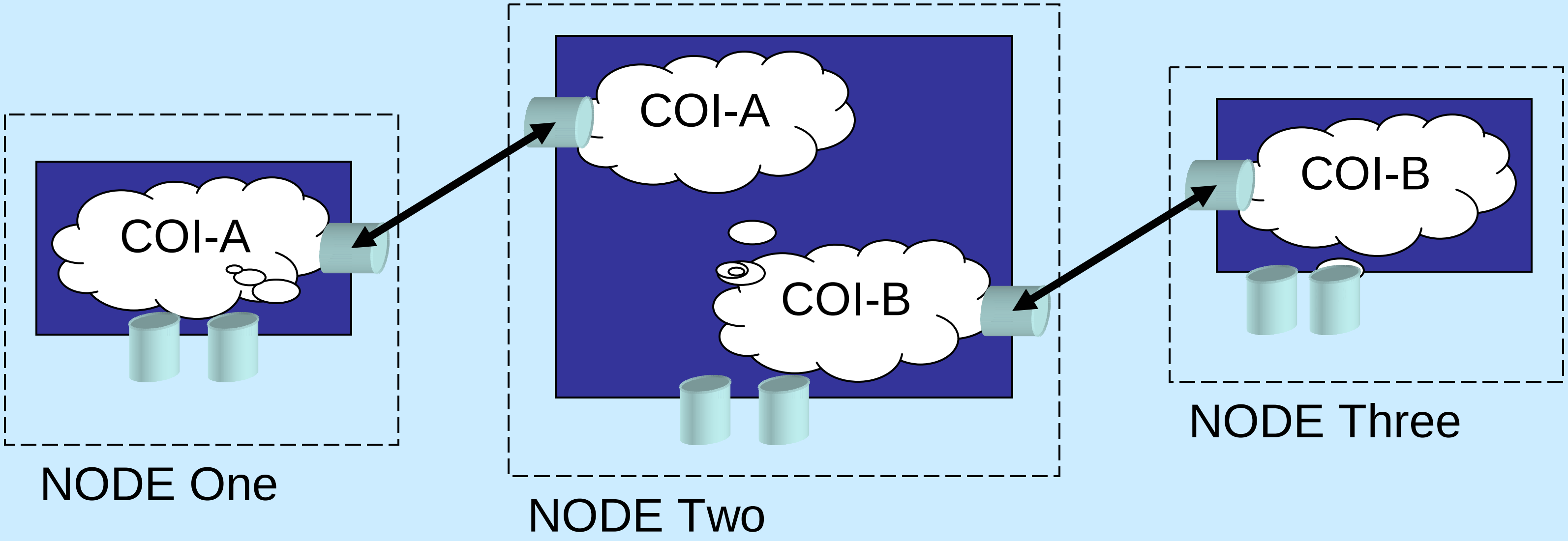
COI Data Representation



Bridging COI's Using Ontologies

Information is produced by Node One and published to COI-A

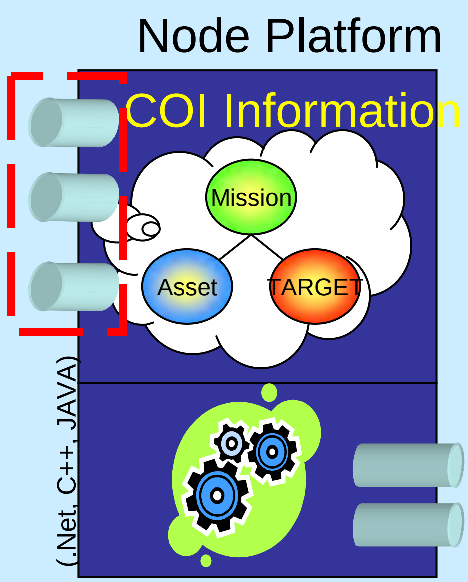
Node Three being a subscriber to the Node Two COI-B information that originated in Node One



Node Two being a subscriber to the Node One COI-A information receives the information. Because Node Two also has interest in COI-B it is aware of the relationship between COI-A & COI-B because of the Ontology data provided as part of the COI. Node Two updates COI-B with the COI-A information and metadata.

Cost of Independently Managed COI Data

- Must centrally track adapters
  - Track COI data utilization across the COI enterprise
  - Adaptor changes may be required if COI data changes impact node adaptors. Adaptors often touch numerous discrete data points
  - Easier for the enterprise to gauge impacts and know who has to be put on contract
- Because appliances are specification and interface based, they may be placed on contract independent of the COI information.
  - COI changes will only increase cost when the COI data impacts an adaptor
  - Because appliances are specification and interface based across a COI, it is more cost effective than iterations of point to point solutions
- Must maintain strong configuration control



Where we see this Heading

- Cursor On Target (COT) – Proves that providing a common schema speeds integration.

- First Prototype IOM System demonstrated – Mission Object Manager demonstrates the integration of ATO, CRD, and Link16 information.

- Trades studies to find the most appropriate standard for use in the three specifications underway.

- We should build 2 more COI schemas with meta-data and ontology's.

- We should build 3 more prototype systems to iron out shortfalls in the specification.

Michael Lindow mlindow@mitre.org 781-377-9117

Enabling Technology Readiness Assessments (TRAs) with Systems Engineering

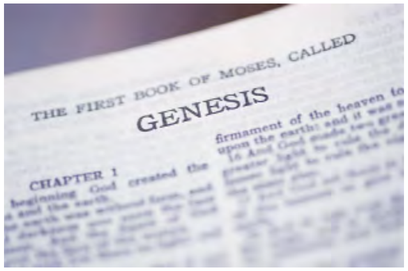
NDIA 8th Annual Systems Engineering Conference
October 24-27, 2005

Dr. Jay Mandelbaum
Institute for Defense Analyses
4850 Mark Center Drive • Alexandria, Virginia 22311-1882

Outline

- Introduction
- Technology Considerations in the SE Process During Systems Acquisition
- References and Resources

How TRAs Got Started

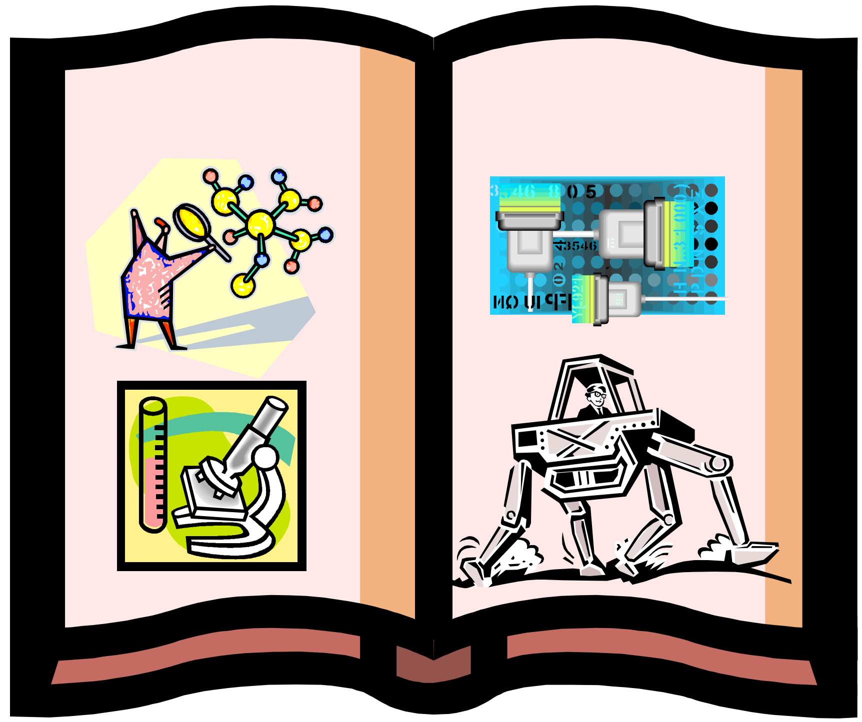


- **"Program managers' ability to reject immature technologies is hampered by (1) untradable requirements that force acceptance of technologies despite their immaturity and (2) reliance on tools that fail to alert the managers of the high risks that would prompt such a rejection."** ***GAO/NSIAD-99-162***
- **"Identify each case in which a major defense acquisition program entered system development and demonstration … into which key technology has been incorporated that does not meet the technology maturity requirement … and provide a justification for why such key technology was incorporated and identify any determination of technological maturity with which the Deputy Under Secretary of Defense for Science and Technology did not concur and explain how the issue has been resolved."** ***National Defense Authorization Act for Fiscal Year 2002***
- **"The management and mitigation of technology risk, which allows less costly and less time-consuming systems development, is a crucial part of overall program management and is especially relevant to meeting cost and schedule goals. Objective assessment of technology maturity and risk shall be a routine aspect of DoD acquisition."** ***DoDI 5000.2, paragraph 3.7.2.2***

Stop launching programs before technologies are mature

What is a TRA?

- **Systematic, metrics-based process that assesses the maturity of Critical Technology Elements (CTEs)**
  - **Uses Technology Readiness Levels (TRLs) as the metric**
- **Regulatory information requirement for all acquisition programs**
  - **Submitted to DUSD(S&T) for ACAT ID and IAM programs**



≠ Not a risk assessment

≠ Not a design review

≠ Does not address system integration

Critical Technology Element (CTE) Defined

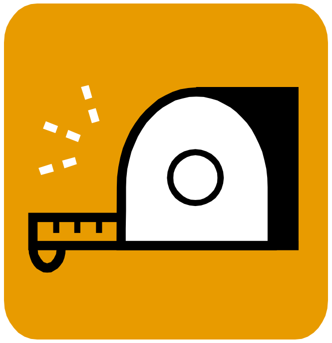
A technology element is "critical" if the system being acquired depends on this technology element to meet operational requirements with acceptable development cost and schedule and with acceptable production and operation costs *and* if the technology element or its application is either new or novel.

Said another way, an element that is new or novel or being used in a new or novel way is critical if it is necessary to achieve the successful development of a system, its acquisition or its operational utility.

CTEs may be hardware, software, or manufacturing technology; at the subsystem or component level.

TRL Overview

- Measures technology maturity
- Indicates what has been accomplished in the development of a technology
  - Theory, laboratory, field
  - Relevant environment, operational environment
  - Subscale, full scale
  - Breadboard, brassboard, prototype
  - Reduced performance, full performance



- Does not indicate that the technology is right for the job or that application of the technology will result in successful development of the system

Hardware and Manufacturing TRLs

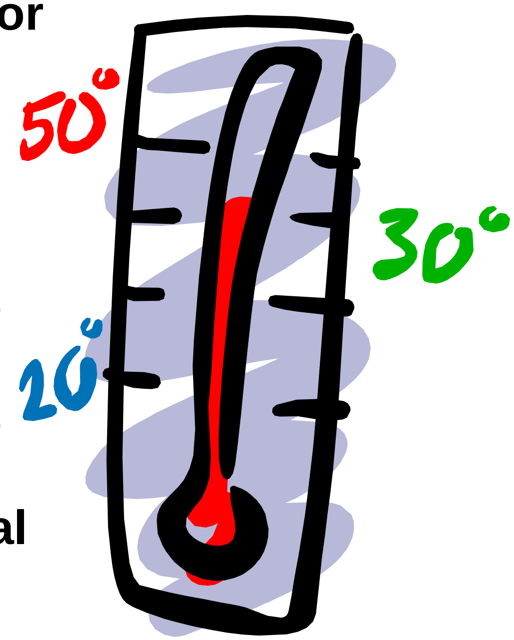
Increasing maturity

1. Basic principles observed and reported
2. Technology concept and/or application formulated
3. Analytical and experimental critical function and/or characteristic proof of concept
4. Component and/or breadboard validation in a laboratory environment
5. Component and/or breadboard validation in a relevant environment
6. System/subsystem model or prototype demonstration in a relevant environment
7. System prototype demonstration in an operational environment
8. Actual system completed and qualified through test and demonstration
9. Actual system proven through successful mission operations

Software TRLs

Increasing maturity

1. Basic principles observed and reported.
2. Technology concept and/or application formulated.
3. Analytical and experimental critical function and/or characteristic proof of concept
4. Module and/or subsystem validation in a laboratory environment, i.e. software prototype development environment
5. Module and/or subsystem validation in a relevant environment
6. Module and/or subsystem validation in a relevant end-to-end environment
7. System prototype demonstration in an operational high fidelity environment
8. Actual system completed and mission qualified through test and demonstration in an operational environment
9. Actual system proven through successful mission proven operational capabilities



Why is a TRA Important?

- The Milestone Decision Authority uses the information to support a decision to initiate a program
  - Trying to apply immature technologies has led to technical, schedule, and cost problems during systems acquisition
  - TRA established as a control to ensure that critical technologies are mature, based on what has been accomplished

- Highlights critical technologies and other potential technology risk areas that require PM attention (and possibly additional resources) both at program initiation and before low rate initial production
- Congress receives a report on immature CTEs in programs

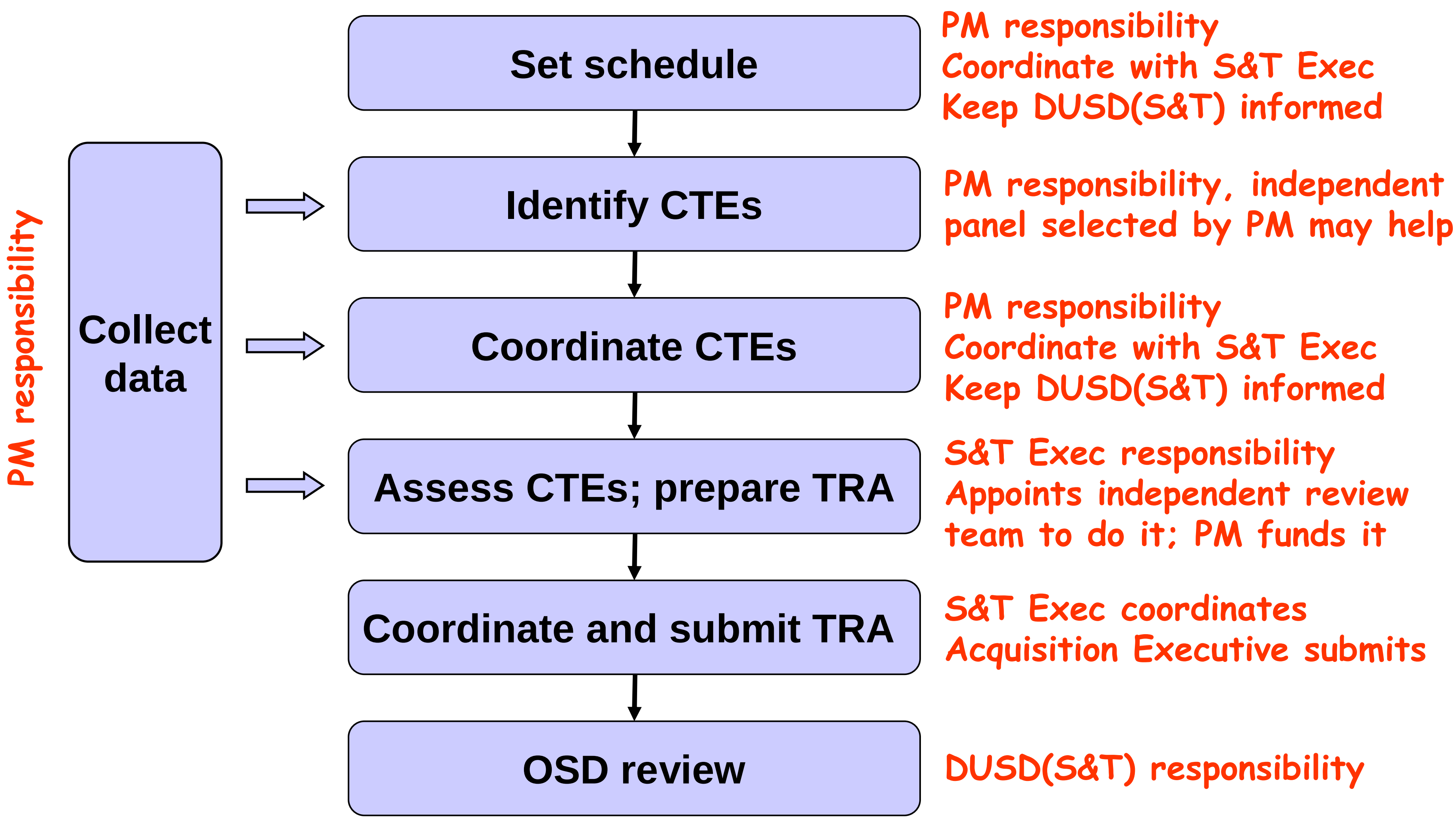
Quantifying the Effects of Immature Technologies

According to a GAO review of 54 DoD programs:

- **Only 15% of programs began SDD with mature technology (TRL 7)**
  - **Programs that started with mature technologies averaged 9% cost growth and a 7 month schedule delay**
  - **Programs that did not have mature technologies averaged 41% cost growth and a 13 month schedule delay**
- **At critical design review, 42% of programs demonstrated design stability (90% drawings releasable)**
  - **Design stability not achievable with immature technologies**
  - **Programs with stable designs at CDR averaged 6% cost growth**
  - **Programs without stable designs at CDR averaged 46% cost growth and a 29 month schedule delay**

Source: Defense Acquisitions: Assessments of Selected Major Weapon Programs, GAO-05-301, March 2005

Process Overview



Outline

- **Introduction**
- **Technology Considerations in the SE Process During Systems Acquisition**
- **References and Resources**

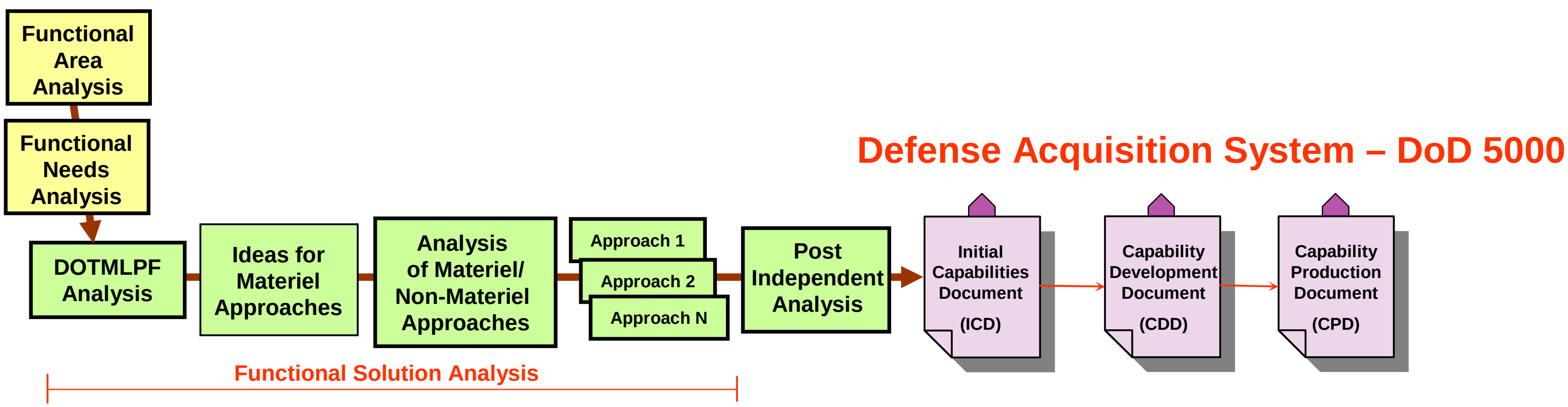
Joint Capabilities Integration and Development System (JCIDS)

Strategic Guidance --

National Security Strategy/National Defense Strategy/National Military Strategy

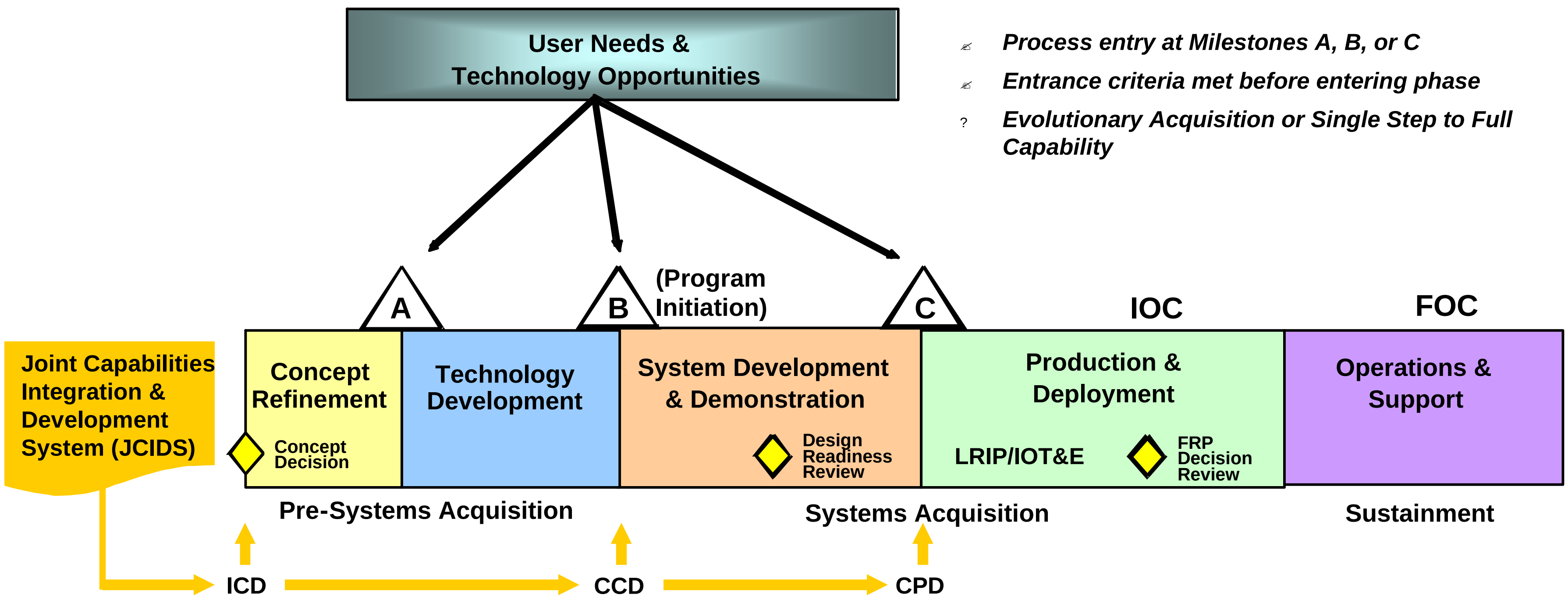
Family of Joint Future Concepts
Concepts of Operations
Joint Tasks

Integrated Architectures



JCIDS governed by -- CJCSI 3170

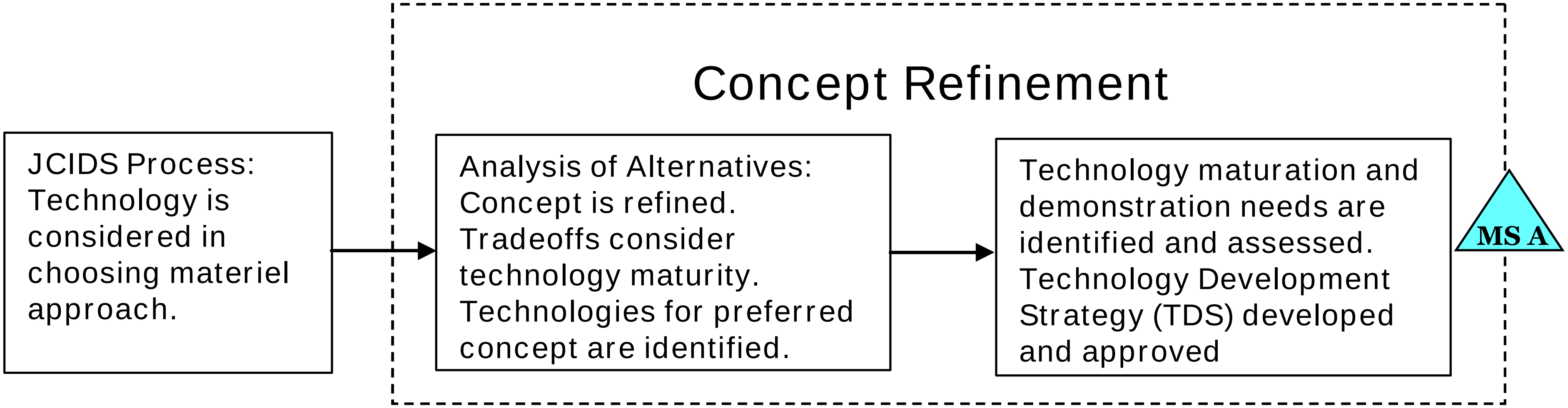
Overview of Technology Considerations During Systems Acquisition



TRAs required at MS B, MS C, and program initiation for ships (usually MS A).

Pre MS A

Technology Considerations Pre Milestone A



CTE identification begins in JCIDS process.
By MS A, CTE component should be demonstrated in a laboratory.

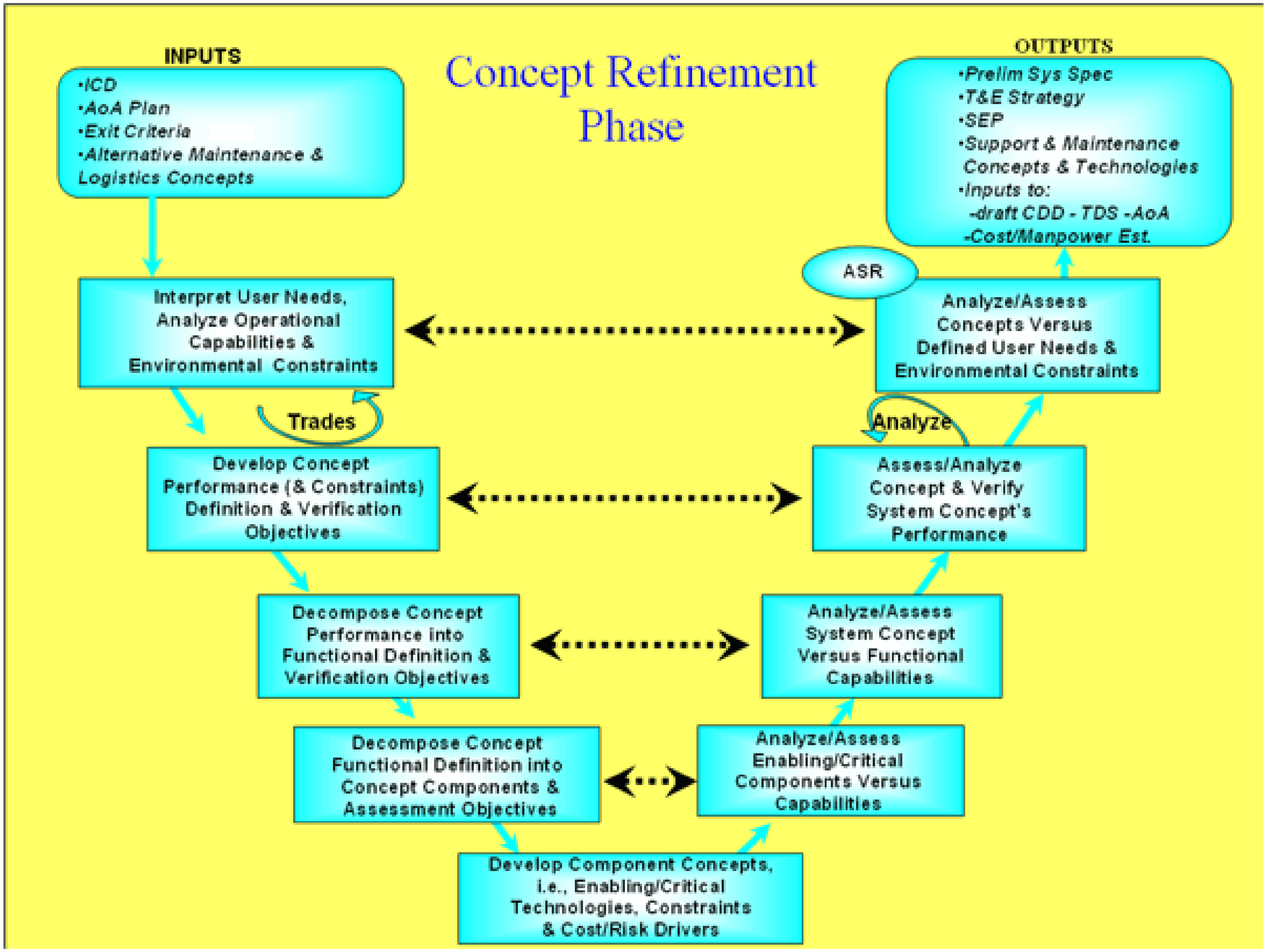
Pre MS A

The Concept Refinement Phase

- **The purpose is to refine the initial concept and prepare a Technology Development Strategy (TDS)**
- **Guided by an Analyses of Alternatives (AoA) Plan for assessing the critical technologies associated with alternative system concepts, including technology maturity, technical risk, and if necessary, technology maturation and demonstration needs.**
- **Ends at Milestone A when Milestone Decision Authority approves:**
  - **Preferred system concept resulting from the AoA**
  - **Associated Technology Development Strategy**

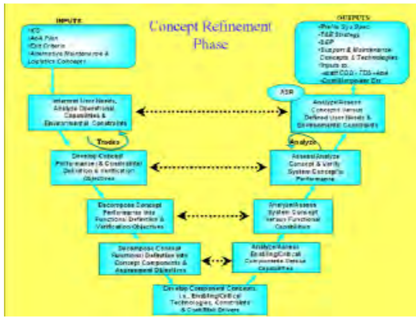
Pre MS A

Overview of Systems Engineering-Related Steps During Concept Refinement



Pre MS A

Overview of Systems Engineering-Related Steps During Concept Refinement (cont'd)

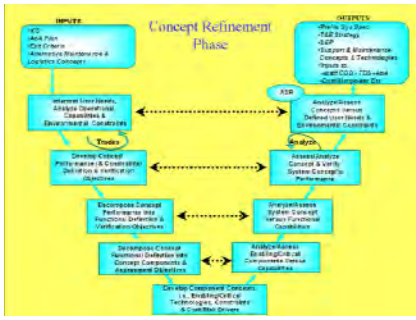


Systems engineering provides top level, iterative analytical processes for each alternative system concept that encompass:

- **Requirements analysis, functional analysis and design**
  - **Occurs iteratively and recursively**
  - **Functional analysis links requirements and system design**
- **Trade offs among system operational requirements, operational utility, and cost, to arrive at best system solution within allowed constraints**
- **Resource allocation guiding design choices**
- **Verification at each step confirming that specified requirements have been fulfilled**
- **Validation at the end of the process confirming that the refined concept meets the needs of the user**

Pre MS A

Purpose of Systems Engineering in Concept Refinement

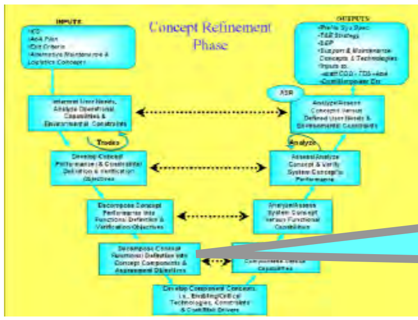


Systems engineering process can provide a technical evaluation of the operational effectiveness and estimated costs of the alternative system concepts that may provide a materiel solution to a needed mission capability

- **CTEs must be identified as part of the systems engineering process during the AoA**
  - **CTEs may be performance related or manufacturing related if production costs are too high**
- **CTE maturity must be a critical input to the decision on the preferred system concept**
- **The Technology Development Strategy encompasses the plans for maturing the CTEs associated with the preferred system concept**

Pre MS A

System Engineering / TRA Interfaces During Concept Refinement (1 of 3)

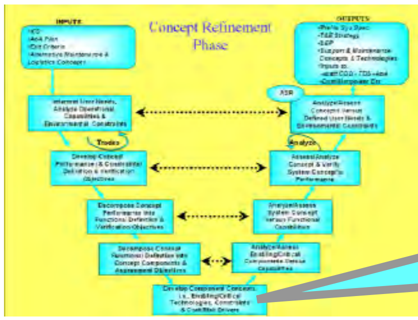


Decompose Concept Functional Definition into Concept Components & Assessment Objectives

- **Initiates the design process for each alternative system concept**
- **First cut at a top level physical architecture or work breakdown structure (system architecture for an IT system)**
- **Iteratively expands physical and functional architecture into greater levels of detail to get a better idea of the design (system and operational views for an IT system)**
- **Framework for beginning CTE identification**

Pre MS A

System Engineering / TRA Interfaces During Concept Refinement (2 of 3)

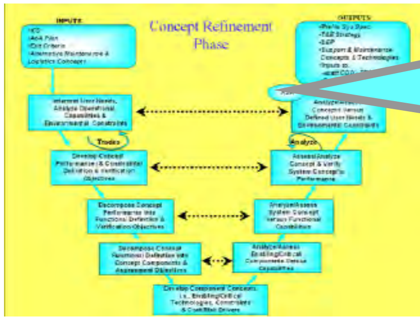


Develop Component Concepts, i.e., Enabling/Critical Technologies, Constraints & Cost/Risk Drivers

- **For each alternative concept, conduct paper studies and build breadboards to evaluate the maturity of the CTEs**
- **Studies and breadboards must be detailed enough to formulate the Technology Development Strategy**

Pre MS A

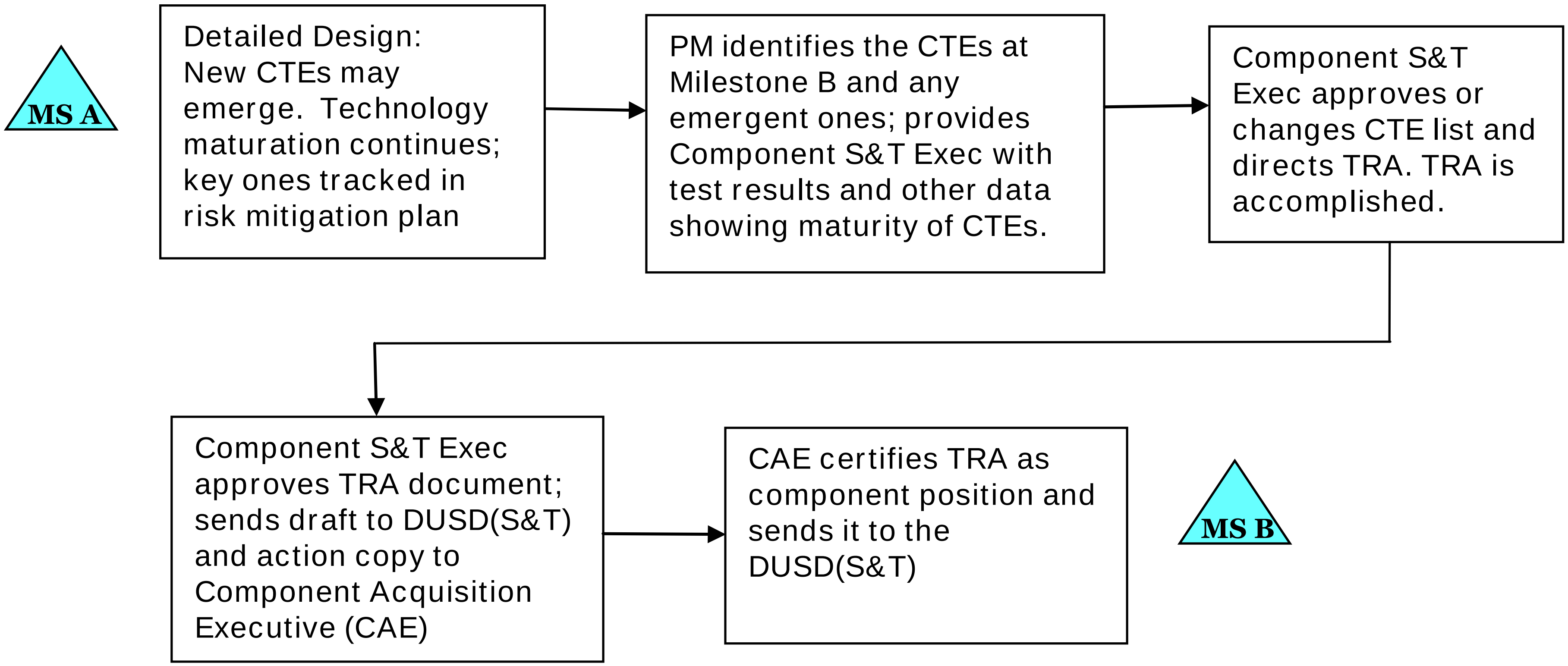
System Engineering / TRA Interfaces During Concept Refinement (3 of 3)



The Alternative System Review (ASR) is a multi-disciplined technical review to ensure that the resulting set of requirements meets the customers' needs and expectations and that the system can proceed into the TD phase. It's completion provides in part:

- **A recommendation on the preferred system concept(s) to take forward** ***(basis for the TRA)***
  - **A comprehensive rationale for the preferred solution, including the AoA that evaluated relative cost, schedule, performance (hardware, human, software), and technology risks**
- **Refined thresholds and objectives initially stated as broad measures of effectiveness** ***(first cut maturity goals for CTEs)***
- **Completed, comprehensive planning for the Technology Development phase (hardware, software and manufacturing), that addresses critical components to be developed and demonstrated, their cost, and critical path drivers** ***(CTE maturation plan)***
  - **A comprehensive risk assessment and risk reduction concept for the Technology Development phase**

Technology Considerations During the Technology Development Phase



By MS B, CTE subsystem should be demonstrated in a relevant, preferably operational environment.

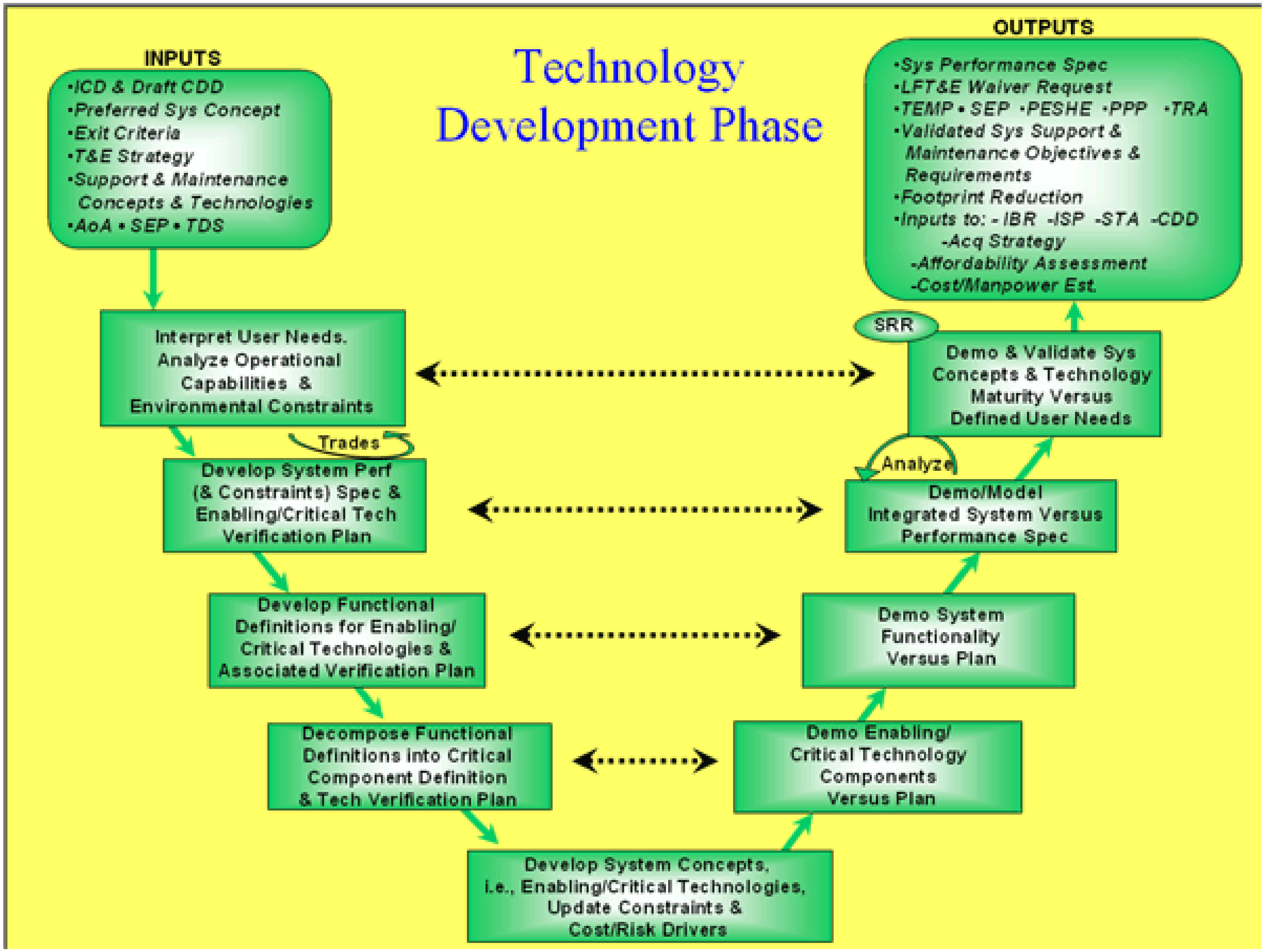
Pre MS B

The Technology Development Phase

- The purpose is to reduce technology risk and to determine the appropriate set of technologies to be integrated into a full system
- Guided by a Technology Development Strategy for maturing those technologies critical to achieving the required capabilities
- Ends, at Milestone B, when an affordable increment of militarily-useful capability has been identified, the technology for that increment has been demonstrated in a relevant environment, and a system can be developed for production within a short timeframe (normally less that five years)

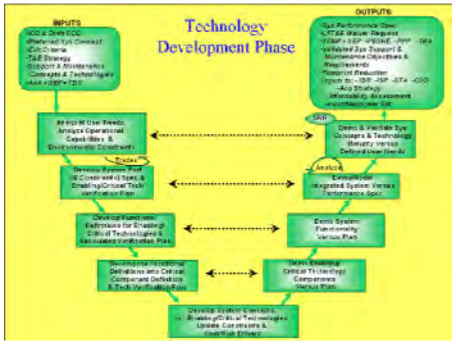
Pre MS B

Overview of Systems Engineering-Related Steps During Technology Development



Pre MS B

Overview of Systems Engineering-Related Steps During Technology Development (cont'd)

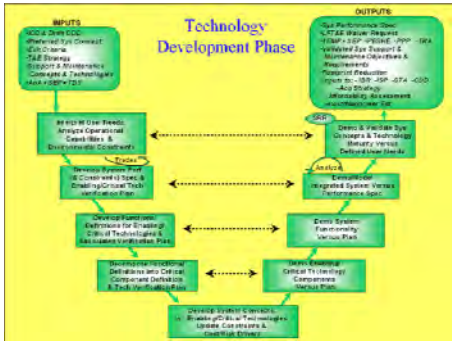


Systems engineering provides comprehensive, iterative processes to accomplish the following activities for critical subsystems:

- **Conduct trade studies and convert required capabilities into performance specifications**
- **Translate user-defined performance parameters into configured critical subsystems**
- **Characterize and manage technical and production risk**
- **Transition technology from the technology base into program specific efforts**
- **Verify that preliminary designs meet operational needs**

Pre MS B

Purpose of Systems Engineering in Technology Development

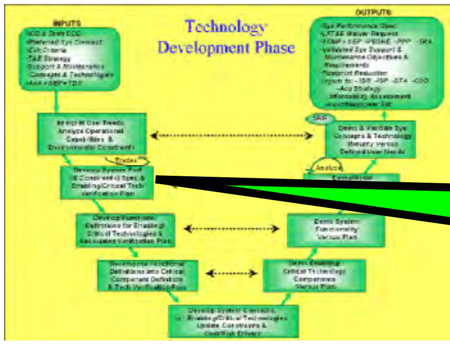


Systems engineering process used to develop the suite of technologies for the preferred system solution

- **CTEs will be matured from (at worst) having a component and/or breadboard validation in a laboratory environment to system/subsystem model of prototype demonstration in a relevant environment**
  - **Applies to critical hardware, software and manufacturing technologies**
- **While most of the CTEs will have been identified during Concept Refinement for the Technology Development Strategy, additional CTEs may be uncovered in the maturation process**

Pre MS B

System Engineering / TRA Interfaces During Technology Development (1 of 5)

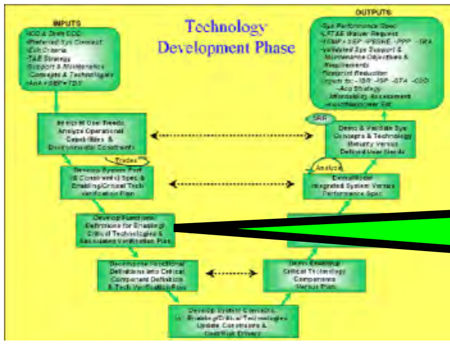


Develop System Perf (& Constraints) Spec & Enabling/Critical Tech Verification Plan

- **Begins where Concept Refinement finished**
- **Processes apply to each technology development effort – in effect, a “V” for each critical subsystem**
- **Establishes the top level critical subsystem requirements**

Pre MS B

System Engineering / TRA Interfaces During Technology Development (2 of 5)

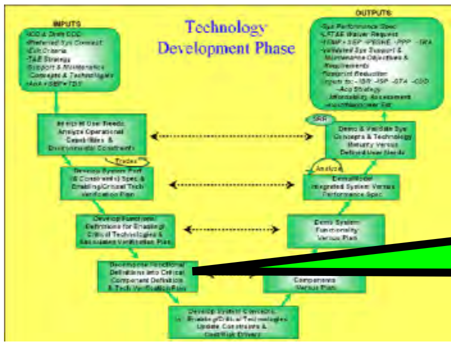


Develop Functional Definitions for Enabling/ Critical Technologies & Associated Verification Plan

- **Functional decomposition in greater detail (operational view for an IT system)**
- **Trade space and risk should be re-analyzed and assessed against available technologies**
- **Enabling and/or critical technologies finalized**
- **Technology functional performance specified** ***(final CTE maturity goals)***

Pre MS B

System Engineering / TRA Interfaces During Technology Development (3 of 5)

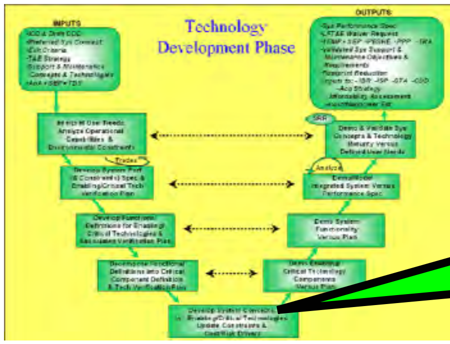


Decompose Functional Definitions into Critical Component Definition & Tech Verification Plan

- **Adds greater levels of detail to the physical architecture (system view for an IT system)**
- **Defines components that will provide the required functionality – these are the CTEs**
  - **New CTEs may emerge**
- **Additional tradeoffs occur to stay within program constraints or identify mature technology alternatives**

Pre MS B

System Engineering / TRA Interfaces During Technology Development (4 of 5)

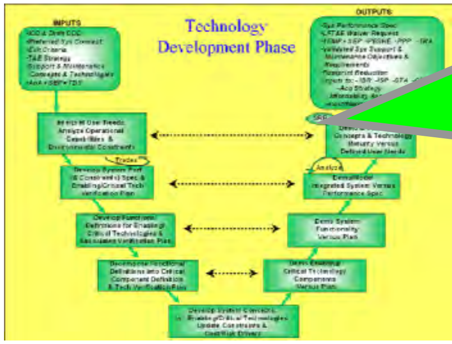


Develop System Concepts, i.e., Enabling/Critical Technologies, Update Constraints & Cost/Risk Drivers

- **All basic design requirements have been analyzed, defined and reconciled with constraints**
- **Components (CTEs) are synthesized to allow verification of the components against requirements**
- **Prepare for tests to demonstrate CTEs in a relevant environment**

Pre MS B

System Engineering / TRA Interfaces During Technology Development (5 of 5)

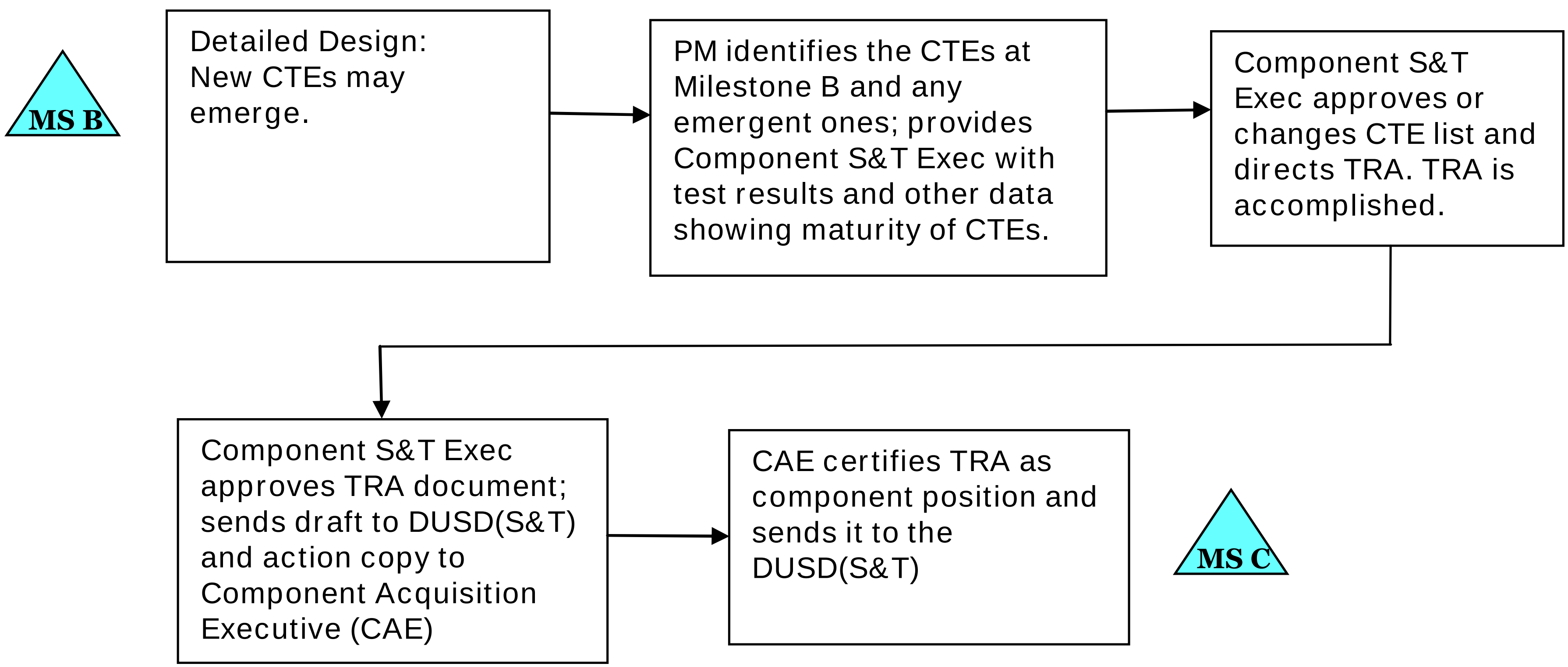


The System Requirements Review (SRR) is a multi-disciplined technical review to ensure that the system can proceed into the SDD phase, and that all system requirements and performance requirements are defined and are consistent with cost, schedule, risk, and other system constraints. It's completion provides in part:

- **An approved preliminary system performance specification**
- **A preliminary allocation of system requirements to hardware, human, and software subsystems**
- **A determination that the available technology, and program resources (funding, schedule, staffing, and processes) form a satisfactory basis for proceeding into the SDD phase**
- **A comprehensive risk assessment for System Development and Demonstration** ***(TRA is input to this assessment)***

Pre MS C

Technology Considerations During the System Development and Demonstration Phase



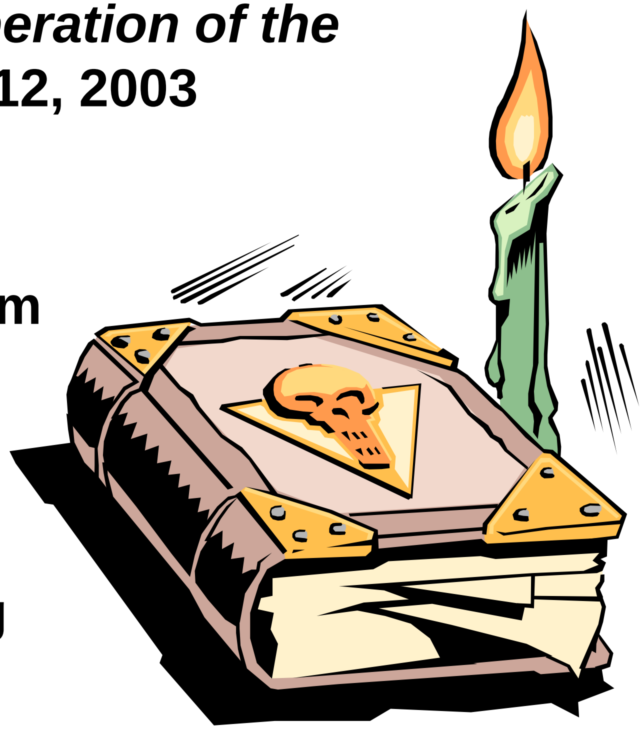
By MS C, system prototype should be demonstrated in an operational environment.

Outline

- **Introduction**
- **Technology Considerations in the SE Process During Systems Acquisition**
- **References and Resources**

References and Resources

- **Defense Acquisition Resource Center http://akss.dau.mil/darc/darc.html**
  - **DoD Directive 5000.1 (DoDD 5000.1), *The Defense Acquisition System*, dated May 12, 2003**
  - **DoD Instruction 5000.2 (DoDI 5000.2), *Operation of the Defense Acquisition System*, dated May 12, 2003**
  - ***Defense Acquisition Guidebook***
- ***TRA Deskbook* http://www.defenselink.mil/ddre/weapons.htm**
- **DDR&E**
  - **Mr. Jack Taylor jack.taylor@osd.mil**
- **Institute for Defense Analyses**
  - **Dr. Cynthia Dion-Schwarz cdion@ida.org**
  - **Dr. Jay Mandelbaum jmandelb@ida.org**



Contact info

- Jay Mandelbaum
- Institute for Defense Analyses
- jmandelb@ida.org
- 703-845-2123

"Implementation of ESE/A"

Mr. Kelly A. Miller, NSA/CSS CSE

NSA/CSS ESE/A Priorities…

- Complete Enterprise Integrated Master Schedule
- Complete Operational Capabilities Baseline
- Provide Architecture guidance to program managers
- Ensure Architecture alignment
- Provide interface specifications and registry
- Provide standards guidance and registry
- Ensure effective integration and test
- Provide a technical review process for the programs
- Perform SE analysis, reviews and provide guidance to programs
- Offer SE training and certification
- Enhance sense of SE/A as cohesive, supportive community
- Enhance SE position as “first responder” for the corporation

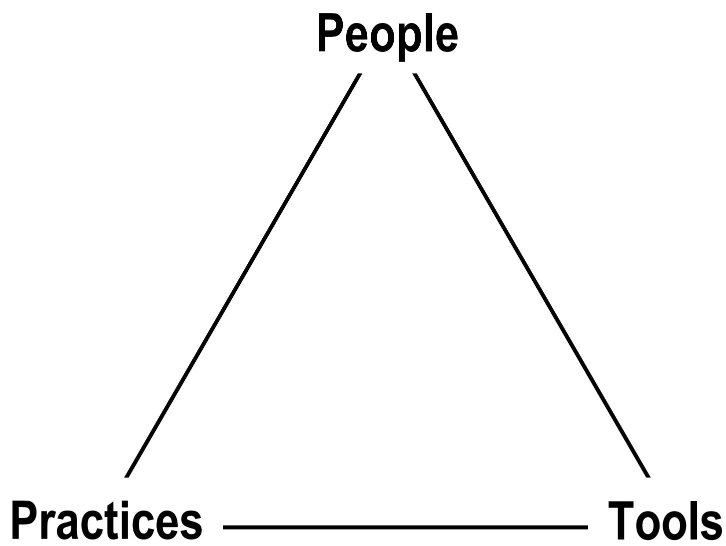
Applying CMMI to System Safety

APT Research, Inc.

Tom Pfitzer

Good System Safety Programs

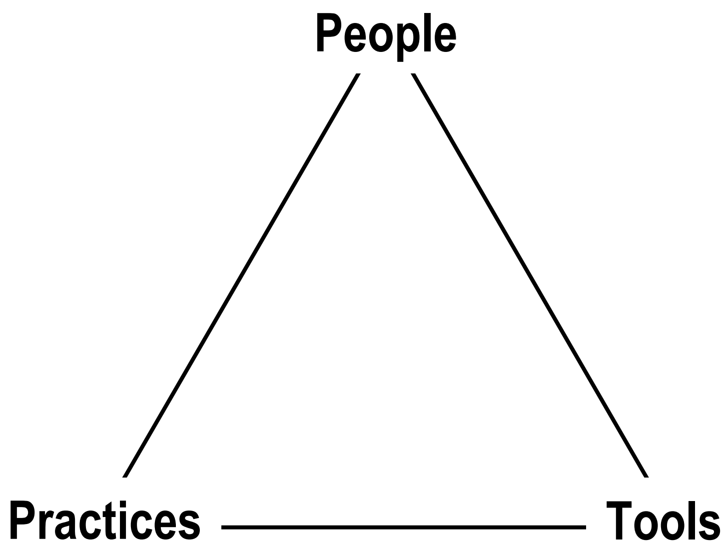
A combination of factors related to people, practices and tools result in the goodness of a system safety program



Each of the main factors can be evaluated to predict the adequacy of the resulting safety program

The CMM Concept

The maturity of an organization's capability depend upon 3 interrelated elements



Maturity is measured by

Achievement Levels:

0 – Incomplete/Entry-level or repeated fledgling level analyses, casually performed

1 – Pro forma/Perfunctorily

2 – Managed (work guided and overseen by trained Supv.)

3 – Defined

4 – Quantified (Metrics applied to various determinants/discriminants)

5 – Optimized (Superior)

Why CMM?

Capability Maturity Model Integration

"…the quality of a system or product is highly influenced by the quality of the process used to develop and maintain it."

Mary Beth Chrissis, et al

"You take you car into a lousy shop, you're gonna get a lousy job!"

Tom & Ray Magliazi

The Use of the CMMI approach could provide:

A. Government organizations a means to specify or evaluate industry safety programs

B. Mature industry and government programs a means to "certify" existing maturity

C. Immature industry or Government programs a way ahead toward more maturity

The CMMI Approach to any discipline such as System Safety

A-P-T Research, Inc.

	Personnel			Methods			Tools		
	P_1	P_2	P_3…	M_1	M_2	M_3…	T_1	T_2	T_3…
0 - Incomplete	None	None	None	None	None	None	None	None	None
1 – Performed	x	y	z	a	b	c	q	r	s
2 – Managed	xx	yy	zz	aa	[illegible]	[illegible]	[illegible]	rr	ss
3 – Defined	xxx	yyy	zzz	[illegible]	[illegible]	ccc	qqq	rrr	sss
4 – Quantitatively Managed	xxxx	yyyy	zzzz	aaaa	bbbb	cccc	qqqq	rrrr	ssss
5 - Optimized	xxxxx	yyyyy	zzzzz	aaaaa	bbbbb	ccccc	qqqqq	rrrrr	sssss

Notional

Measurement Categories

Measurement Indices

Levels of Maturity

Personnel

	P_1 - Training	P_2 - Experience	P_3 - Credentials	P_4 - Depth of Staff	P_5 …
0	None	None		0 - 1 Fulltime	
1	1 Week Training	1 – 3 Years			
2	3 – 5 Short Courses	3 – 7 Years	SSS Me[illegible]		
3		7 – 15 [illegible]			
4		15 – 25 Years			
5	Advanced Degree in System Safety	25 + Years	Advanced Degree		

Methods

	M_1 – Review of Analysis	M_2 – Matrix Tailoring	M_3 – Mission Phasing	M_4 – Asset Selection	M_5 – Use Effectiveness Hierarchy	M_6 – Use of Risk Tolerant Limits	M_7 – Hazard Tracking
0							
1	None performed (solo Analysis)	None performed	None	Pro-forma (ad-hoc)	Not evident		None
2	Peer (1)	Disciplined matrix selection	Modest, pro-forma (eg., startup/run/stop)	Two, rote-selected	Used but not monitored		Informal
3	Peer/Mgmnt (>1 or 1st level mgmnt)	Subjective matrix tailoring	TBD	[illegible], selected	Used and Monitored		Procedure-driven, documented
4	Mgmnt (2nd level)	Quantitative matrix scaling	All significant transients	3, + severity levels tailored to case	Use enforced		Coupled w/Config. Mgmnt. or Quality Prgm
5	3rd Party (>5 long-term sample)	Full Matrix (indicates/spans /Resolution)	4, + maintenance/ calibration, etc.	3 & 4, + maintenance/ calibration, etc.	4, + design change use generously evident		4, + auditable evidence of closeout

A-P-T Research, Inc.

Methods (cont.)

	M_8 – Influence of Design	M_9 – Cross Coupled "illities"	M_{10} – Selection of Risk Tolerant Limits	M_{11} – Risk Summation	M_{12} – Hazard Identification
0					
1	None	None	Pro-forma	None	"What-if"
2	Infrequent design reviews (e.g., 30/60/90%)	Modest, informal cross-feed w/Reliability	TBD	Subjective, loosely disciplined	1, + Checklist
3	Frequent design reviews (e.g., ≈15% intervals)	Formal, mandatory cross-feed w/Reliability	TBD	Procedurally documented	2, + Energy source inventory
4	Concurrent engineering	TBD	TBD	3, + Numerically done	Operational walkthroughs
5	Designers trained/intermediate application	Full-bore, readily auditable w/Reliability, Availability	Tailored to program/system needs	Rigorous	3 &4, + FMEA or HAZOP, or FHA

Tools

	T_1 – Hazard Inventory Tools	T_2 – Logic Tree Tools	T_3 – Probalistic Risk Assessment
0			
1	PHL	FTA (unquantified)	TBD
2	PHA (w/o matrix use)	ETA (unquantified)	TBD
3	PHA or HAZOP (w/matrix)	FTA a/o ETA (quantified)	TBD
4	FMEA or FHA	CCA (quantified)	TBD
5	Top-Down + Bottom-Up	CCA + (FTA or ETA)	TBD

Conclusion

- If interest exists, G-48 could develop recommended standards to measure/evaluate System Safety program maturity.
  - APT will host a collegial workshop to define a strawman set of measurement categories and indices for each.
  - Produce a report with recommended categories and indices.

Contact Information:

Tom Pfitzer

256.327.3388

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pfitzer@apt-research.com

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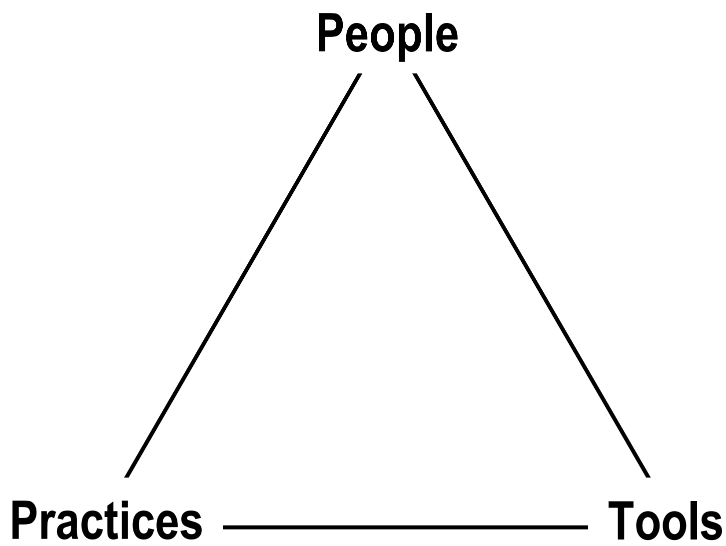

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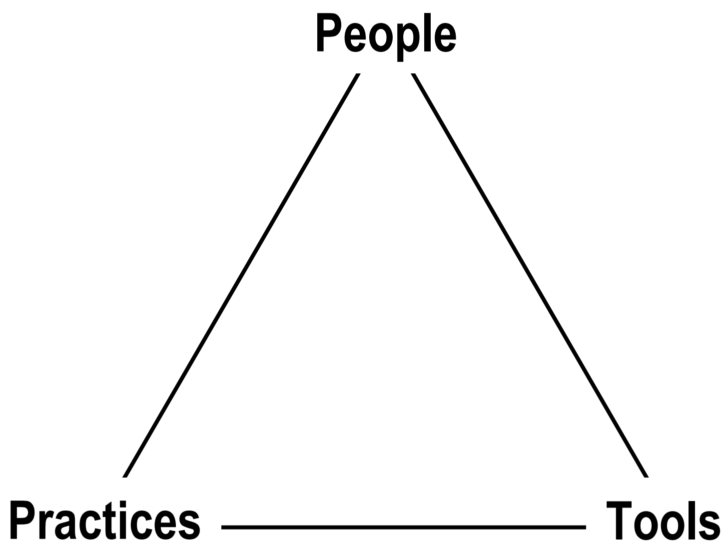

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STRENGTH THROUGH INDUSTRY & TECHNOLOGY

Welcome

to the

8th Annual

Systems Engineering Conference

Sponsored by

NDIA Systems Engineering Division

In Conjunction With

Office of the Under Secretary of Defense, Acquisition Technology & Logistics, Director, Systems Engineering;

With Technical CoSponsorship By

Institute of Electrical & Electronics Engineers (IEEE)
Aerospace & Electronic Systems Society and
Systems Council, and
International Council on Systems Engineering(INCOSE)

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

Program - Tuesday Oct 25

0830 - 1200 PLENARY SESSION Regency Ballroom

0840 – 0930: Keynote Address

Mr. John Landon, Deputy Assistant Secretary of Defense (NII), C3ISR & IT Acquisition

0930 - 1000 COFFEE BREAK Pavillion (aka "Tent")

1000 - 1200: Senior Executive Panel:

Mr. Mark Schaeffer, OUSD(AT&L) Director, System Engineering and Principal Deputy, Defense Systems

Mr Terry Jaggers, Director, Science, Technology & Engineering, USAF SAF/AQR

Mr. Carl Siel, USN, ASN/RDA Chief Engineer

Mr Doug WIltsie, USA, ASA-ALT, Asst Deputy for Acquisition & Systems Management

Mr. Kelly Miller, NSA, Director, Systems Engineering

Luncheon Activities

Lunches in Pavillion

Tuesday

Mr Greg Shelton, Raytheon

Vice President, Engineering, Technology, Manufacturing & Quality

Wednesday

Presentation of NDIA Lt Gen Thomas Ferguson Awards for Excellence in Systems Engineering

Individual & Group

Thursday lunch will be in Islands Restaurant

Program - Tuesday Oct 25

1330-1500

2C1 Systems Engineering Effectiveness	Regency A
2C2 Systems Engineering Effectiveness	Regency B
2C3 Test & Evaluation in SE	Regency C
2C4 Net Centric Operations	Mission A
2C5 Logistics	Mission B
2C6 Integrated Diagnostics	Mission C
2C7 Systems Safety	Garden A
2C8 Software Supportability	Garden F
1500 - 1530 COFFEE BREAK	Pavillion

1530- 1700/1730

All above continue

1730 - 1900

RECEPTION in Displays Area	Pavillion

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

Program - Wednesday Oct 26

0815 - 0945

8 Parallel Tracks, see Program for details

0945 - 1015 COFFEE BREAK **Pavillion**

1015 - 1145

8 Parallel Tracks continue

1200 - 1315

Lunch **Pavillion**

1330 - 1500

8 Parallel Tracks continue

1500 - 1530 COFFEE BREAK **Pavillion**

3:30 PM – 5:00 PM

8 Parallel Tracks continue

Program - Thursday Oct 27

0815 - 1000

8 parallel tracks – see Program for details

9:45 AM - 10:15 AM COFFEE BREAK **Pavillion**

1015 - 1145

8 parallel tracks continue

1200 - 1300

Lunch – **Islands Restaurant**

1:00 PM – 2:30 PM

7 final parallel tracks

1445-1500 – Conference Adjourns

Some Logistics Info---

Message Number: (619) 224-1234 (and ask for NDIA desk)

Displays & Coffee Breaks are in Displays area in Pavillion. 15 Exhibitors are there to discuss their capability in Systems Engineering

Lunches (Tues & Wed) are in Pavillion at 1200, Thursday is in Islands Restaurant

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

And Special Thanks To---

Technical Program Chairs:

Rex Sallade, Northrop Grumman

Dr. Tom Christian, USAF

Session & Track Chairs:

Gordon Neary, Boeing; Bob Lyons, IEEE AES; Bob Skalamera, OUSD(AT&L), Dr. Tom Christian, USAF; Mike Ucchino, USAF: Mark Wilson, USAF; Bob Ernst, NAVAIR; Jim Hollenbach, SIMSTRAT; Jerry Beck, ODUSD/L&MR; Jack Zavin, ASD(NII); Dr Tom Croak, CSC; Gary Belie, Lockheed Martin; Jesse McCurdy, NAVAIR; Bob Ernst, NAVAIR; Dennis Hecht, Boeing; Howard Savage, Savage Consultants; Paul Croll, CSC; Joel Moorvitch, Raytheon, Col Ken Flowers, OUSD(AT&L)OSJTF; Paige Ripani, Booz Allen Hamilton; Sherman Forbes, USAF SAF/AQR

NDIA Meeting Executive:

Veronica Allen

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

9th Annual Systems Engineering Conference

October 23-26, 2006

Hyatt Islandia

San Diego California

Call for Papers & Call for Displays is in your registration information

Papers Due Date: April 30, 2005

STRENGTH THROUGH INDUSTRY & TECHNOLOGY

Systems Engineering

Always read the words carefully--

NDIA 8th Annual Systems Engineering Conference

"Automated Software Testing Increases Test Quality and Coverage Resulting in Improved Software Reliability."

October 25, 2005

Frank Salvatore
High Performance Technologies, inc.
3159 Schrader Road
Dover NJ, 07801
(973) 442-6436 ext 249
fsalvatore@hpti.com

Outline

- Introduction
  - Background
  - Project Purpose & Goals
- Overview
  - SW Reliability
  - Statistical Testing
  - Model Based Specification and Testing
- Development Flow
  - Tool Set Architecture
  - Module Review
  - Auto Tester
  - Conventional vs Statistical Testing

Background

- Phase I SBIR Completed in FY 2004 proving feasibility.
- Phase II SBIR to Start in FY 2006
- Sponsor: US ARMY ARDEC, Fire Control Systems & Technology Division (FCSTD)
- Contractors:
  - Cognitive Concepts, LLC Prime
  - High Performance Technologies, Inc (HPTi)
  - Software Silver Bullets

Project Purpose & Goals

- ❑ Generate an integrated process which enables any SW Development organization to apply Model based Specification and Testing (MST)
- ❑ Significantly advance the state of the practice for system level MST.
  - ✓ Create large models of complex system software behaviors that closely represent expected operational behavior of a specific system.
  - ✓ Automatically generate test cases from the model.
  - ✓ Define and store test scripts associated with every stimulus in the test population.
  - ✓ Generate executable test scripts.
- ❑ Implement the required tools that will enable bringing Model Based Specification and Testing technology to market.
- ❑ Reduce Software Life Cycle Maintenance Costs.

Overview SW Reliability

- ***Software Reliability* - Probability of failure-free software execution in a specified operating environment.**
- ***Software Reliability Engineering* - Systems engineering process activities ensuring reliable software systems.**
  - ***Assessment* - software reliability can be assessed (measured) only when the software is executing, either in a test lab or in the field.**
  - ***Prediction* - prior to having executable software, assessment is done by inference via a forecast.**

SRE Challenges

- Verifying the system does what users want.
- Integrating Requirements analysis and System Software testing.
- Determining what to measure and when to measure it.
- Limiting scope and breath of testing to stay on schedule.

SRE Fundamental Principal

SRE involves:

- **Developing an operational, or usage, profile of the software system under test and**
- **Exercising random test cases from the profile to obtain a direct assessment of the reliability of a software system**

Statistical Testing in a Nutshell

Statistical Testing

- ❑ Specification represented in the form of usage models
- ❑ System tests generated directly from usage models

Markov-chain usage models

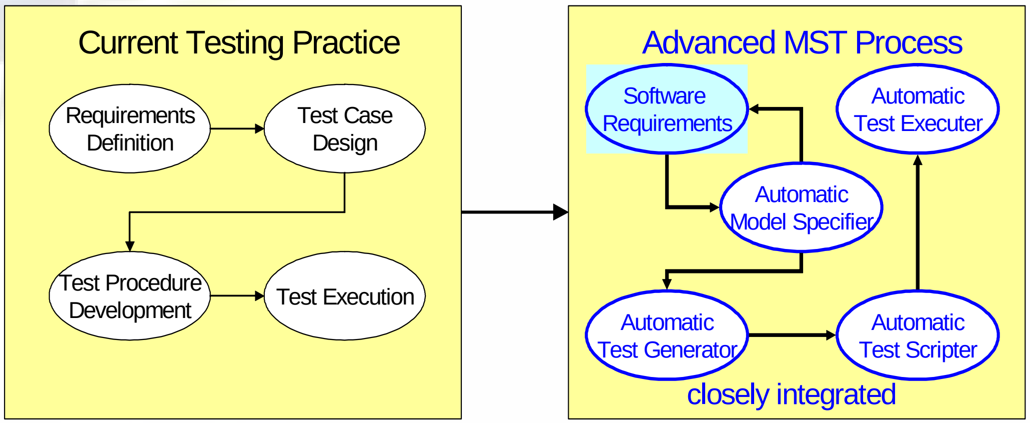
- ❑ Black box state-based models that cover every possible state of *usage* for a software system
- ❑ External behavioral representation of system
- ❑ Composed of states (conditions) and arcs (stimuli)

Software tool generates random test cases

Current State of System Software Testing

Industry practice for testing military applications uses a requirements-based approach.

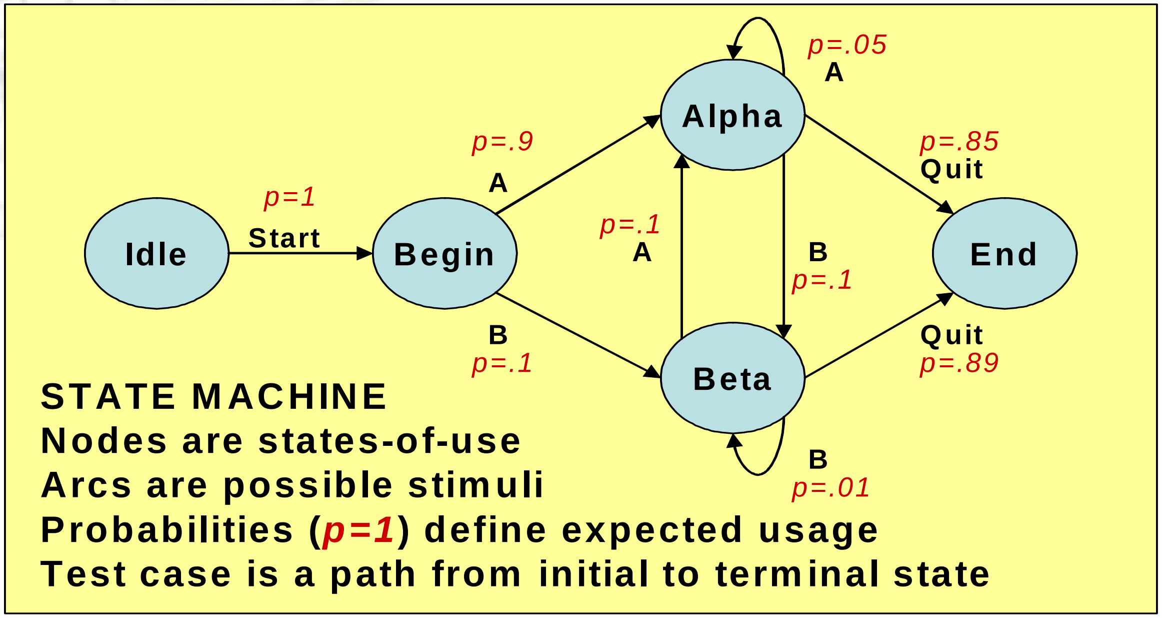
- **Test cases are defined for each requirement, or shall statement.**
- **Test cases are designed manually or with a software tool that is independent of the requirements tool.**
- **Test cases are scripted manually or with a tool that is not integrated with the test design tool.**
- **Tests are executed manually or in some cases the tests are automated utilizing a project specific test automation tool.**



An innovative approach to requirements specification and testing

MBT Structure

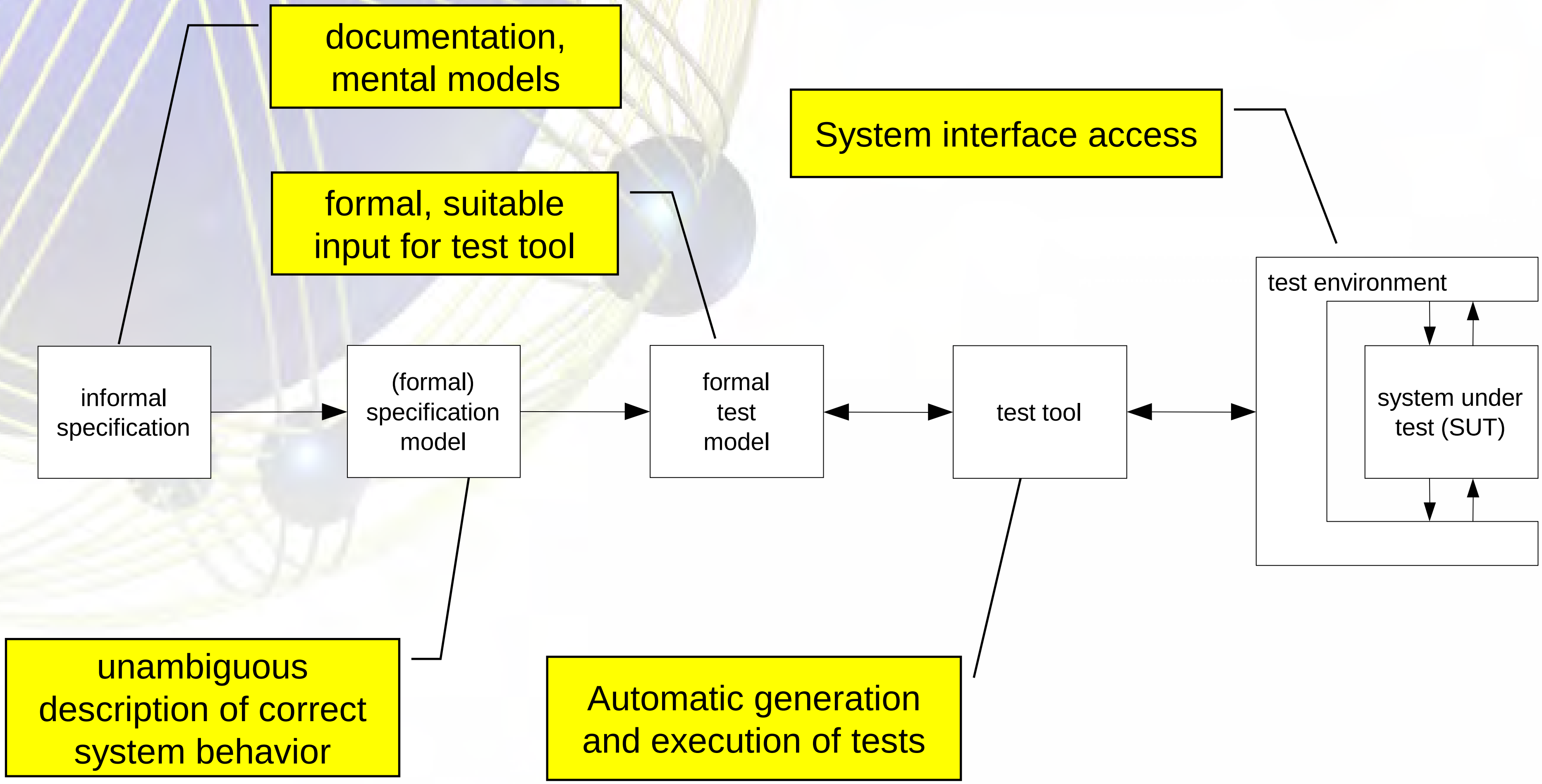
- MBT is a black box representation of the expected behavior of system software.
- A model-based specification is called a usage model specifying how the system is used, or behaves.



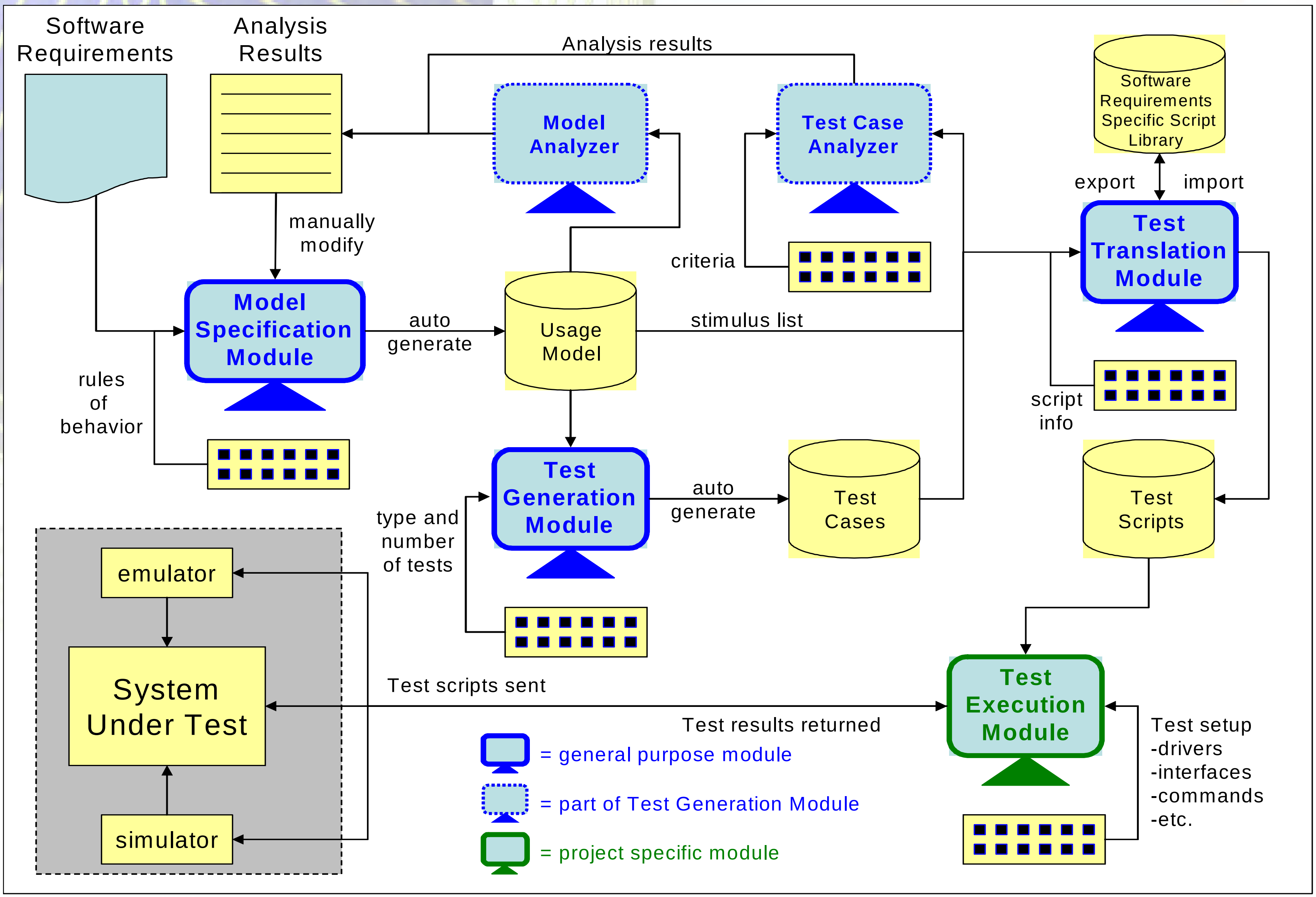
MST

- Provides a structured approach to requirements analysis and software test design.
- Ensures the system specification prescriptive and consistent to enable automatic generation of system software test cases.
- Facilitates an objective assessment of system software reliability.
- Enhanced communication between developers and testers.
- Eases the updating of test suites for changed requirements.
- Shorter schedules, lower cost, and better quality.
- A model of user behavior.
- Early exposure of ambiguities in specification and design

MBT Development Flow



Toolset Architecture



Model Specification Module

Capability:

- **Tabular entry of system requirements.**
- **Definition of the system boundary by itemizing all input stimuli and responses**
- **Specifying traceability via requirement tags.**
- **Enumeration of input stimulus sequences**
- **Automatic analysis of the completed enumeration to verify coverage and to construct the usage model.**
- **Define usage variables and associate a unique set with each state in the model.**
- **Assigning probabilities to each transition in the usage model.**
- **XML schema for storing and managing the above data**

Test Generation and Analysis Module.

Capability:

- **Provides Markov analysis of the usage model for properties useful for model validation and test planning.**
- **Enables test case generation via random walk, relative probability, and graph coverage algorithm.**
- **Enables test case management necessary for pass/fail recording and format conversion.**
- **Provides analysis of test results to compute coverage and reliability metrics**

Test Translation Module

Capability:

- **Accepts operator input to build script fragments for each system stimulus and export the result to the script library.**
- **Reads stimulus mapping information from the script fragment library that maps the stimuli used in the model to codes readable by the Test Execution Module.**
- **Determines proper code sequences to perform the test cases created by the Test Case Generator.**
- **Generates test scripts for the Test Execution Module from the fusion of script fragments**

Test Execution Module

Capability:

- **Executes target specific test scripts using hardware and software elements designed to interface with the system under test.**
- **Provides the operator an interface to observe the test steps being performed as well as enabling the operator to pause or restart testing.**
- **Logs any results generated from the testing in formats for human interpretation and for input to the Test Case Analysis and Generation Module**

Auto-Tester

Capability:

- **Perform end-to-end testing of System Software.**
- **Record scripts from a PC keyboard and play them back to the keyboard port of a PC.**
- **Translate the serial communication between the Display Unit (DU) and the AFCS Computer Unit (ACU).**
- **In order to support the Enhanced Display System (EDS), the connection to the Auto Tester would be inserted between FBCB2 and the ACU, not between the EDU and FBCB2**

Automated Test Capability

Capability:

- **Supports Developmental, Integration, and Formal Qualification Testing (FQT) of a Fire Control Software System.**
- **Provides and demonstrates a means to capture test cases and procedures in a reusable form.**
- **Supports management of test artifacts, including storage, retrieval, editing, merging, and searching.**
- **Perform end-to-end testing of a Fire Control system software.**
- **Monitors and records the system's responses to stimulus, and, as necessary, emulates the appropriate response via a system interface to complete a given test case.**

Applying MST to Achieve Software Safety

- Traditional approaches include static analysis
- MST provides a robust, dynamic approach
  - ✓ Models cover all usage states, including rare ones.
  - ✓ Statistical testing ensures that potentially hazardous unknown or unforeseen events are covered in the system test suite. Static analysis alone cannot predict the consequences of highly complex behaviors.
- MST is a supplement to, not a replacement for, methods such as Fault Tree Analysis and Hazard Analysis.

Summary

- Automated Software Testing Increases Test Quality and Coverage Resulting in Improved Software Reliability.
- Project starts FY06
- Results will be provided in a final report and demonstration.
- Advance the state of the practice for system level MST.
  - ✓ Create large models of complex system software behaviors that closely represent expected operational behavior of a specific system.
  - ✓ Automatically generate test cases from the model.
  - ✓ Define and store test scripts associated with every stimulus in the test population.
  - ✓ Generate executable test scripts.
- Integrated Suite of Tools.

Questions?

State of Systems Engineering within DoD

8th Annual NDIA Systems Engineering Conference
Plenary Session

October 25, 2005

Mr. Mark D. Schaeffer
Principal Deputy, Defense Systems
Director, Systems Engineering
Office of the Under Secretary of Defense (AT&L)

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 practices back into the way we do business."

No Course Change from Mr. Krieg—"Press On"

Summary: State of Systems Engineering within DoD

- Issued Department-wide Systems Engineering (SE) policy
- Issued guidance on SE, T&E, and SE Plans (SEPs)
- Continue working with Defense Acquisition University to strengthen and expand curricula
- Continue to leverage close working relationships with Services, Agencies, Industry, and Academia

Summary: State of Systems Engineering within DoD - 2

- Continue to provide systems engineering, test & evaluation support to the DAB, OIPT, DAES, and individual programs
- Expanding emphasis on design considerations – open systems, corrosion, system safety, anti-tamper, etc.
- Defining the role of systems engineering in capability-based acquisition planning

Way Ahead for SE…

- OSD’s fundamental role is to set policy, provide relevant and effective education and training, and foster communication throughout the community—much has been accomplished
- OSD cannot do everything…NOR should we
- Services and Agencies, along with Industry, must take ownership of the institutionalization of SE

… It’s Beginning!

Service / Agency Implementation and Institutionalization Plenary Session

- Mr. Carl Siel, Deputy ASN (RDA/CHENG)
- Mr. Doug Wiltsie, Assistant Deputy for Acquisition and Systems Management, ASA (ALT)
- Mr. Terry Jaggers, Deputy Assistant Secretary of the Air Force for Science, Technology and Engineering, SAF/AQR
- Mr. Kelly Miller, National Security Agency/Central Security Service

Raytheon

Customer Success Is Our Mission

Mission Assurance and Systems Engineering

Gregory Shelton
Corporate Vice President
Engineering, Technology, Manufacturing and Quality
Raytheon Company

October 25, 2005

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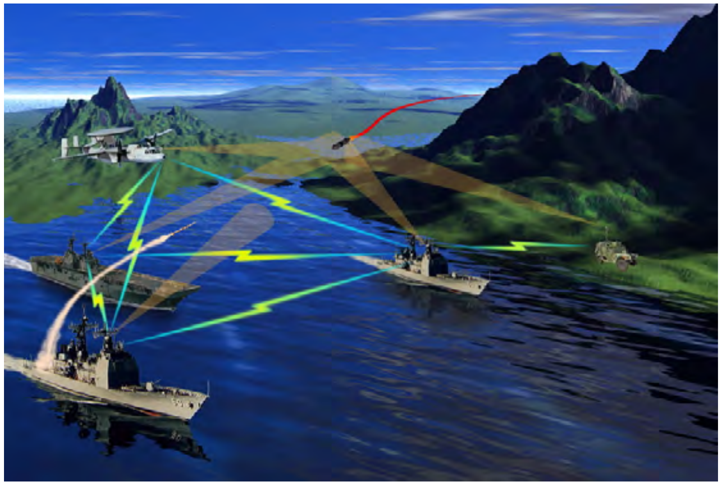
Introduction

- Why Mission Assurance? Why now?
- What is the role of Systems Engineering in achieving Mission Assurance?
- What actions can we, as Systems Engineers, undertake?
- And how will it affect the warfighter?

Mission Assurance should be at the forefront of Systems Engineering.

Architecture and the Customer

- Warfighter now transformed to Peacekeeper
  – Do the system requirements change?
- NATO interoperability
  – JTRS
  – FCS
  – E-3 AWACS
  – F-35
- Intel time lag
  – Cannot afford one-day or one-hour delay of information
  – Must be seconds…
  IEDs, high-value target information
- Challenges
  – Need for Flexibility
  – Need for Speed
  – Need for Accuracy
  – Need for ASSURANCE



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The Role of the ~~Warfighter~~… PeaceKeeper

– IEDs counter threats
  - Armoring Humvees
  - Trigger-signal jamming
– Fratricide and combat identification issues
– Killing of non-combatants
  - Collateral damage in peacekeeping missions
  - Precision munitions
– Example: Defective bullet-proof vests ("Faulty Body Armor May Have Endangered Bush," Associated Press, Sept. 26, 2005 by John Solomon)
  - Inadequate testing
  - Processing problems
  - Materials issues

It <u>IS</u> all about the warfighter.

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Mission Assurance

- How does Systems Engineering relate to Mission Assurance?
  - Systems Engineering, Architecture, Processes, Cycle time all are inherently part of Mission Assurance.
  - The challenge is focusing System Engineering, Architecture and Process on Mission Assurance.
  - It's all about Mission Assurance: the product has to do what it's supposed to do when it's supposed to do it.
  - The challenge is doing the right amount of system engineering and developing the right architecture while still following good process and meeting the required cycle time.
  - The result is a product with its most important attribute: Mission Assurance.

System Engineering is the glue that brings everything together to achieve Mission Assurance.

Systems Engineering/Mission Assurance

- System Engineering must become Mission Assurance Centric
  - Improve internal processes
    - CMMI, ISO, MAP
  - Architecture
    - Open Architecture enabled
    - P3I & Spiral Capable- top level
  - Customer involvement
    - Customer (procuring community through to the warfighter)
    - Know what you are buying, and get what you bought!
    - Deliver on our designs throughout the life cycle

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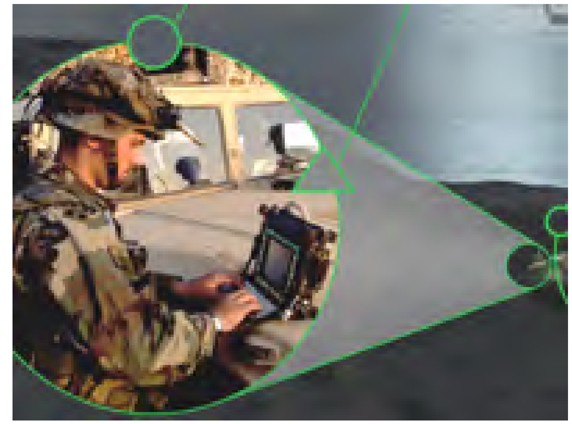
The Warfighter

- Does the product meet the warfighter's needs?
  - Is it adaptable for use in the field?
  - What is the cost of architectural consideration, and how do you plan for the unanticipated need?
    - A proven, flexible & open architecture
  - How are products being used in a different way than originally planned?
    - Warfighter versus Peacekeeper
  - How do we manage quick reaction needs? ACTDs, etc.
    - How do these architectures affect Mission Assurance?
    - What needs change as the mission changes?

Global Hawk, Predator, Boeing X35/X45 each have a varying need for flexibility.



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The Warfighter

- How does Mission Assurance and Systems Architecture affect the warfighter?
  - Command and control at the soldier level
  - UAVs for the soldier, not just the battlefield commander
    - Provides more control and awareness for the user
    - Drives need to provide on-demand, real-time Intel in seconds, not minutes or hours
  - UAVs carrying weapons
    - Hellfire (shoulder-fired missile)
    - JDAM (Joint Direct Attack Munition, precision-guided bomb)
    - GBU-15 (General Bomb Unit)
  - Communications gear on the ground
    - Need for radio interoperability between services and civil space (JTRS)
    - Example: a downed Air Force pilot has to be able to call Army ground forces
    - Example: Iraqi police: Example: ***Katrina***

Warfighter's need is <u>right now & it must work.</u>

Increasing Mission Assurance capabilities

- An orthogonal approach
  - Better union between warfighter and application
    - Capture intent
    - Get away from designed-in mission limits
    - Involve warfighter in entire process so it's understood

      Drill down / visualization

      Technology to reason *and communicate* as the warfighter would

      Product team becomes part of the *mission team*
- *These can be combined with dynamic & adaptable systems*
  - Dynamic systems *require* increased integrated capabilities
  - Adaptable to new warfighter needs in the Field

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One Approach: Reliability

- We can manage risk by making a reliable product
  - Warfighter must know how the equipment works in the field
  - Warfighter must have a simple, intuitive interface to the equipment
    - Usable under stress
    - Usable even when distracted
  - Performance of product must match contract capabilities
    - Contract must project unanticipated conditions (Spiral, P3I)
    - Over-design adds safety margins, but also costs… Must be Balanced
  - Boost MTBF
    - Built-in Redundancy
    - Fault Tolerance / High Availability
    - Adaptability/survivability

The cost of reliability should be measured in lives saved

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One Chess Master Noted…

- "When I play [chess], the pieces get in the way." (paraphrased)
  - – Famous for a strategy of offering the opponent superior trades in exchange for positional advantages, leading to victory
- What is the lesson here for "Mission Assurance"?

Common wisdom may not be the winning move.

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Another Way to Formulate Mission Assurance

- Make sure there is more than one path to mission success
  - That there ARE other places to "allocate resources"
  - High redundancies may lead to cheaper technologies
    - Dumb bullets and a machine gun
    - Swarm Theory

      Semi-autonomous control wherein a group of UAVs will automatically follow a general path chosen by the leader, which would be the real-time remote-controlled UAV, and is being explored to offset the issues with remotely controlling multiple UAVs in a small squadron – practically impossible.
- Remote Building Search Example
  - Really smart, expensive, autonomous robot
  - Non-autonomous (cheaper) robot, that fails if radio contact lost
  - Lots of "cheap" autonomous robots that work together (e.g., *Minority Report*)
  - Sensor cloud
    - Individual low lifetime (minutes) and low reliability

      BUT COLLECTIVELY SOLVE PROBLEM FAST & CHEAP

Potential for "Discontinuous Change"

- Clay Cristensen (*Innovator's Dilemma)* talks about disruptive changes as those that are initially cheaper solutions to existing technologies, but undermine the usual "catering to the high end of the market" mentality – subsequently undercutting existing (and often leading) providers.
- Changes to Mission Assurance may undercut existing products *but also open new markets*
  - A potential opportunity to
    - Change Doctrine
      - Work with Our Customer on the real problems, not just address the issues with existing solutions
    - Be seen as a real leader
      - By helping Our Customer redefine their needs, we become a "trusted partner"
      - Differentiation of mission/product

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P(Mission Success) as a QoS Issue

- If we treat our probability of mission success as a Quality of Service
  - It becomes an independent variable, for which dynamic systems solutions are possible
    - C3I impact
    - Network impact
    - Doctrine/Training impact
  - Need Customer Buy-In

Recast Mission Success as a Systems/technology problem.

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Architecture

- How does architecture impact Mission Assurance?
  - Transition from ACTD to warfighter to peacekeeper
    - Global Hawk
    - Predator
      - Monthly changes to requirements
    - E8/JSTARS program (went quickly from development to production)
    - Boeing X35/X45 Platform
    - Non-lethal weapons - New technology too quickly deployed? Or not quick enoug
      - Active Denial Systems (High-Power Microwaves)
      - Tasers
      - Rubber Bullets
    - High-power laser environment
      - Solid state laser
      - Chemical laser

Products may not be used the same way throughout the entire product lifecycle.

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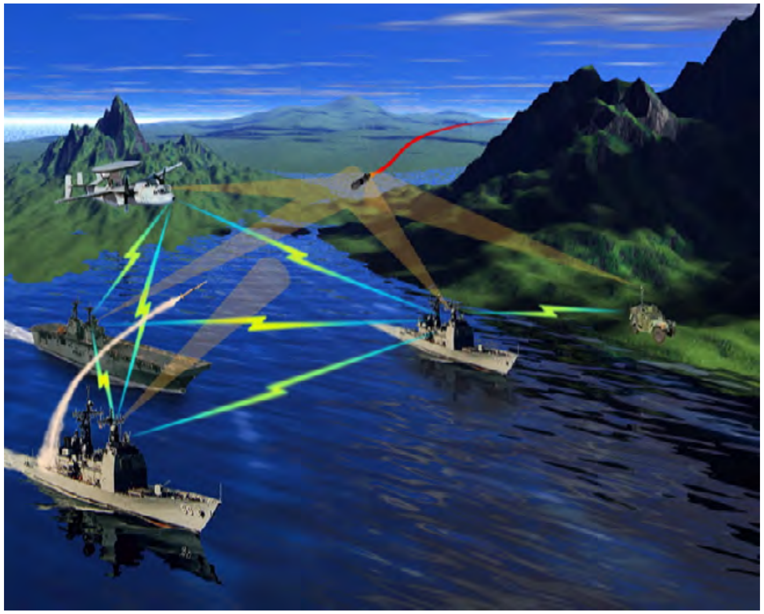
Product Lifecycle

- Peer reviews and customer involvement in the requirements definition cycle have not examined the lifecycle costs adequately
  - Lifecycle CAIV analysis
  - Requirements management throughout the program
  - Technical upgrades & improvement
  - End-of-Life disposal



We need speed with Discipline.

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Quick Reaction Programs

- When is quick too quick?
  - ACTDs and Demonstration programs
    - Do we adequately plan for success?
    - Do we bring in the "ilities" on these ACTDs early enough?
    - Do we get enamored by the technology instead of focusing on user needs?
    - Are we doing the right amount of systems engineering up-front to help provide Mission Assurance?
    - Are we building-in the right architecture?

      Expandable

      Flexible
  - The need for speed needs to be balanced with the need for process discipline
    - If you need it bad, you will likely get it bad…

There has to be a balance between good process and program speed.

Mission Assurance Summary

- Mission Assurance is the application of:
  - Technology
  - Architecture
  - Process
  - Discipline
  - Commitment
  - Innovation
  - Warfighter Involvement

No Doubt it will work!

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Mission Assurance – Standards and Specs

- MIL SPEC 9858A
  – Clear Quality guidelines on design and development; Quality standards
- Mil-Specs used to guide industry in common standards
  – Guidelines for everything from development to production & field Support
- Willoughby Best Manufacturing Practices – Navy Guidelines
  – http://www.bmpcoe.org/index.html
- Military Design Guidelines
  – http://hfetag.dtic.mil/hfs_docs.html
- Missile Defense Agency Mission Assurance Plan
  – MDA-QS-001-MAP

We must address the disciplines that made Systems Engineering great!

ASN (RDA)
Chief Engineer

System Engineering Re-vitalization within DoN Status

25 October 2005

Mr. Carl Siel
ASN(RDA) Chief Engineer
carl.siel@navy.mil

Unclassified

Reinvigoration of Systems Engineering

THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

ACQUISITION,
TECHNOLOGY
AND LOGISTICS

FEB 20 2004

MEMORANDUM FOR: SEE DISTRIBUTION

SUBJECT: Policy for Systems Engineering in DoD

Application of rigorous systems engineering discipline is paramount to the Department's ability to meet the challenge of developing and maintaining needed warfighting capability. This is especially true as we strive to integrate increasingly complex systems in a family-of-systems, system-of-systems, net-centric warfare context. Systems engineering provides the integrating technical processes to define and balance system performance, cost, schedule, and risk. It must be embedded in program planning and performed across the entire acquisition life cycle.

Toward that end, I am establishing the following policy, effective immediately and to be included in the next revision of the DoD 5000 series acquisition documents:

> Systems Engineering (SE). All programs responding to a capabilities or requirements document, regardless of acquisition category, shall apply a robust SE approach that balances total system performance and total ownership costs within the family-of-systems, systems-of-systems context. Programs shall develop a Systems Engineering Plan (SEP) for Milestone Decision Authority (MDA) approval in conjunction with each Milestone review, and integrated with the Acquisition Strategy. This plan shall describe the program's overall technical approach, including processes, resources, metrics, and applicable performance incentives. It shall also detail the timing, conduct, and success criteria of technical reviews.

In support of the above policy, the Director, Defense Systems shall:

a. Identify the requirement for a SEP in DODI 5000.2, and provide specific content guidance tailorable by the MDA in the Defense Acquisition Guidebook.

b. Assess the adequacy of current Department-level SE related policies, processes, practices, guidance, tools, and education and training and recommend to me necessary changes.

c. Establish a senior-level SE forum with participation from the Military Departments, and appropriate defense agencies, as a means to collaborate and leverage activities within the components and to provide a forum to institutionalize SE discipline across the Department. A goal of this forum will be extending the SE process to address family-of systems, system-of-systems capability-based acquisition.

d. For programs where I am the MDA, review each program's SEP as part of the preparation for Defense Acquisition Board Milestone Reviews (DAB) and other acquisition reviews, provide me with a recommendation on the program's readiness to proceed during the DAB. Together with other members of the OSD staff, lead program support assessments to identify and help resolve issues to ensure program success.

To assist in these efforts, each Component Acquisition Executive and defense agency with acquisition responsibilities will, within 90 days, provide the Director, Defense Systems its approach and recommendations on how we can ensure that application of sound systems engineering discipline is an integral part of overall program planning, management, and execution within both DoD and defense industry. Further, I direct each Component Acquisition Executive and those defense agencies with acquisition responsibilities to provide, within 30 days, a flag officer or Senior Executive Service-level representative to participate in the Director, Defense Systems-led systems engineering forum. The first such forum will be held within 60 days.

I need your assistance to ensure we drive good systems engineering processes and practices back into the way we do business. We can accomplish this goal by establishing clear policies, reinvigorating our training, developing effective tools, and using and institutionalizing best practices, applying performance incentives, and making systems engineering an important consideration during source selections and throughout contract execution. Collectively these actions will reinvigorate our acquisition community - including our industry partners - thus assuring affordable, supportable, and above all, capable solutions for the warfighter.

Michael W. Wynne
Acting

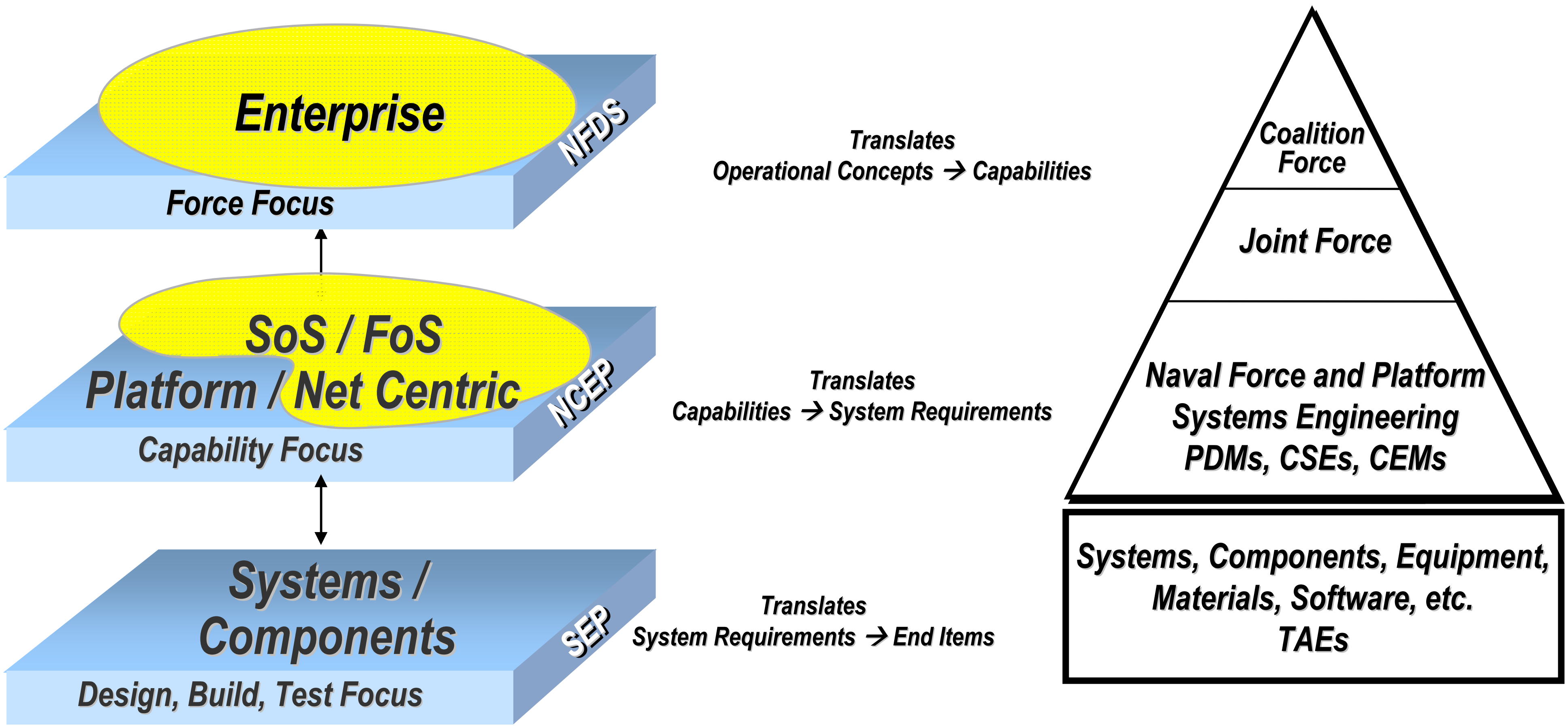
Purpose

- Up-date you on some of our activities since last year
- Use the opportunity to stimulate you on our common challenge: *Capability-Based Systems Engineering*

The New Continuum

Enterprise ⟺ FoS/SoS ⟺ Systems

Capability-Based System Engineering



Requires Alignment of Multiple Processes, Process Owners and Products

Topics

- Virtual System Commands
- ASN (RDA) Policy for Systems Engineering Plan
- Software Acquisition: Best Practices
- System / System of Systems Safety
- Naval Capability Evolution Process
- FORCEnet / Open Architecture Integration and Interoperability
- The Technical Cooperation Panel – Technical Panel 4
- Naval Force Development System

Scope

Marine Corps
System Command

Naval Sea
System Command

Naval Air
System Command

Space: Naval Warfare
Systems Command

Must address the full range of Land, Sea, Undersea, Air and Space applications/operative environments

Topics

- Virtual System Commands
  - Naval Systems Engineering Guide
  - Engineering Technical Authority
  - Risk Management Process
  - Systems Engineering Technical Review Process
  - System Certification Policy
- ASN (RDA) Policy for Systems Engineering Plan
- Software Acquisition: Best Practices
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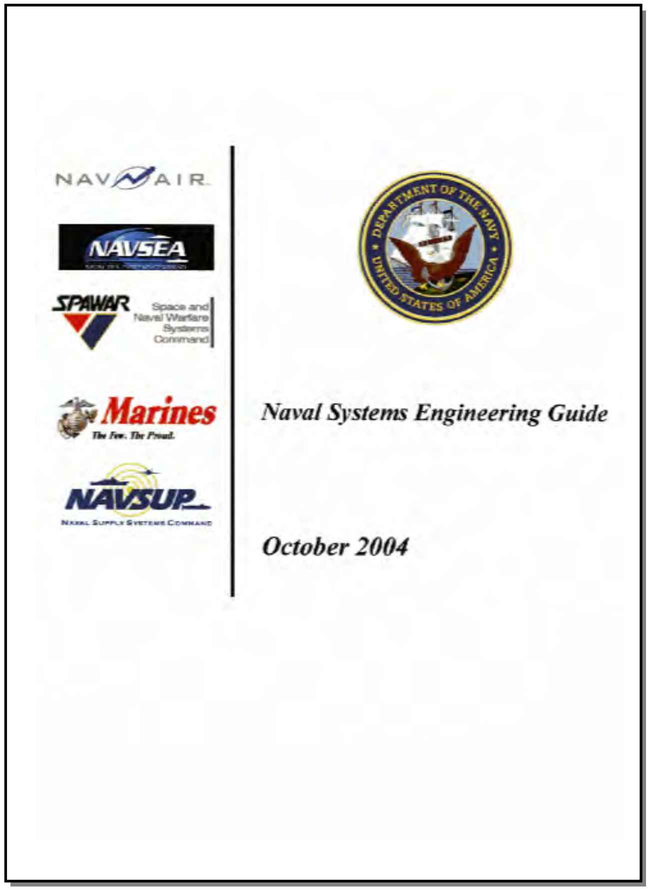
Naval System Engineering Guide

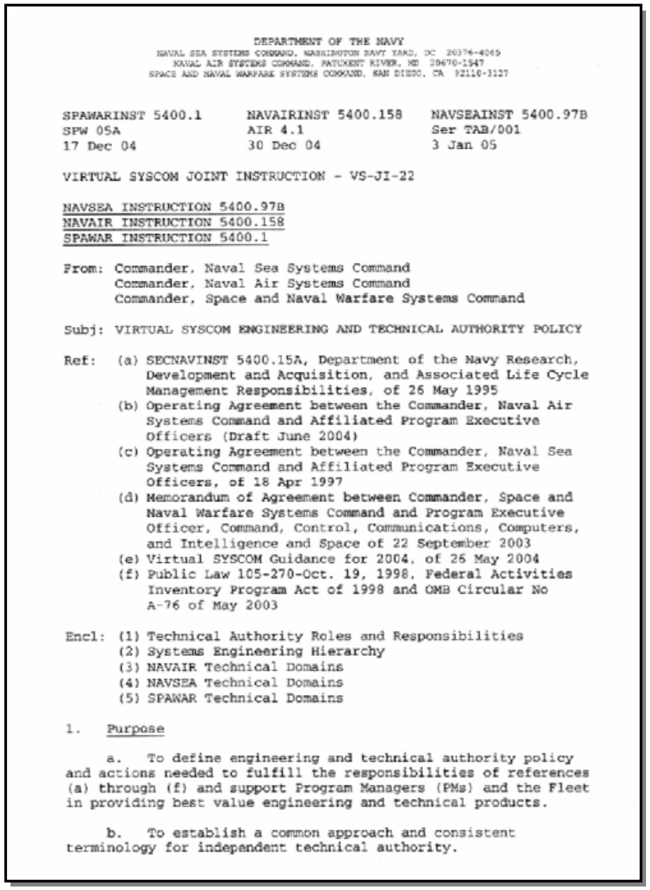


Purpose:

- Characterize the contents of the Systems Engineering Discipline
- Promote a consistent and common view of Systems Engineering across the Navy
- Clarify the boundary of Systems Engineering with respect to other disciplines
- Provide a foundation for curriculum development and Systems Engineering Certification

Status: Completed Oct 04

Engineering and Technical Authority



DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND, WASHINGTON NAVY YARD, DC 20376-4065
NAVAL AIR SYSTEMS COMMAND, PATUXENT RIVER, MD 20670-1547
SPACE AND NAVAL WARFARE SYSTEMS COMMAND, SAN DIEGO, CA 92110-3127

SPAWARINST 5400.1	NAVAIRINST 5400.158	NAVSEAINST 5400.97B
SPW 05A	AIR 4.1	Ser TAB/001
17 Dec 04	30 Dec 04	3 Jan 05

VIRTUAL SYSCOM JOINT INSTRUCTION - VS-JI-22

NAVSEA INSTRUCTION 5400.97B
NAVAIR INSTRUCTION 5400.158
SPAWAR INSTRUCTION 5400.1

From: Commander, Naval Sea Systems Command
Commander, Naval Air Systems Command
Commander, Space and Naval Warfare Systems Command

Subj: VIRTUAL SYSCOM ENGINEERING AND TECHNICAL AUTHORITY POLICY

Ref: (a) SECNAVINST 5400.15A, Department of the Navy Research, Development and Acquisition, and Associated Life Cycle Management Responsibilities, of 26 May 1995
(b) Operating Agreement between the Commander, Naval Air Systems Command and Affiliated Program Executive Officers (Draft June 2004)
(c) Operating Agreement between the Commander, Naval Sea Systems Command and Affiliated Program Executive Officers, of 18 Apr 1997
(d) Memorandum of Agreement between Commander, Space and Naval Warfare Systems Command and Program Executive Officer, Command, Control, Communications, Computers, and Intelligence and Space of 22 September 2003
(e) Virtual SYSCOM Guidance for 2004, of 26 May 2004
(f) Public Law 105-270-Oct. 19, 1998, Federal Activities Inventory Program Act of 1998 and OMB Circular No A-76 of May 2003

Encl: (1) Technical Authority Roles and Responsibilities
(2) Systems Engineering Hierarchy
(3) NAVAIR Technical Domains
(4) NAVSEA Technical Domains
(5) SPAWAR Technical Domains

1. Purpose

a. To define engineering and technical authority policy and actions needed to fulfill the responsibilities of references (a) through (f) and support Program Managers (PMs) and the Fleet in providing best value engineering and technical products.

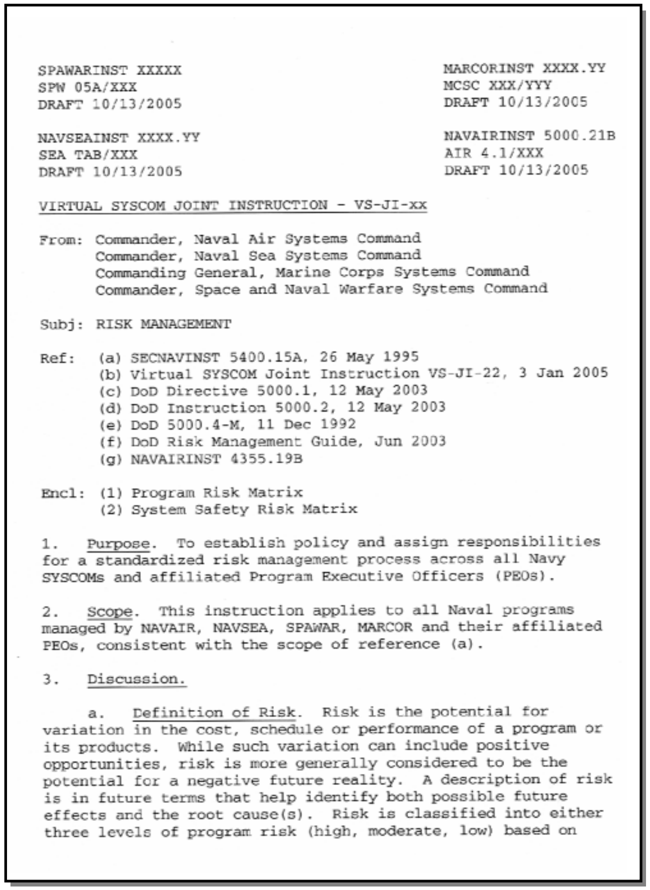
b. To establish a common approach and consistent terminology for independent technical authority.

Purpose:

- Define Engineering and Technical Authority Policy
- Establish a common approach and consistent terminology
- Describle Inter-relationship between Technical Authority and related disciplines (e.g., programmatic and certification authority)

Status: Completed Jan 05

Risk Management Process



SPAWARINST XXXXX
SPW 05A/XXX
DRAFT 10/13/2005

MARCORINST XXXX.YY
MCSC XXX/YYY
DRAFT 10/13/2005

NAVSEAINST XXXX.YY
SEA TAB/XXX
DRAFT 10/13/2005

NAVAIRINST 5000.21B
AIR 4.1/XXX
DRAFT 10/13/2005

VIRTUAL SYSCOM JOINT INSTRUCTION - VS-JI-xx

From: Commander, Naval Air Systems Command
Commander, Naval Sea Systems Command
Commanding General, Marine Corps Systems Command
Commander, Space and Naval Warfare Systems Command

Subj: RISK MANAGEMENT

Ref: (a) SECNAVINST 5400.15A, 26 May 1995
(b) Virtual SYSCOM Joint Instruction VS-JI-22, 3 Jan 2005
(c) DoD Directive 5000.1, 12 May 2003
(d) DoD Instruction 5000.2, 12 May 2003
(e) DoD 5000.4-M, 11 Dec 1992
(f) DoD Risk Management Guide, Jun 2003
(g) NAVAIRINST 4355.19B

Encl: (1) Program Risk Matrix
(2) System Safety Risk Matrix

1. Purpose. To establish policy and assign responsibilities for a standardized risk management process across all Navy SYSCOMs and affiliated Program Executive Officers (PEOs).

2. Scope. This instruction applies to all Naval programs managed by NAVAIR, NAVSEA, SPAWAR, MARCOR and their affiliated PEOs, consistent with the scope of reference (a).

3. Discussion.

a. Definition of Risk. Risk is the potential for variation in the cost, schedule or performance of a program or its products. While such variation can include positive opportunities, risk is more generally considered to be the potential for a negative future reality. A description of risk is in future terms that help identify both possible future effects and the root cause(s). Risk is classified into either three levels of program risk (high, moderate, low) based on

Purpose: Establish Policy and assign responsibilities for standardized risk management process across all Navy SYSCOMs and affiliated Program Executive Officers (PEOs)

Status: Working Draft – Estimated completion date Dec 05

System Engineering Technical Review

Interim Version
1.4B
11/17/04

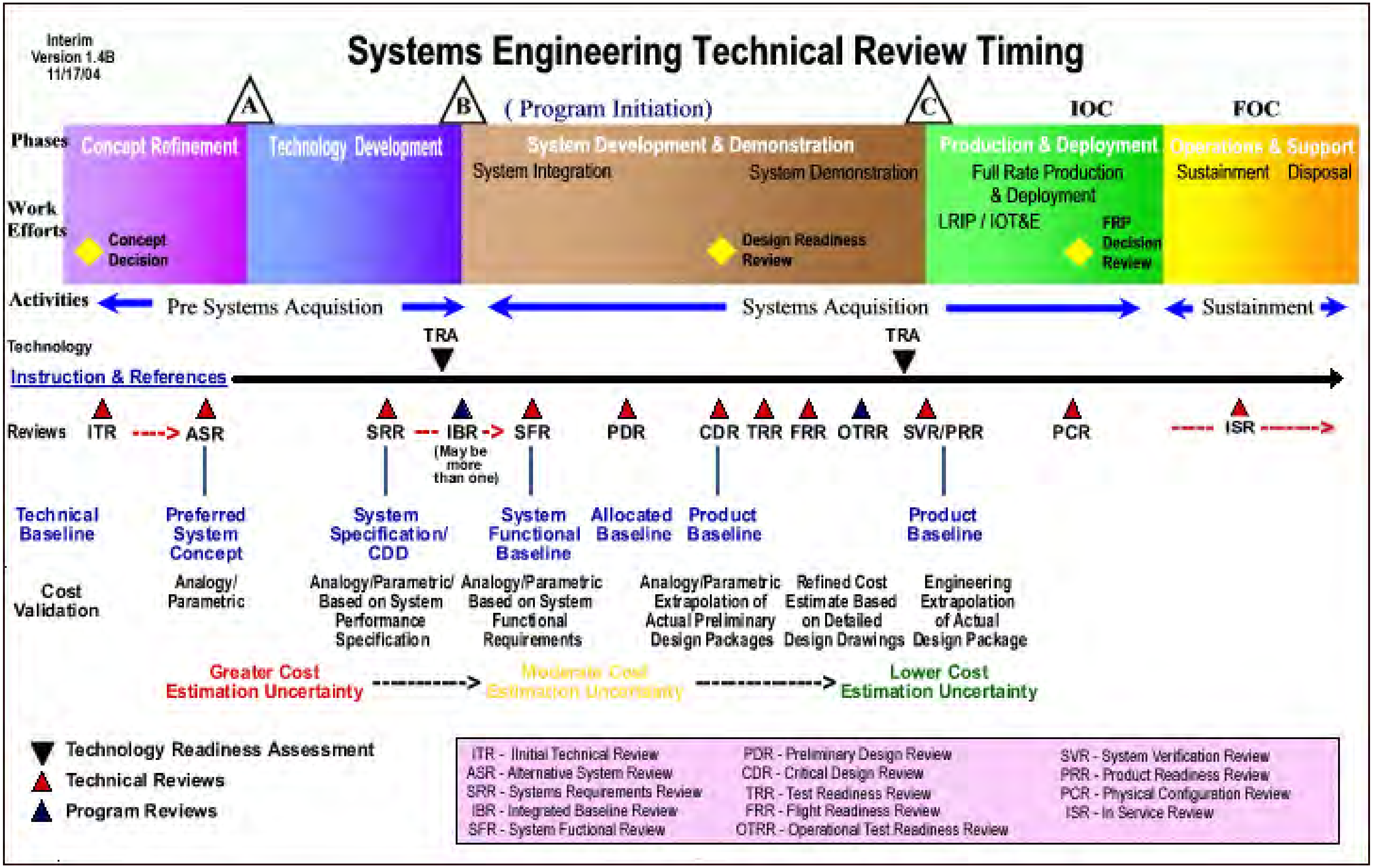
Welcome To The Interactive SETR Timeline

To Begin, Simply Click The Link Below!

Systems Engineering Technical Review Timeline

The SETR Timeline Has ▲ Indicating Each Review. By Placing Your Cursor On These You Can Select It's Corresponding Documentation. There Is Also A Link In Blue Instruction & References For Additional Documents.

https://www.kmsonline.net/41G/KMS/Library/index.htm


Interim
Version 1.4B
11/17/04
Systems Engineering Technical Review Timing
A
B
(Program Initiation)
C
IOC
FOC
Phases
Work Efforts
Concept Refinement
Concept Decision
Technology Development
System Development & Demonstration
System Integration
System Demonstration
Design Readiness Review
Production & Deployment
Full Rate Production & Deployment
LRIP / IOT&E
FRP Decision Review
Operations & Support
Sustainment
Disposal
Activities
Pre Systems Acquisition
Systems Acquisition
Sustainment
Technology
TRA
TRA
Instruction & References
Reviews
ITR ----> ASR
SRR --- IBR -> SFR
(May be more than one)
PDR
CDR
TRR
FRR
OTRR
SVR/PRR
PCR
----- ISR ------->
Technical Baseline
Preferred System Concept
System Specification/ CDD
System Functional Baseline
Allocated Baseline
Product Baseline
Product Baseline
Cost Validation
Analogy/ Parametric
Analogy/Parametric/ Based on System Performance Specification
Analogy/Parametric Based on System Functional Requirements
Analogy/Parametric Extrapolation of Actual Preliminary Design Packages
Refined Cost Estimate Based on Detailed Design Drawings
Engineering Extrapolation of Actual Design Package
Greater Cost Estimation Uncertainty ----------->
Moderate Cost Estimation Uncertainty -------------->
Lower Cost Estimation Uncertainty
Technology Readiness Assessment
Technical Reviews
Program Reviews
ITR - Initial Technical Review
ASR - Alternative System Review
SRR - Systems Requirements Review
IBR - Integrated Baseline Review
SFR - System Fuctional Review
PDR - Preliminary Design Review
CDR - Critical Design Review
TRR - Test Readiness Review
FRR - Flight Readiness Review
OTRR - Operational Test Readiness Review
SVR - System Verification Review
PRR - Product Readiness Review
PCR - Physical Configuration Review
ISR - In Service Review

Preliminary Design Review

PDR – Preliminary Design Review

1. Purpose - The Preliminary Design Review (PDR) is a multi-disciplined product and process assessment to ensure that the system under review can proceed into detailed design, and can meet the stated performance requirements within cost (program budget), schedule (program schedule), risk, and other system constraints. Generally this review assesses the system preliminary design as captured in performance specifications for each configuration item in the system (allocated baseline), and ensures that each function in the functional baseline has been allocated to one or more system configuration items. Configuration items may consist of hardware and software elements, and include items such as airframe, avionics, weapons, crew systems, engines, trainers/training, etc.

For complex systems, a PDR may be conducted for each subsystem or configuration item. These incremental reviews would lead up to an overall system PDR. When incremental reviews have been conducted, the emphasis of the overall system PDR should be on configuration item functional and physical interface design, as well as overall system design requirements. PDR determines whether the hardware, human and software preliminary designs are complete, and the IPT is prepared to start detailed design and test procedure development.

The subsystem requirements are evaluated to determine whether they correctly and completely implement all system requirements allocated to the subsystem, and whether traceability of subsystem requirements to system design is maintained. At this review the IPT should also review the results of peer reviews on requirements and preliminary design documentation. A successful review is predicated on the IPT's determination that the subsystem requirements, subsystem preliminary design, results of peer reviews, and plans for development and testing form a satisfactory basis for proceeding into detailed design and test procedure development.

The review may be tailored in accordance with the technical scope and risk of the system. Under no circumstances should the review be tailored completely out of the development plan. Details of any tailoring should be described in the SEP, or should occur as part of the APMSE or systems engineer coordination of the review elements with the AIR-4.1 cognizant authority (APEO(RDT&E)). Notwithstanding successful completion of the PDR, the contractor remains responsible for the system design/performance requirements within the terms of the contract.

Completion of this review should provide:

a. An established system allocated baseline,
b. An updated risk assessment for SDD,
c. An updated Cost Analysis Requirements Description (CARD) based on the system allocated baseline, and
d. An updated program schedule including system and software critical path drivers
e. An approved Acquisition Logistics Support Plan (ALSP) with updates applicable to this phase

NAVAIR

Preliminary Design Review

Program Risk Assessment Checklist (1 August 2004 version)

For The __________________Program

Date:

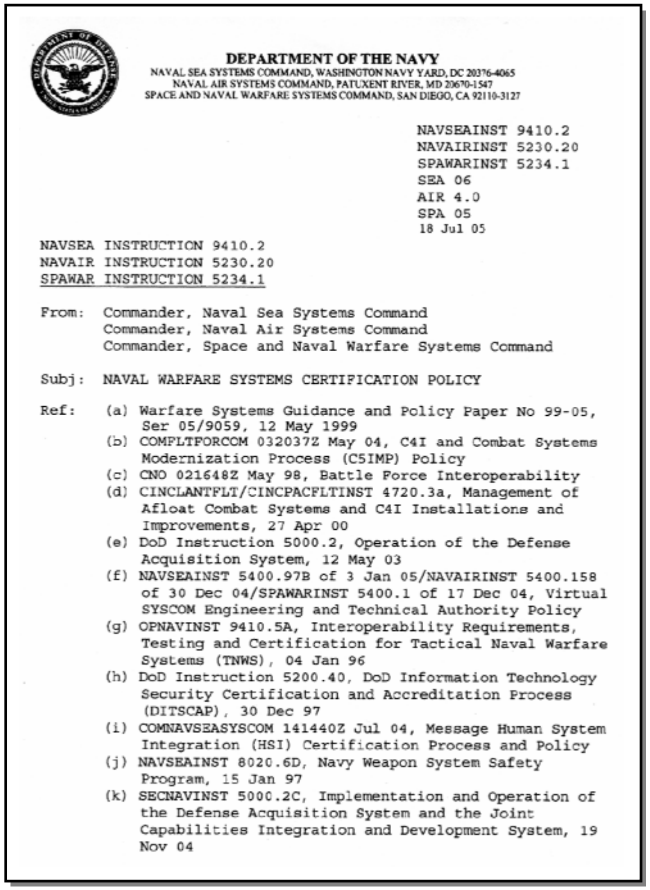
Legend: R | Y | G | U | NA

Instructions: Type the appropriate risk character in the space to the right of each question. The risk characters {R,Y,G,U or NA} are not case sensitive. The total number of each character will be displayed in the summary status at the beginning of each section.

R = Red
Y = Yellow
G = Green
U = Unknown/Unavailable
NA = Not Applicable

	R	Y	G	U	NA	Item	Comments/Mitigation
1. Timing / Entry Criteria	0	0	0	0	0	1	
2. Planning	0	0	0	0	0	2	
3. Program schedule	0	0	0	0	0	3	
4. Management metrics relevant to life cycle phase	0	0	0	0	0	4	
5. Program Staffing	0	0	0	0	0	5	
6. Process Review	0	0	0	0	0	6	
7. Requirements Management	0	0	0	0	0	7	
8. FORCEnet Compliance Checklist	0	0	0	0	0	8	
9. Battlespace engineering. Does the preliminary design conform with requirements per JOINT CAPABILITIES INTEGRATION AND DEVELOPMENT SYSTEM (JCIDS) CHAIRMAN OF THE JOINT CHIEFS OF STAFF INSTRUCTION CJCSI 3170.01D 12 March 2004?						9	
10. System Preliminary Design	0	0	0	0	0	10	
11. Program Risk Assessment	0	0	0	0	0	11	
12. Completion/Exit Criteria	0	0	0	0	0	12	

Systems Certification Policy



DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND, WASHINGTON NAVY YARD, DC 20376-4065
NAVAL AIR SYSTEMS COMMAND, PATUXENT RIVER, MD 20670-1547
SPACE AND NAVAL WARFARE SYSTEMS COMMAND, SAN DIEGO, CA 92110-3127

NAVSEAINST 9410.2
NAVAIRINST 5230.20
SPAWARINST 5234.1
SEA 06
AIR 4.0
SPA 05
18 Jul 05

NAVSEA INSTRUCTION 9410.2
NAVAIR INSTRUCTION 5230.20
SPAWAR INSTRUCTION 5234.1

From: Commander, Naval Sea Systems Command
Commander, Naval Air Systems Command
Commander, Space and Naval Warfare Systems Command

Subj: NAVAL WARFARE SYSTEMS CERTIFICATION POLICY

Ref: (a) Warfare Systems Guidance and Policy Paper No 99-05, Ser 05/9059, 12 May 1999
(b) COMPLTFORCOM 032037Z May 04, C4I and Combat Systems Modernization Process (C5IMP) Policy
(c) CNO 021648Z May 98, Battle Force Interoperability
(d) CINCLANTFLT/CINCPACFLTINST 4720.3a, Management of Afloat Combat Systems and C4I Installations and Improvements, 27 Apr 00
(e) DoD Instruction 5000.2, Operation of the Defense Acquisition System, 12 May 03
(f) NAVSEAINST 5400.97B of 3 Jan 05/NAVAIRINST 5400.158 of 30 Dec 04/SPAWARINST 5400.1 of 17 Dec 04, Virtual SYSCOM Engineering and Technical Authority Policy
(g) OPNAVINST 9410.5A, Interoperability Requirements, Testing and Certification for Tactical Naval Warfare Systems (TNWS), 04 Jan 96
(h) DoD Instruction 5200.40, DoD Information Technology Security Certification and Accreditation Process (DITSCAP), 30 Dec 97
(i) COMNAVSEASYSCOM 141440Z Jul 04, Message Human System Integration (HSI) Certification Process and Policy
(j) NAVSEAINST 8020.6D, Navy Weapon System Safety Program, 15 Jan 97
(k) SECNAVINST 5000.2C, Implementation and Operation of the Defense Acquisition System and the Joint Capabilities Integration and Development System, 19 Nov 04

Purpose: **Promulgate platform level and strike force level Naval Warfare Systems Certification Policy**

Status:

- **Phase I implements Fleet Response Plan (FRP) Compliant Platform Level Certification Policy for Navy surface platforms and introduces Strike Force Certification Policy for all surface platforms- Issued Jul 05**
- **Phase 2 completes FRP Compliant Platform across SYSCOMs for all platforms and for Strike Force Certification Policy - FY06**
- **Phase 3 aligns Certification Policy and process with Navy Acquisition Policy – FY07**

Topics

- Virtual System Commands
- **ASN (RDA) Policy for Systems Engineering Plan**
- Software Acquisition: Best Practices
- System / System of Systems Safety
- Naval Capability Evolution Process
- FORCEnet / Open Architecture Integration and Interoperability
- The Technical Cooperation Panel – Technical Panel 4
- Naval Force Development System

Policy for DoN Systems Engineering Plan

DEPARTMENT OF THE NAVY
OFFICE OF THE ASSISTANT SECRETARY
RESEARCH, DEVELOPMENT AND ACQUISITION
1000 NAVY PENTAGON
WASHINGTON DC 20350-1000
JUN 0 6 2005

MEMORANDUM FOR DISTRIBUTION

SUBJECT: Policy for DoN Systems Engineering Plan (SEP) Review and Approval

The program Systems Engineering Plan (SEP) will be developed and approved for each Milestone review to recognize that Systems Engineering practices are integral in the execution of our acquisition programs. This memorandum provides guidance to be implemented by Navy and Marine Corps Program Managers (PMs), Program Executive Officers (PEOs), Systems Command (SYSCOM) Commanders and Direct Reporting Program Managers (DRPMs) for the development, review and approval of their program's SEPs.

Although there is no prescribed format for SEPs within the Defense Acquisition Guidebook, the SEP Preparation Guide provides a recommended content. Additional instructions and forms outlined in the following attachments will be used in Navy and Marine Corps programs to facilitate review and coordination. My expectation is that the Program Office lead or Chief Systems Engineer will have the primary role in developing the SEP. SYSCOM Technical Authorities and PEO Programmatic Authorities must also be engaged to ensure quality, completeness and acceptable level of risk.

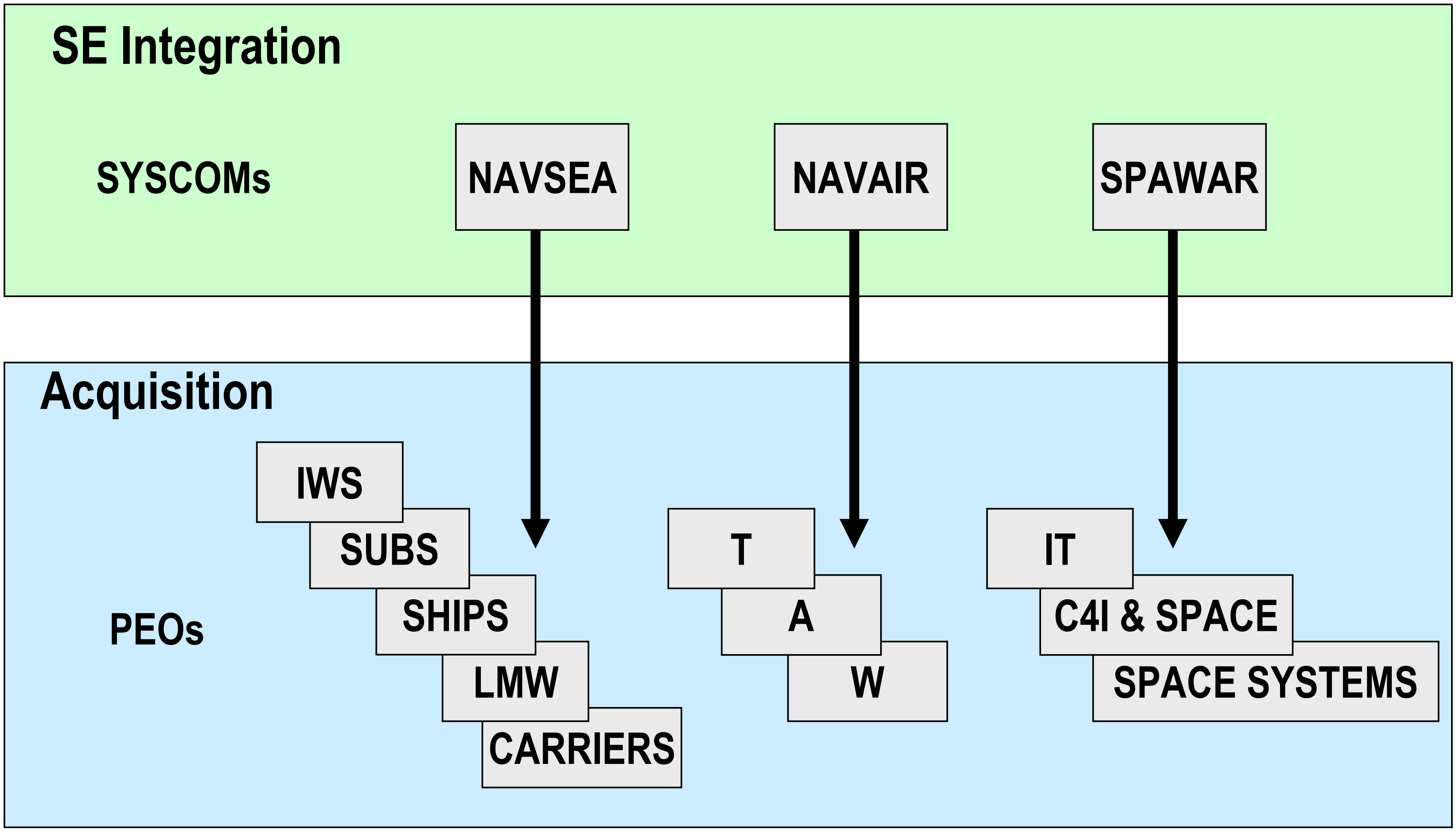
ASN (RD&A) Chief Engineer (CHENG) will coordinate with the OSD staff to facilitate document reviews and ensure Navy and Marine Corps issues are addressed in future SEP instructions and guides. Additionally, the Chief Engineer will collaborate with Navy and Marine Corps programs to collect lessons learned and best practices to improve the process.

John J. Young, Jr.

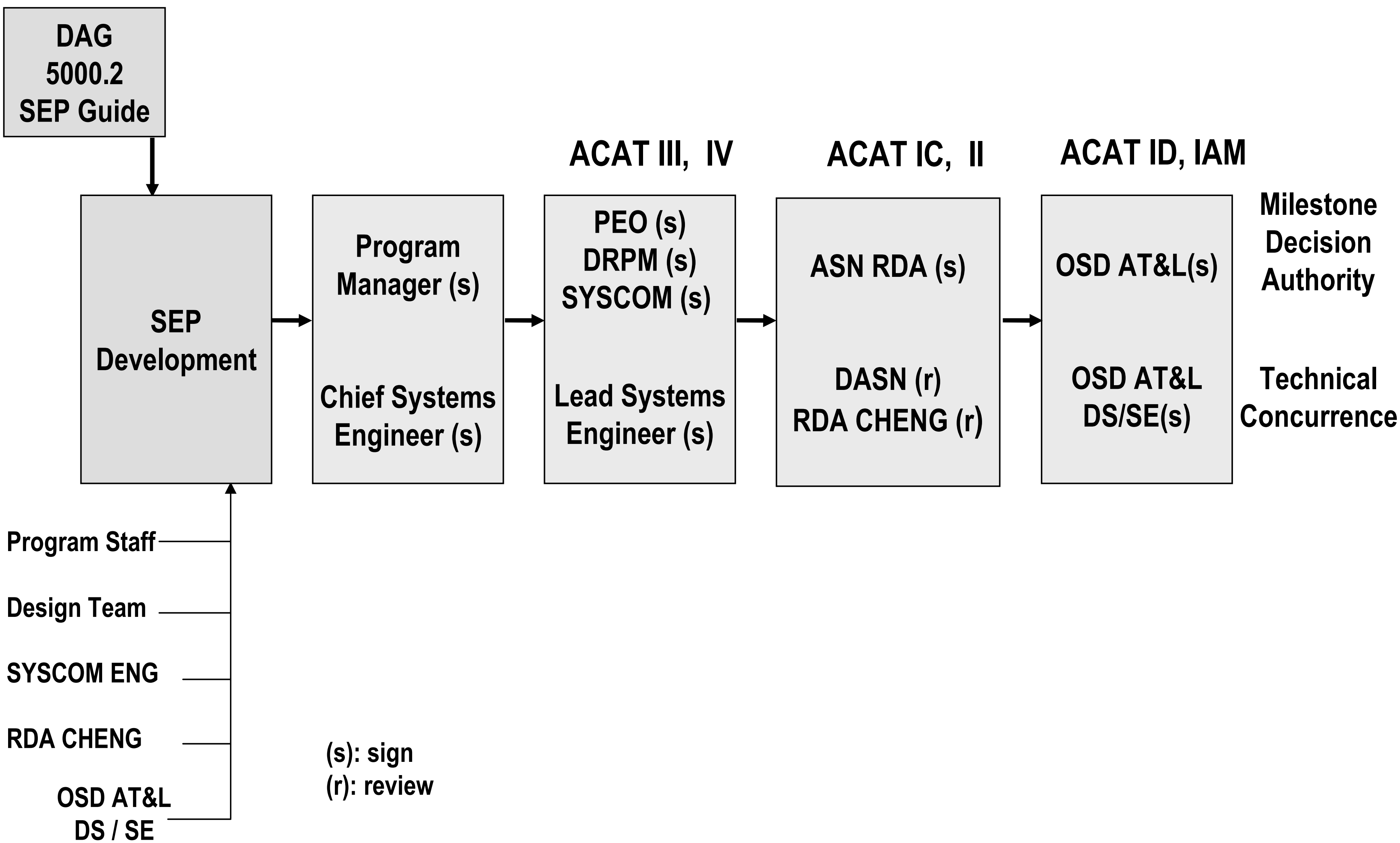
Purpose: **Provide guidance for the Development, Review and Approval of Systems Engineering Plans**

Status: **Promulgated 6 June 05**

Navy SE Structure



SEP Approval Process



Topics

- Virtual System Commands
- ASN (RDA) Policy for Systems Engineering Plan
- **Software Acquisition: Best Practices**
  - **Software Acquisition Policy**
  - **Software Assurance**
  - **CMMI for Acquisition**
- System / System of Systems Safety
- Naval Capability Evolution Process
- FORCEnet / Open Architecture Integration and Interoperability
- The Technical Cooperation Panel – Technical Panel 4
- Naval Force Development System

Software Acquisition Policy

Draft

DEPARTMENT OF THE NAVY
OFFICE OF THE ASSISTANT SECRETARY
RESEARCH, DEVELOPMENT AND ACQUISITION
1000 NAVY PENTAGON
WASHINGTON, DC 20350-1000

August 15, 2005

MEMORANDUM FOR: Distribution

Subj: Software Acquisition Policy for the Naval Strategic Software Improvement Program (NSSIP)

Ref: (a) HR 4546; FY 2003 Defense Authorization Act, Public Law 107-314 Section 804
(b) OSD Memorandum for Secretaries of the Military Departments, Subject: Software Acquisition Process Improvement Program, 21 March 2003
(c) OSD Memorandum for Secretaries of the Military Departments, Subject: Policy for Systems Engineering in DOD, 20 February 2004
(d) OSD Memorandum for Secretaries of the Military Departments, Subject: Implementing Systems Engineering Plans in DOD – Interim Guidance, 30 March 2004
(e) OSD Memorandum for Secretaries of the Military Departments, Subject: Policy Addendum for Systems Engineering, 22 October 2004
(f) OSD Memorandum for Technical Director, Audit Follow-Up and GAO Affairs, Office of the Inspector General, Department of Defense, 21 December 2004

Encl: (1) Guidance for Core Software Management Metrics

This memorandum establishes the NSSIP as a means to address the mandates of reference (a) and applies to organic government software development as well as software development contracted to the private sector. Reference (b) extends the mandates of reference (a) and identifies additional requirements. The NSSIP is intended to establish the DON's overall acquisition objectives for software development procurement and management. Software development policies and processes will be defined and applied as an integral part of acquisition systems engineering processes and will adhere to the systems engineering revitalization policy described in references (c) through (f).

The following software development focus areas should be integrated into software related activities in the Systems

Purpose

- Establish the Naval Strategic Software Improvement Program as a means to address mandates of Public Law 107-314 Section 804
- Establish DoN's overall acquisition objectives for Software Development, Procurement and Management

Status: Draft-estimated completion date Dec 05

Software Assurance (SwA)

- OSD NII/AT&L Tiger Team established Dec 04 to establish "holistic strategy" and implementation plan
  - Examining potential security issues with (Software) SW
    - Malicious Code insertion
    - Vulnerable Code inadvertently left in COTS/NDI products
- Focus Areas:
  - Engineering-in-Depth (RDA CHENG co-chairs)
  - Prioritization (ID critical systems)
  - Supplier Assurance
  - Science & Technology (tools and mitigation services)
- SwA requirements will be addressed in the SEP and TEMP
  - Leverage existing policy (eg.IA, JCIDS,PPP,etc)

CMMI for Acquisition; CMMI A

- CMMI best practices model for the acquirer being developed – CMMI A
  - Past CMMI models have been for the developer
  - CMMI – Acquisition Module (AM) first attempt at organizing a tool for the acquirer; not successful
- Requirements gathering workshop for the CMMI A to be held on 9 November 2005
  - The plan is to incorporate this model as a "constellation" in version 1.2 of the CMMI model framework

Topics

- Virtual System Commands
- ASN (RDA) Policy for Systems Engineering Plan
- Software Acquisition: Best Practices
- **System / System of Systems Safety**
  - Principal for Safety Certification
  - Systems Safety in Capability-Based Acquisition
- Naval Capability Evolution Process
- FORCEnet / Open Architecture Integration and Interoperability
- The Technical Cooperation Panel – Technical Panel 4
- Naval Force Development System

Principal for Safety Certification

NAVSEAINST 12410.5
Ser

NAVSEA INSTRUCTION 12410.5

From: Commanding Officer, Naval Ordnance Safety and Security Activity

Subj: CERTIFICATION FOR NAVY ACQUISITION PROGRAM PRINCIPAL FOR SAFETY (PFS)

Ref: (a) DODINST 5000.1
(b) DODINST 5000.2
(c) OPNAVINST 5100.24A
(d) DOD 5000.52
(e) DOD 5000.52M
(f) SECNAVINST 12410.22A
(g) MIL-STD-882D

Encl: (1) Definition of Basic Terms
(2) Minimum Requirements for PFS Certification
(3) PFS Certification Program Application Checklist

1. Purpose. To establish policy and guidance for Naval Sea Systems Command (NAVSEA) Principal for Safety (PFS) certification.

2. Scope. This instruction applies to all NAVSEA acquisition programs. Reference (a) requires that a fully proficient acquisition technology and logistics workforce be maintained. It further mandates that system safety engineering and management controls be appropriately applied in the acquisition and life cycle support of DoD weapon systems.

Reference (b) requires that a Program Manager prevent Environment, Safety and Occupational Health (ESOH) hazards where possible, and manage them where they cannot be avoided. Reference (c) requires a trained, and appropriately certified, system safety manager be assigned to each program or system. This manager is to act as the point of contact, for the Program Manager (PM), for system safety matters. References (d), (e), and (f) require the professional development of acquisition workforce personnel, and that assignment of system safety responsibilities only be delegated to qualified personnel.

Point of contact. The NAVSEA point of contact for assistance is The Certification and Standard's Officer, Naval Ordnance Safety and Security Activity, Code XXXXX.

Purpose: Establish policy and guidance for Naval Sea Systems Command Principal for Safety (PFS) Certification

Status: Draft – estimated completion FY06

The U.S. Navy and BCSP Cooperative Agreement

…the U.S. Navy's Weapon System Explosives Safety Review Board (WSESRB) and the Board of Certified Safety Professionals (BCSP) established a cooperative agreement for the certification of Navy weapon system safety personnel as Principals for Safety (PFS).

NEWS RELEASE

Contacts:

For Immediate Release:

Jim Gerber

Weapon System

(301) 744-6018

Heather Murphy, *Communication & Marketing Manager*

Board of Certified Safety Professionals
217/359-9263; heather@bcsp.org

The U.S. Navy and BCSP Establish Cooperative Agreement

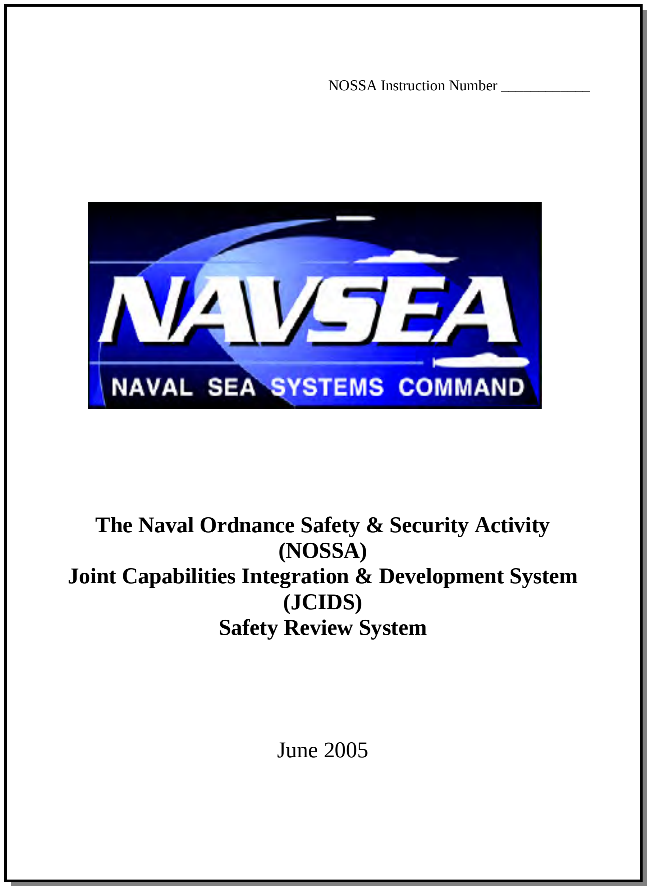
Indian Head, Maryland—July 26, 2004—On March 16, 2004, the U.S. Navy's Weapon System Explosives Safety Review Board (WSESRB) and the Board of Certified Safety Professionals (BCSP) established a cooperative agreement for the certification of Navy weapon system safety personnel as Principals for Safety (PFS). WSESRB has established an implementation date of December 31, 2004 for the PFS certification program.

BCSP supports the PFS certification program by managing and operating the examination that PFS candidates must successfully complete to demonstrate competence in system safety concepts. After successfully completing this examination, PFS candidates must finish additional training in weapon system safety concepts and demonstrate competence on another WSESRB-managed examination to earn the PFS certification. WSESRB and BCSP have agreed to maintain the system safety examination in accordance with national and international examination-related accreditation standards.

"BCSP is privileged to cooperate with a leading military safety-centered organization like the WSESRB," said BCSP Executive Director, Roger Brauer, Ph.D., CSP, P.E. "The WSESRB Principal for Safety certification program is a well-designed program that will promote safety professionalism and encourage a continued high level of system safety competence within the WSESRB and the Navy's weapon system safety community."

"By working with BCSP and implementing this high-profile internal safety certification program, the WSESRB can seek to better protect the Navy's personnel and platforms from the risks associated with complex weapon systems in the Fleet," said Edward Kratovil, Chairman of the WSESRB.

Systems Safety in Capability-Based Acquisition


NOSSA Instruction Number ___________

NAVSEA
NAVAL SEA SYSTEMS COMMAND

The Naval Ordnance Safety & Security Activity (NOSSA)
Joint Capabilities Integration & Development System (JCIDS)
Safety Review System

June 2005

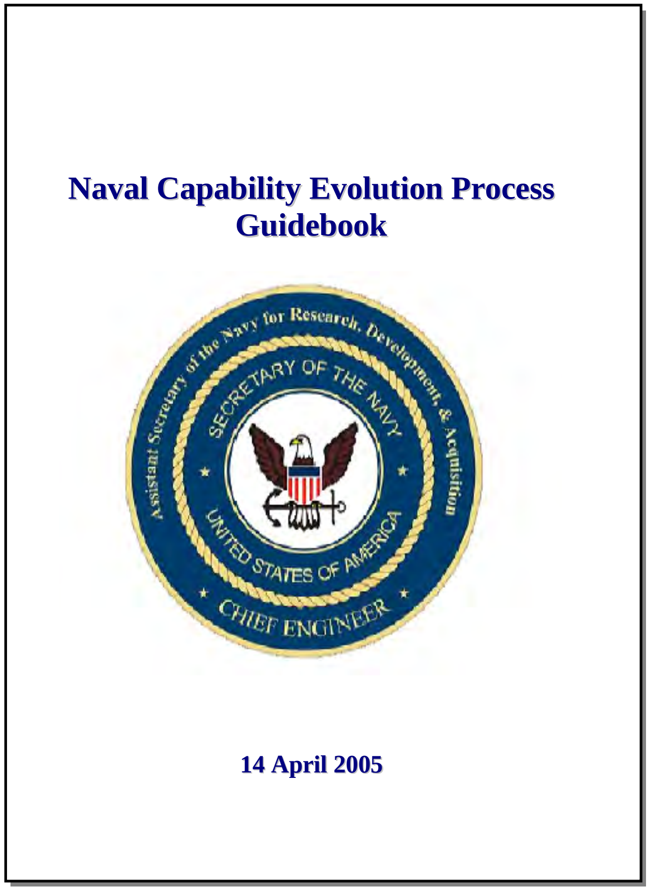
Purpose: Describe a new Naval Ordnance Safety and Security Activity (NOSSA) System for conducting acquisition document safety reviews and for complying with the Joint Capabilities Integration and Development System

Status: Issued Jun 05

Topics

- Virtual System Commands
- ASN (RDA) Policy for Systems Engineering Plan
- Software Acquisition: Best Practices
- System / System of System Safety
- **Naval Capability Evolution Process**
  - **Vol I - Guidebook**
  - **Vol II – Best Practices**
- FORCEnet / Open Architecture Integration and Interoperability
- The Technical Cooperation Panel – Technical Panel 4
- Naval Force Development System

NCEP Vol I - Guidebook



Naval Capability Evolution Process Guidebook

14 April 2005

Purpose:

- Describes The Naval Capability Development Process
- Provides guidance for its use by the DoN acquisition community

Status: Version 1.1 issued 14 April 05

https://www.asnrdacheng.navy.mil/cheng/general/docs/CHENG.NCEP.v1.Final.pdf

NCEP Vol I - Guidebook

- Aligned with CJCSI-3170.1C, DODI-5000.2, SECNAV-5000.2C
- Key Elements
  - Capability Evolution Planning
    - Current Architecture Assessment (Capability Needs Identification)
    - Capability Alternatives Identification
    - Analysis of Alternatives
    - Capability Evolution Plan
  - Capability Engineering (Abstracted the Systems Engineering Process)
    - Operational Analysis
    - Functional Analysis & Allocation
    - Portfolio Synthesis
    - Portfolio Analysis
  - Portfolio Execution
    - Portfolio Assessment
    - Program Alignment
    - Program Status & Milestone Reviews
  - SE IPT Collaborative Engineering Environment

NCEP Vol II – Best Practices

Naval Capability Evolution Process Guidebook
Volume II – Best Practices

Prepared by the
Office of the ASN (RDA)
Chief Engineer
(Working Draft)

Purpose:

- Provide recommended methods, techniques and tools that enable execution of activities described by Vol I
- Provide examples of real world problems and uses cases

Status: Draft Version 1.1- estimated completion date Nov 05

https://www.asnrdacheng.navy.mil/cheng/general/docs/CHENG.NCEP.v1.Final.pdf

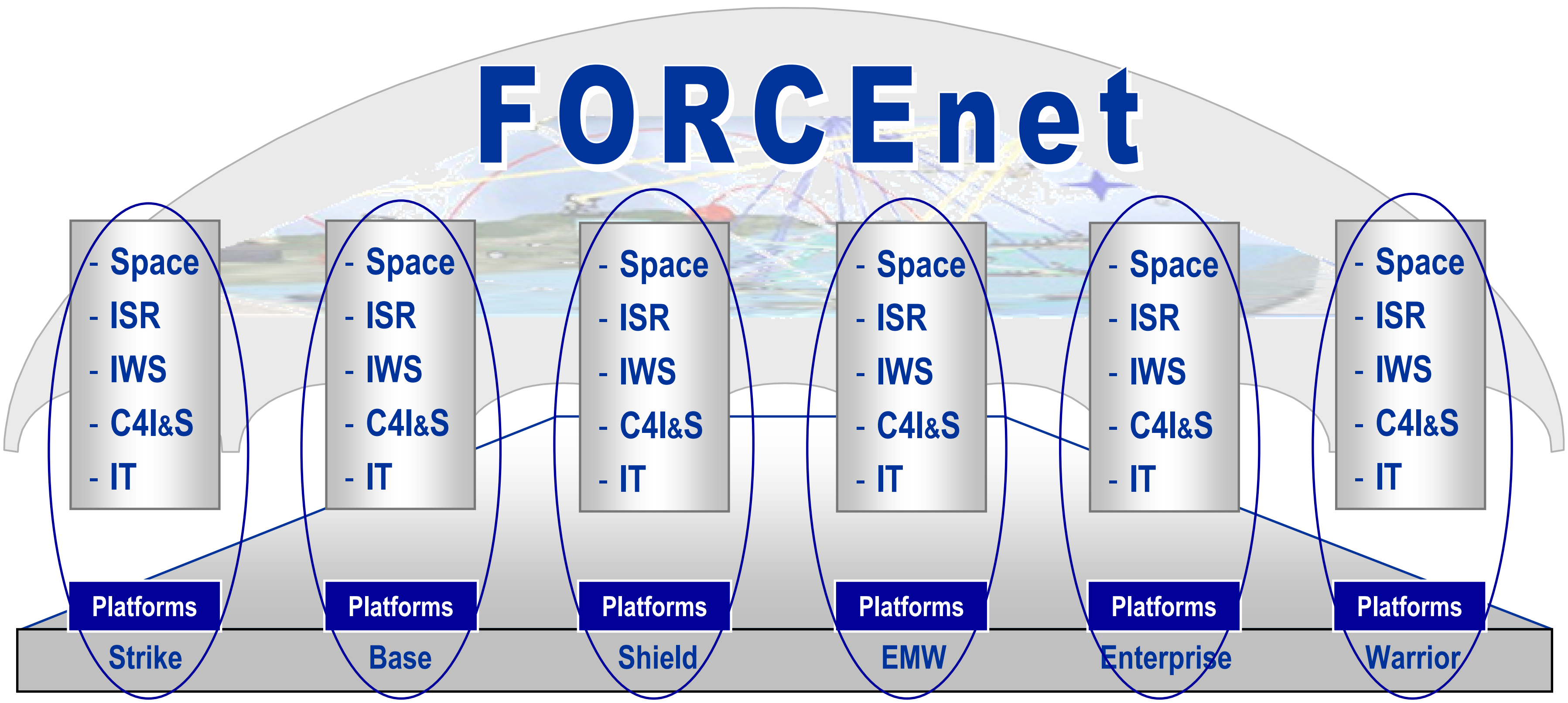
NCEP Vol II – Best Practices

- Capability Specification and Metrics
- Applying QFD to Capability-based Planning
- Role of Architecture
- Capability Evolution Plan
  - Mission Threads/Concept of Operations
  - Capability Evolution Objectives
  - Force Package Structure
  - Readiness Concepts
  - Sustainment Concepts
  - System Service-life Profile
  - Technology Adoption Milestones
  - Force Training and Transition Plan
  - Capability Investment Strategy
  - Acquisition Portfolio Risk Abatement Plan
- Force Package Engineering Models

Topics

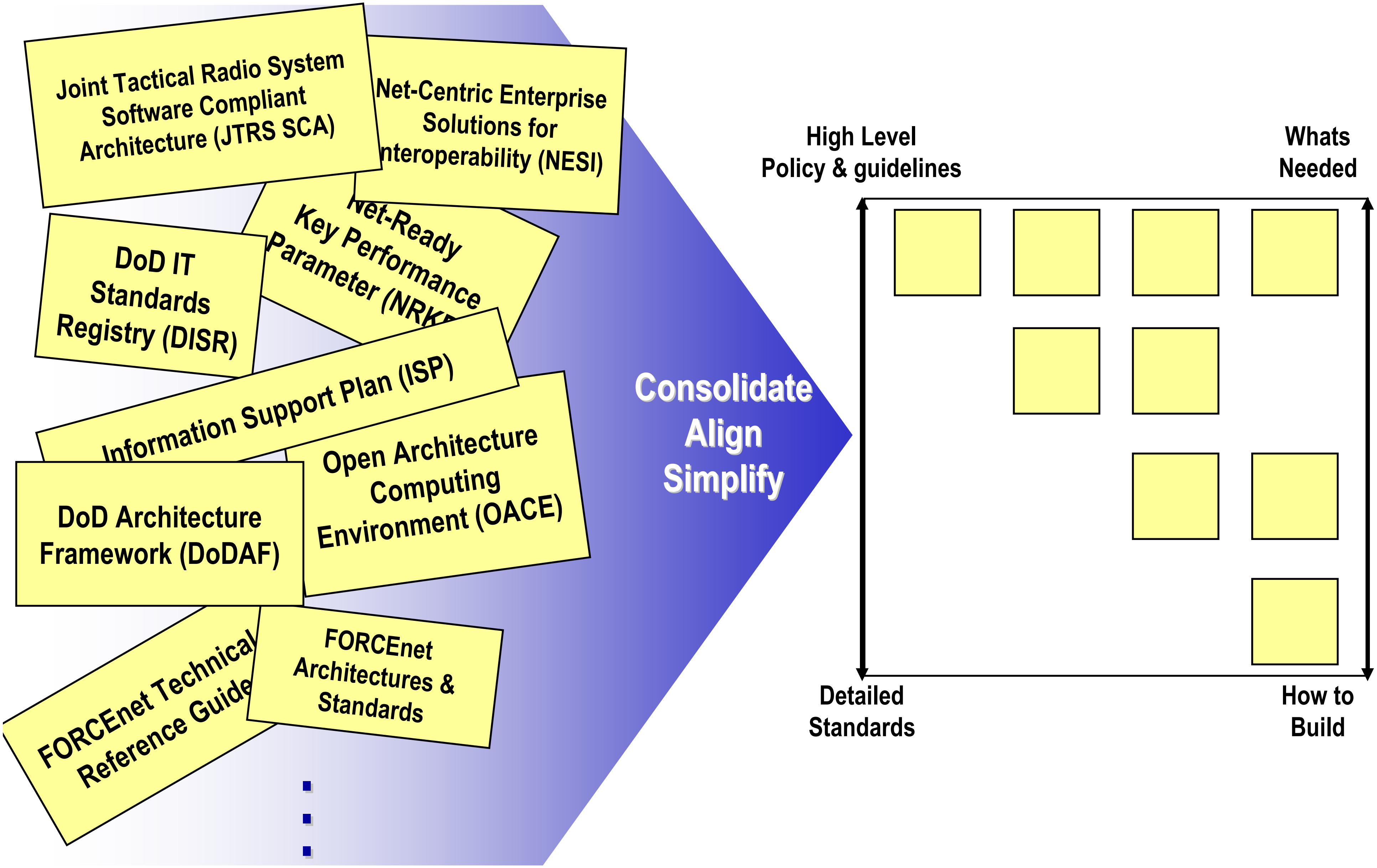
- Virtual System Commands
- ASN (RDA) Policy for Systems Engineering Plan
- Software Acquisition: Best Practices
- System / System of System Safety
- Naval Capability Evolution Process
- **FORCEnet / Open Architecture Integration and Interoperability**
  - **Technical document consolidation**
  - **Test & Evaluation Risk Management**
  - **FORCEnet Integration & Interoperability Management Plan**
- The Technical Cooperation Panel – Technical Panel 4
- Naval Force Development System

Breadth of FORCEnet



Warfighting + Warfighting Support + Business Systems

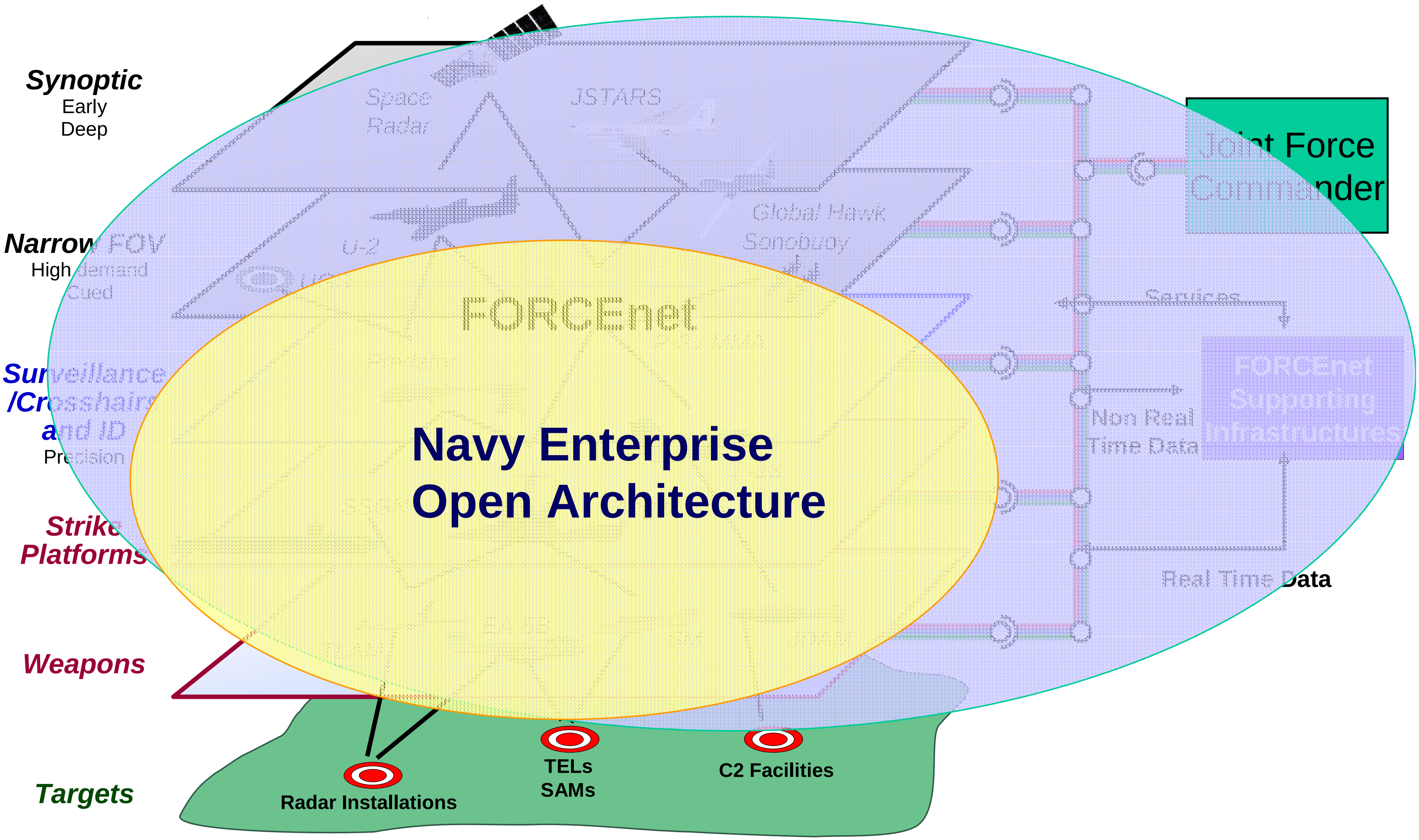
Technical Documentation Consolidation



OA/FN Alignment Experimentation Strategy

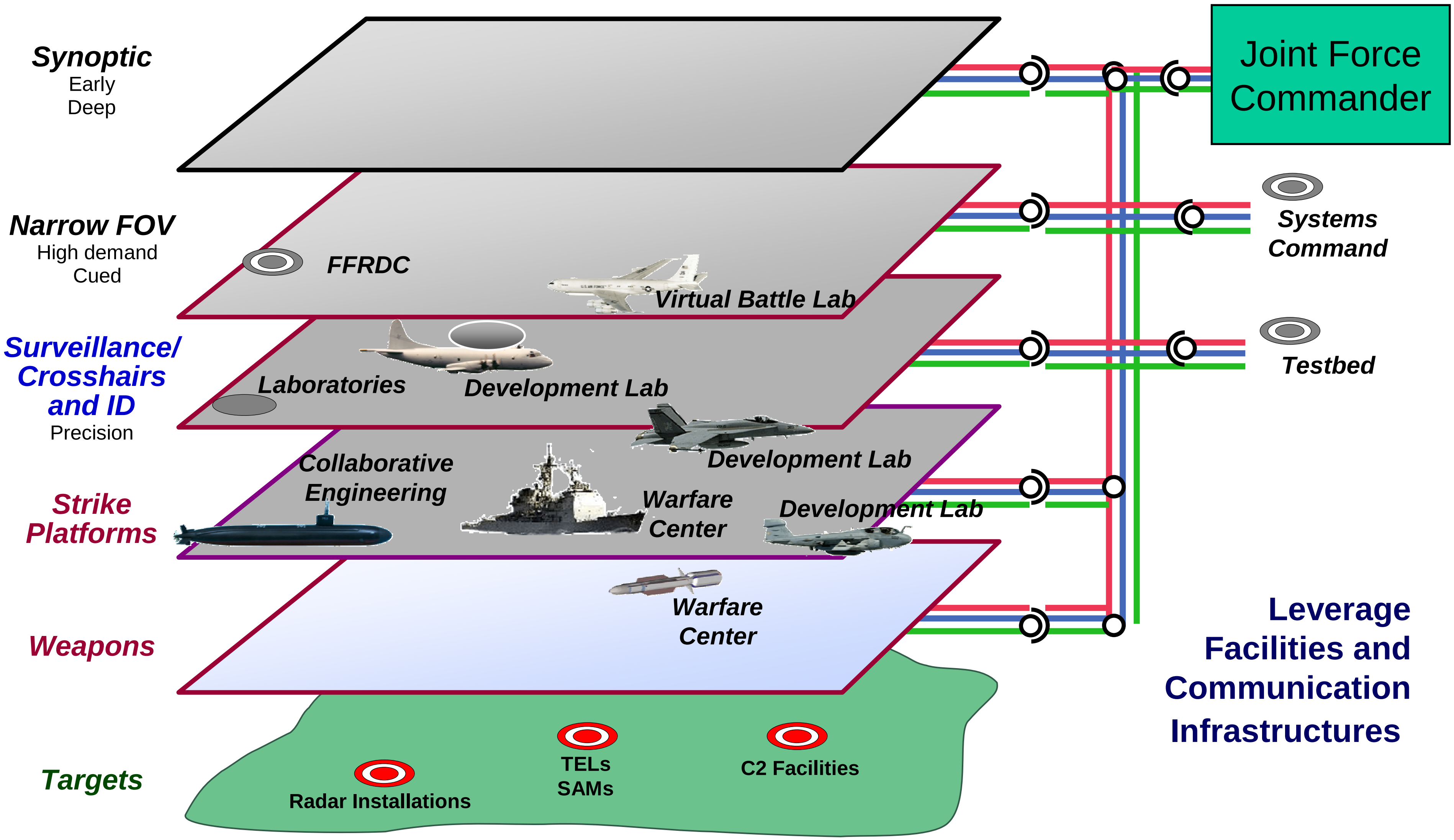
- **End-to-End Force Level System Engineering**
  - Experimentation to resolve issues that needed to be solved
- **Testing Reusable Component Effects across systems and domains**
- **Foster Team work and common understanding across domains**
- **Use Open/Collaborative Engineering Environment across Navy Enterprise**
  - **Leverage existing Netted environments of Land based Test Sites and Live Assets (Via Sea Trial Process) where applicable**
    - Hook up Labs and Fleet connectivity only as needed–Leverage existing facilities and networks
  - **Data Repository/Tools – Enterprise Level Engineering Assessment Capability**
    - Leverage existing tools (e.g. ASN RDA CHENG/NCEE,…) and processes (such as CBM and Business Case Analysis) where applicable

Operational Context View
The Net-Centric Lattice Strike Example

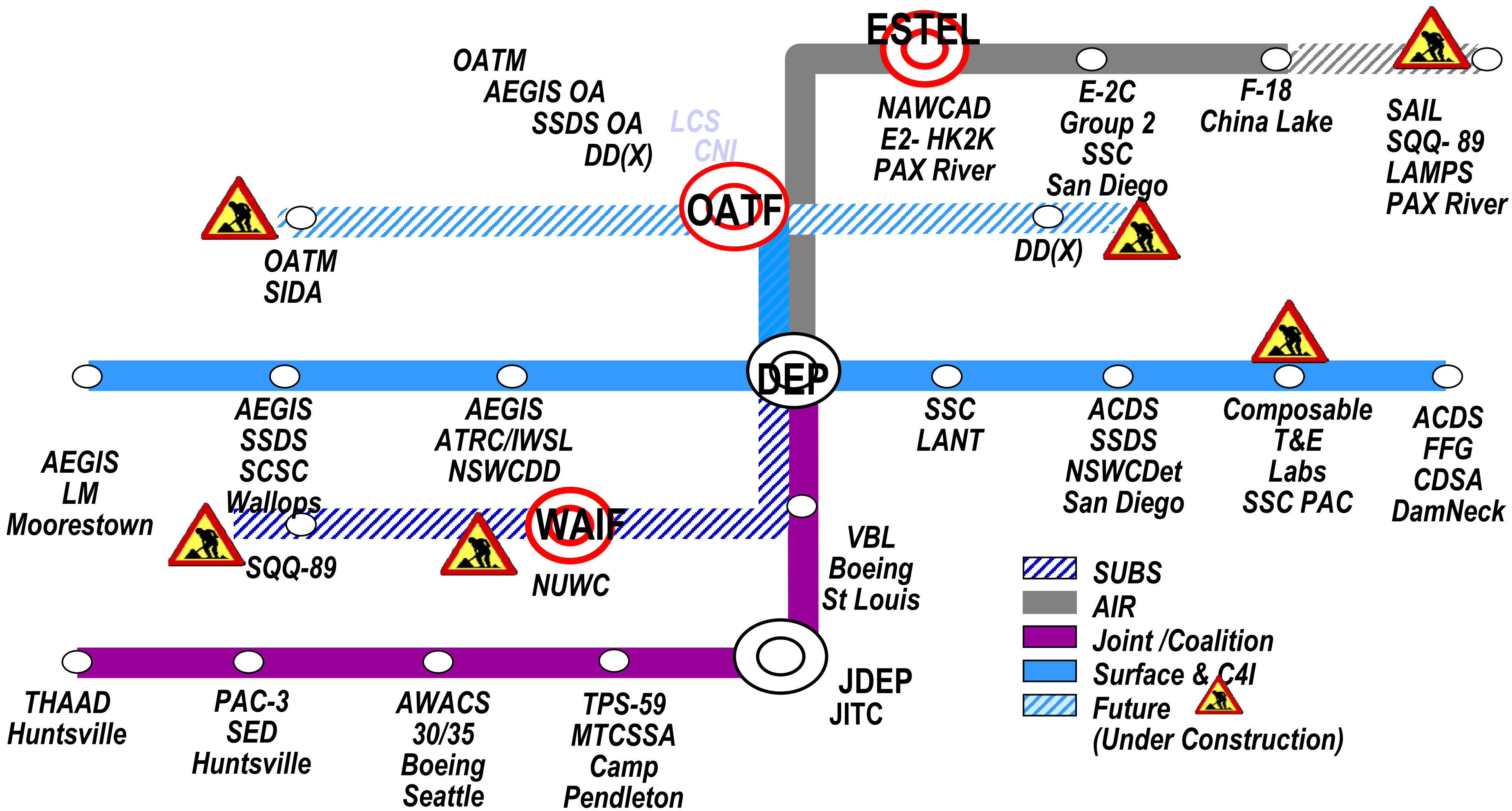


Land-based Test Sites Connectivity View

The Net-Centric Lattice Strike Example

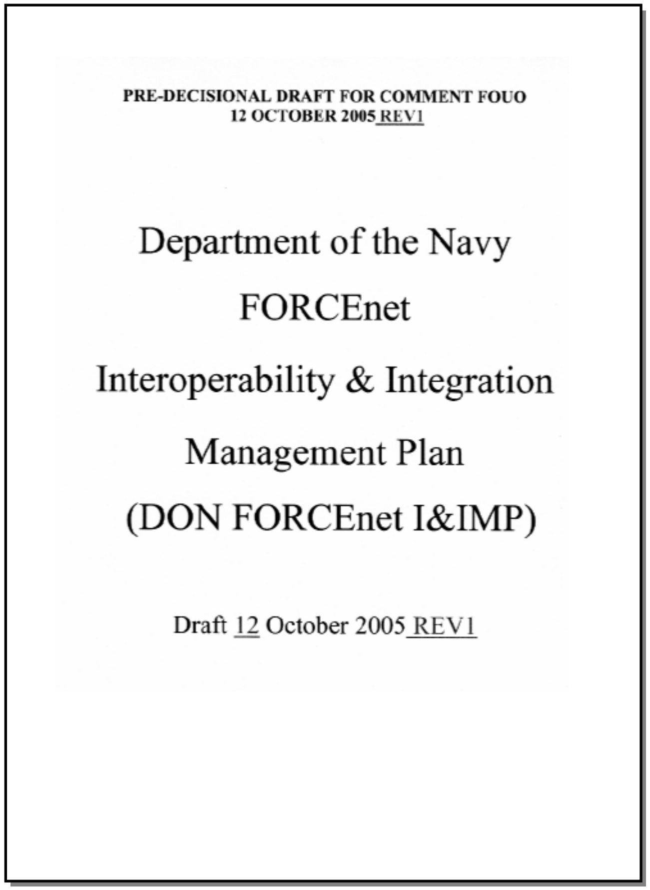


… through a OA / FORCEnet risk reduction experimentation initiative



Transformation Through Collaboration

FORCEnet Integration & Interoperability Management Plan


PRE-DECISIONAL DRAFT FOR COMMENT FOUO
12 OCTOBER 2005 REV1

Department of the Navy

FORCEnet

Interoperability & Integration

Management Plan

(DON FORCEnet I&IMP)

Draft 12 October 2005 REV1

Purpose:

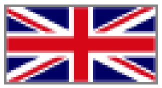
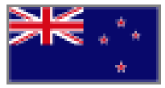
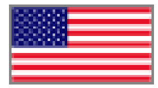
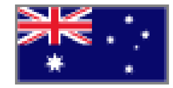
- Establish a management structure and plan for managing I&I of FORCEnet Systems
- Describe procedures, processes and authorities within acquisition community for cooperative design, development, testing and fielding of FORCEnet Systems
- Provide material foundation for capabilities in FORCEnet Functional Concept

Status: In preparation – estimated completion date Mar 06

Topics

- Virtual System Commands
- ASN (RDA) Policy for Systems Engineering Plan
- Software Acquisition: Best Practices
- System / System of System Safety
- Naval Capability Evolution Process
- FORCEnet / Open Architecture Integration and Interoperability
- **The Technical Cooperation Panel – Technical Panel 4**
- Naval Force Development System

TTCP-JSA-TP4 Terms of Reference

A Technical Panel under Joint Systems and Analysis Group of TTCP

Scope: ***Review and exchange best practice and latest research in the application of systems engineering to the enterprise of Defence.***

Vision: ***Shape national acquisition strategies and practices to result in effective joint and coalition capabilities.***

TP-4 Status

- Shared the Naval Capability Evolution Process Guidebook with participating countries

- Established a prototype Coalition Collaborative Engineering Environment (CCEE) based on NCEE

- Initiated development of a Coalition Systems Engineering Demonstrator Project

Topics

- Virtual System Commands
- ASN (RDA) Policy for Systems Engineering Plan
- Software Acquisition: Best Practices
- System / System of System Safety
- Naval Capability Evolution Process
- FORCEnet / Open Architecture Integration and Interoperability
- The Technical Cooperation Panel – Technical Panel 4
- **Naval Force Development System (NFDS)**

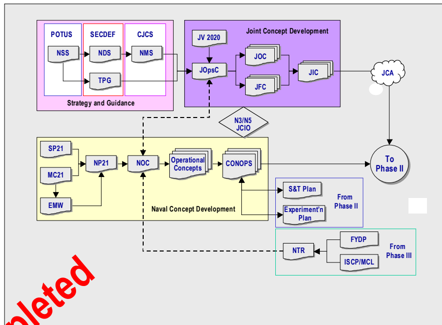
NFDS Objectives

- Capture the “as is” state of the Navy and Marine Corps capability definition, budgeting, and acquisition decision processes and to determine process owners within each of the frameworks
- Identify gaps, overlaps, and misalignments in the services’ processes, as well as intersections of the services’ methodologies
- Provide a basis for implementing corrective actions to fill gaps, correct misalignments, and improve overall efficiency through greater alignment of processes and commonality of products
- Support senior Navy and Marine Corps leadership to better align naval processes with evolving OSD and Joint Staff transformation to joint capabilities-based investment decisions

Promote informed decisions at all levels

NFDS Status

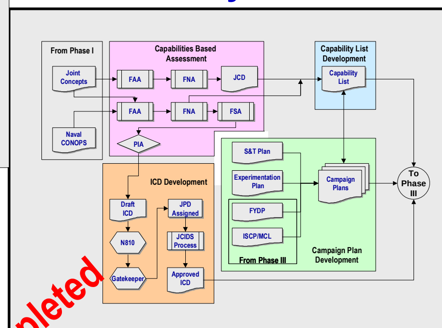
Phase I – Concept Development



Completed

- Operational Concepts
- Warfighting CONOPs

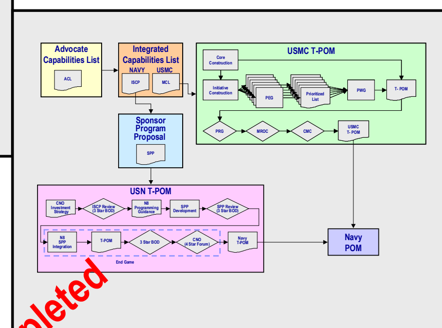
Phase II- Capability Analysis



Completed

- ICD
- Capability List
- Campaign Plans

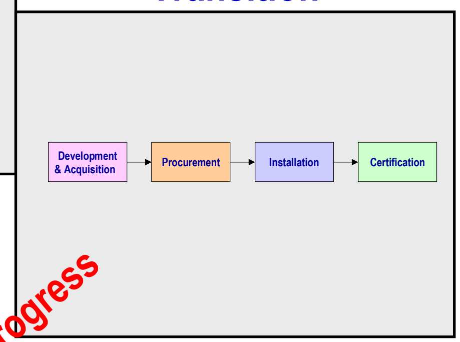
Phase III - Capability Prioritization & Resourcing



Completed

- Advocate Requirement List
- ISCP
- Validated POM
- Etc

Phase IV - Capability Acquisition, Fielding & Transition



In Progress

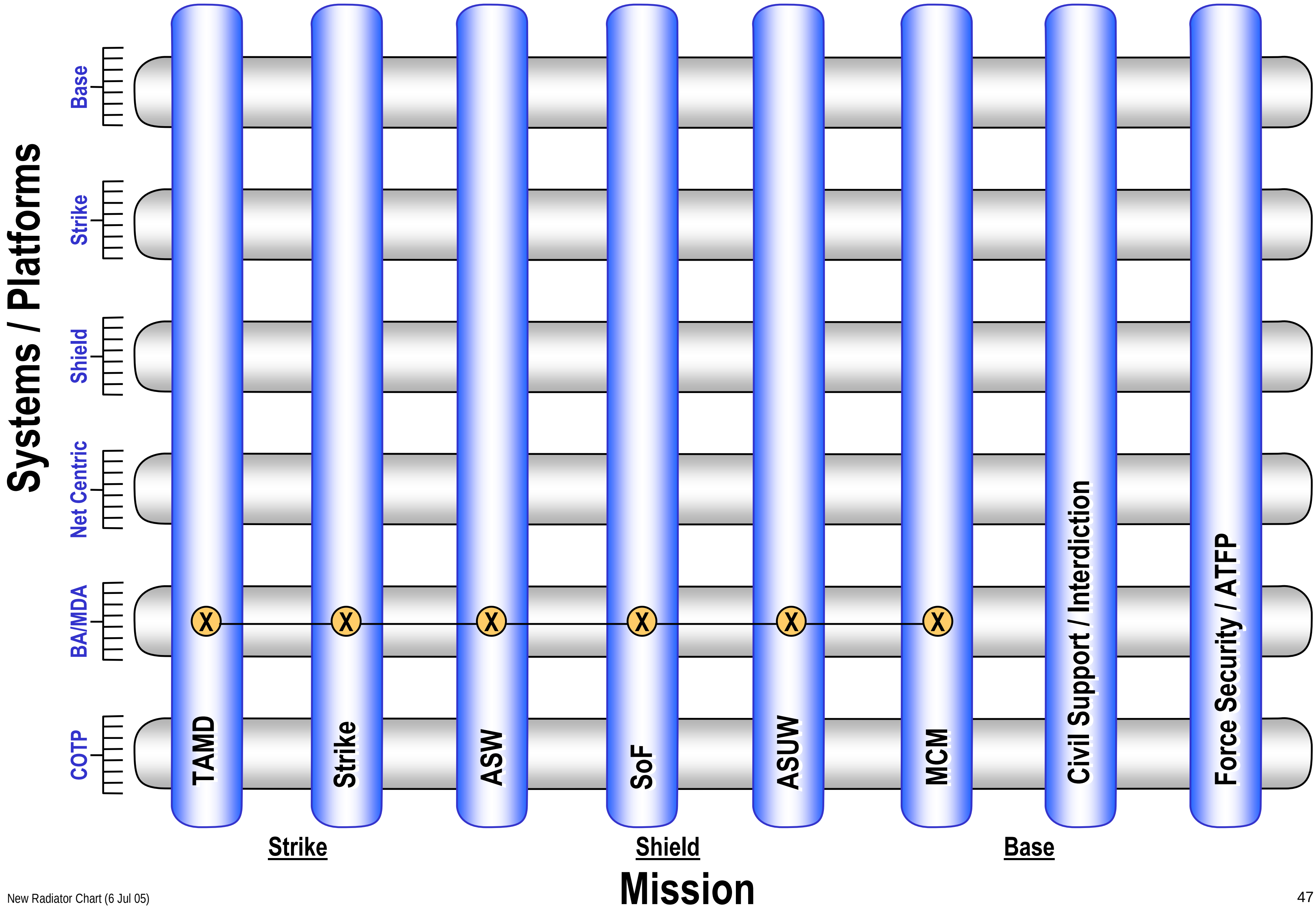
- Acquisition Baselines
- Capability Evolution Document
- Fielding Plans
- Etc

Recommendations

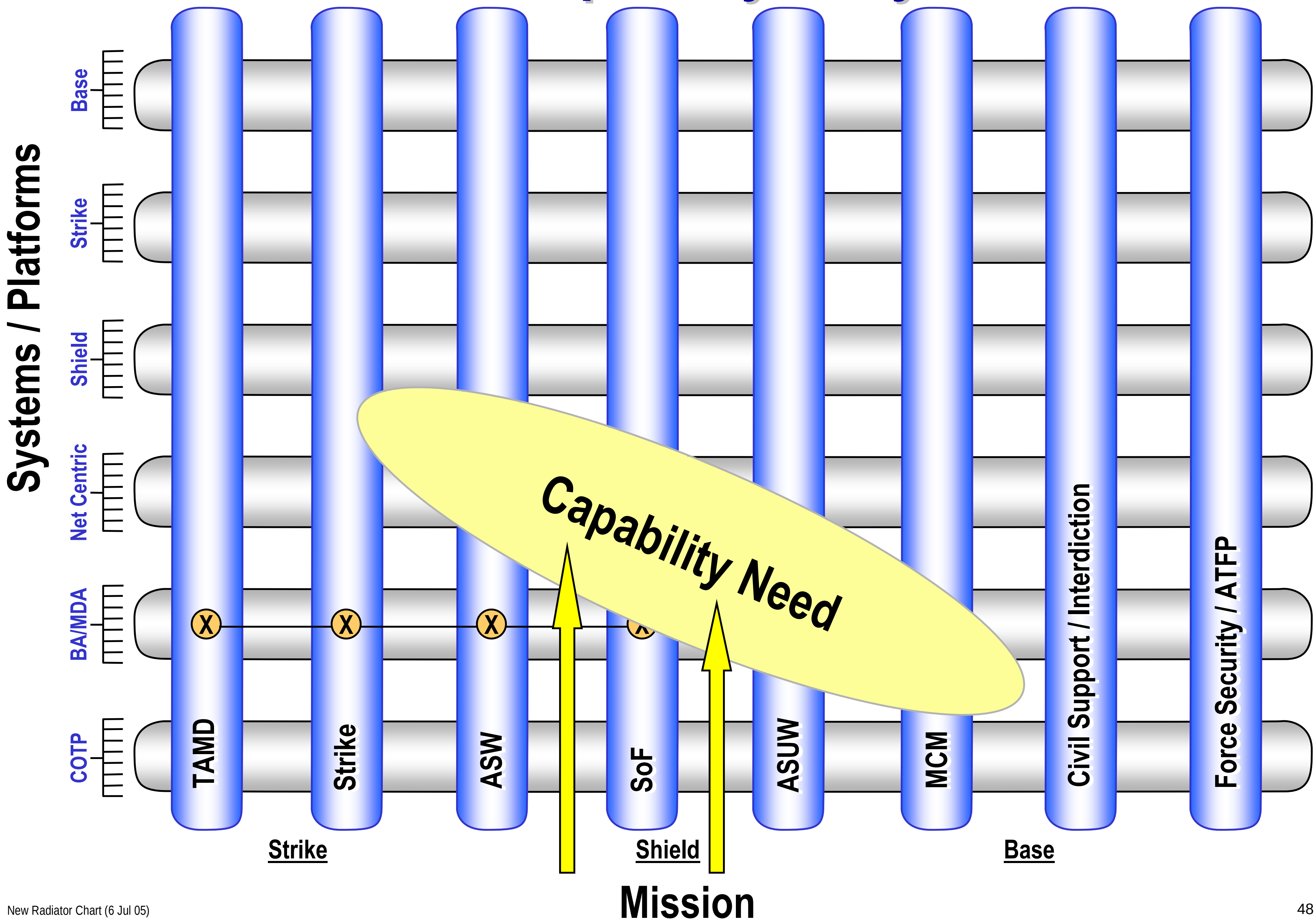
- Formalize enterprise level stakeholder participation among OPNAV, the Fleet, S&T, Acquisition and Secretariat communities
  - Align acquisition community with OPNAV staff to facilitate coordination
- Assign overall concept development responsibility and complete development of Naval concepts
- Implement a Naval Architecture Development and Governance Process
- Designate capability advocates
  - To develop, maintain, and publish capability campaign plans
  - To generate and maintain a required capabilities list as basis for capability gap analysis and POM programming recommendations
- Establish a core POM to improve program stability

Establish Stability, Continuity, and Ownership

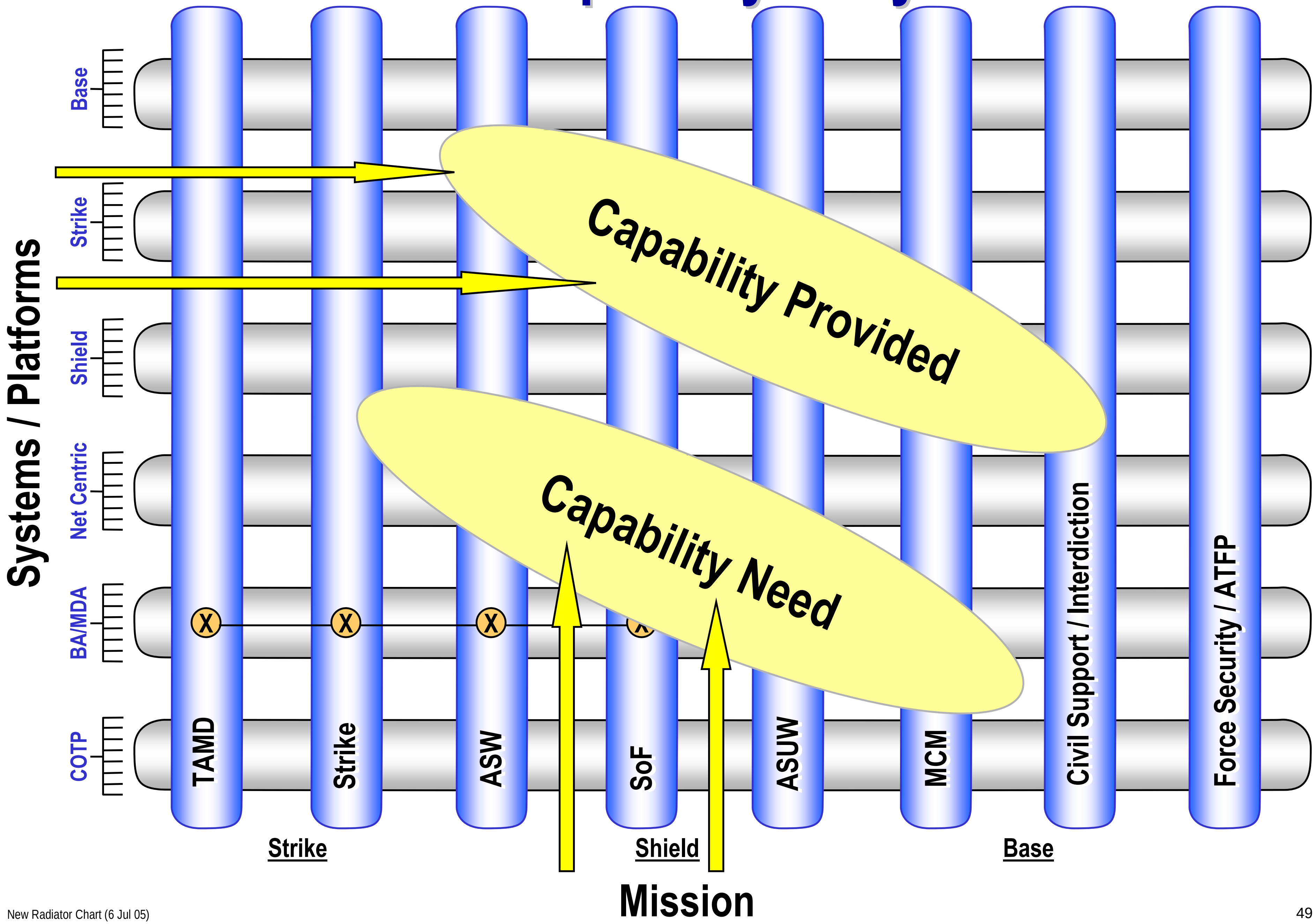
Mission to Capability to System



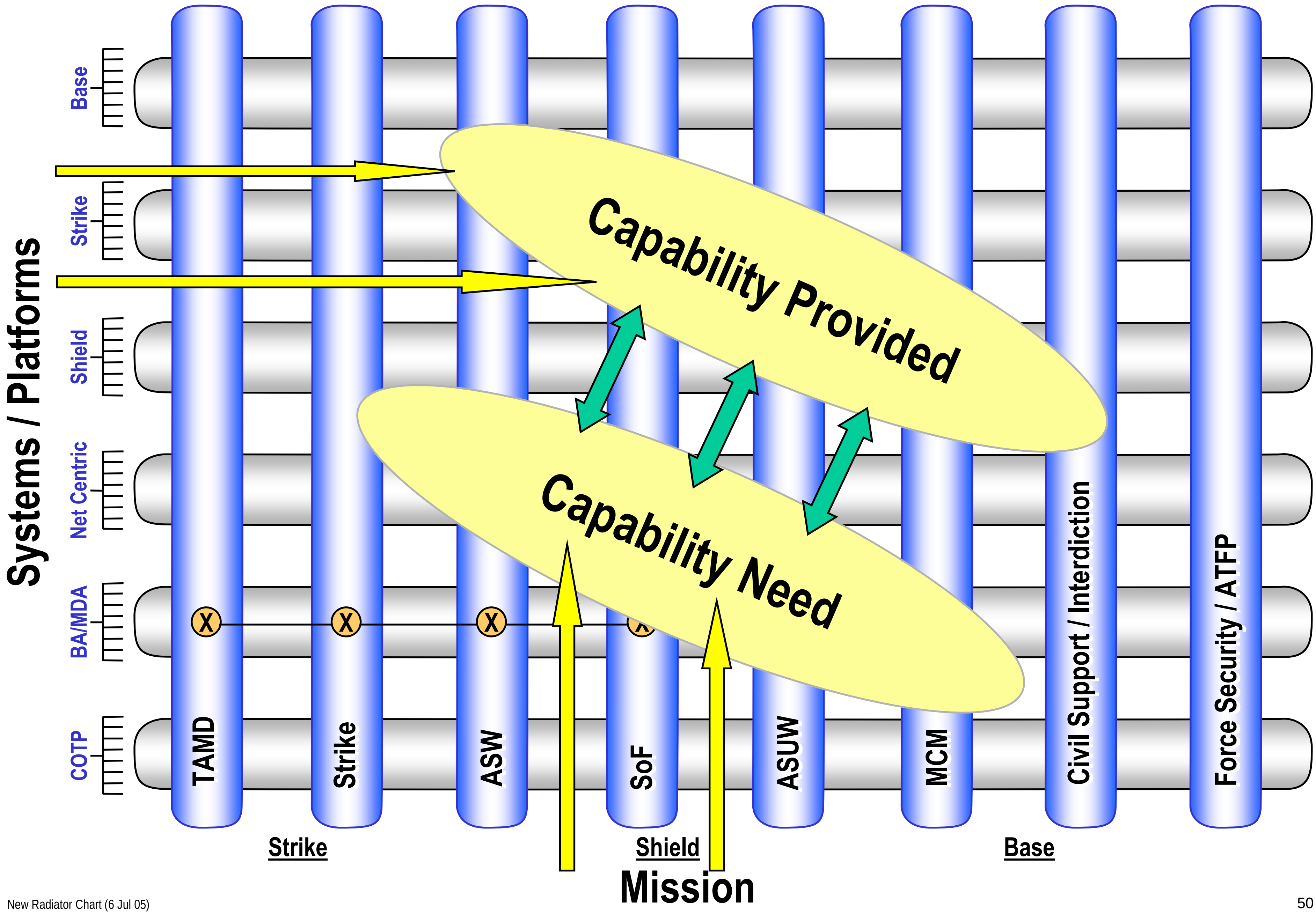
Mission to Capability to System



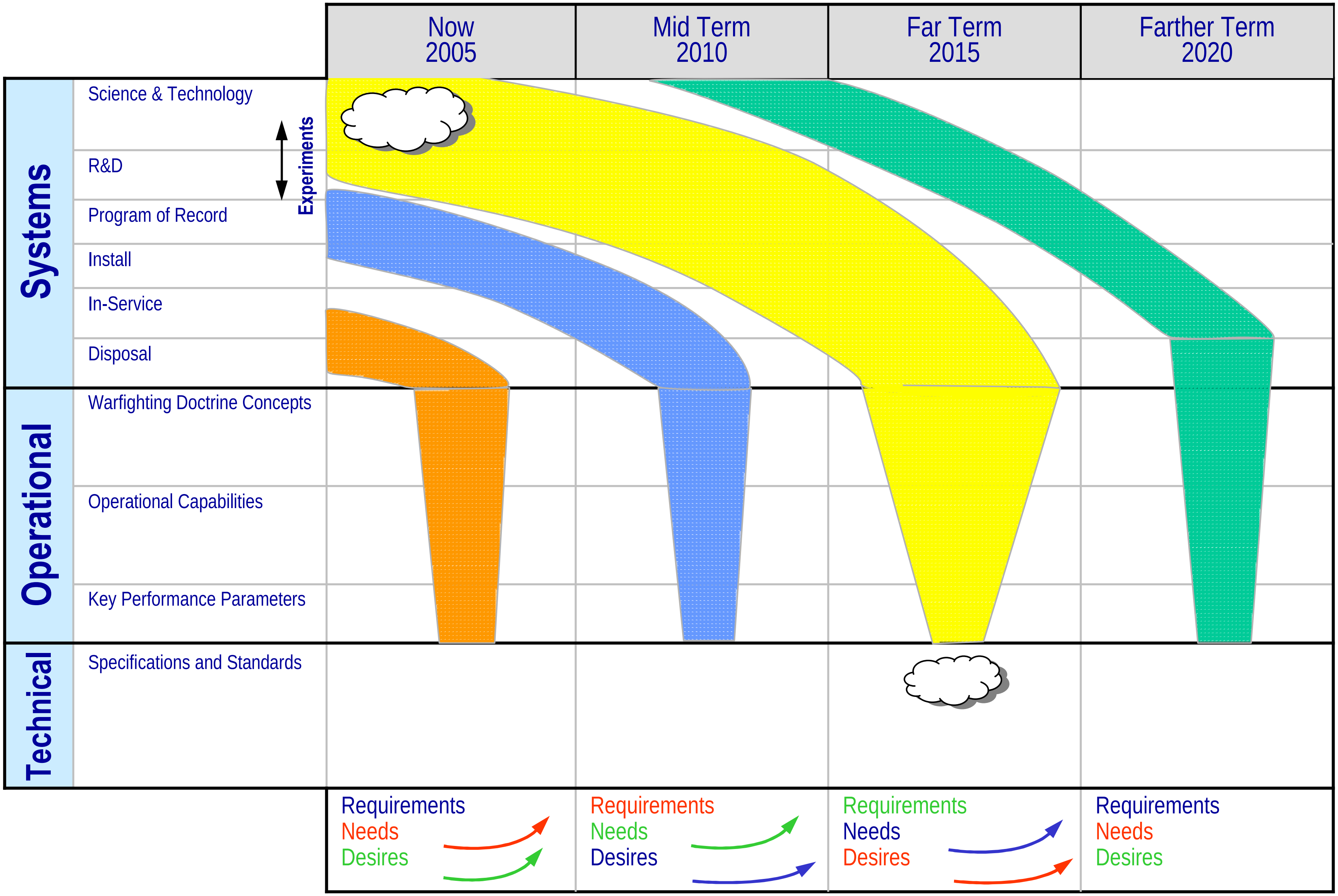
Mission to Capability to System



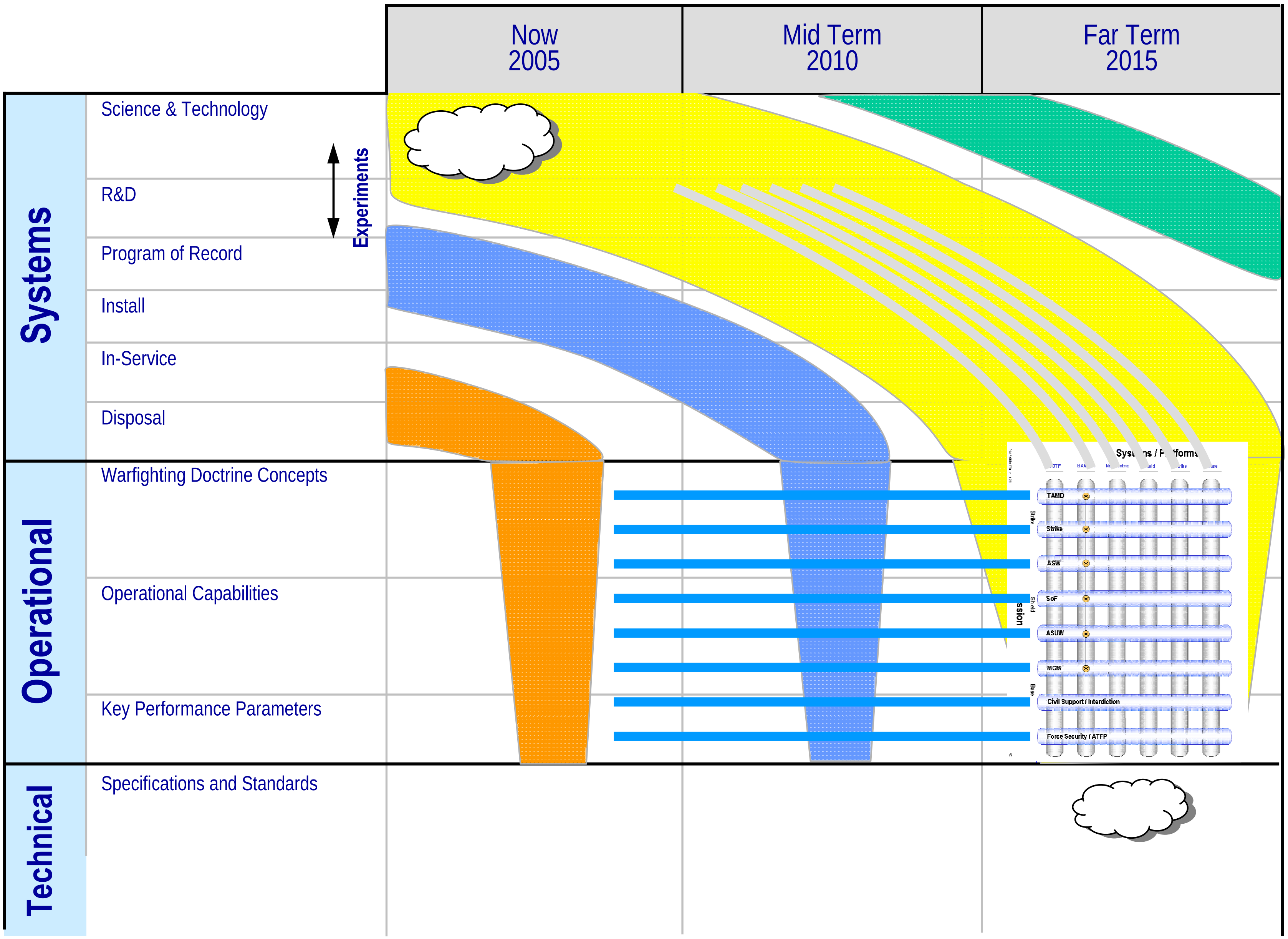
Mission to Capability to System



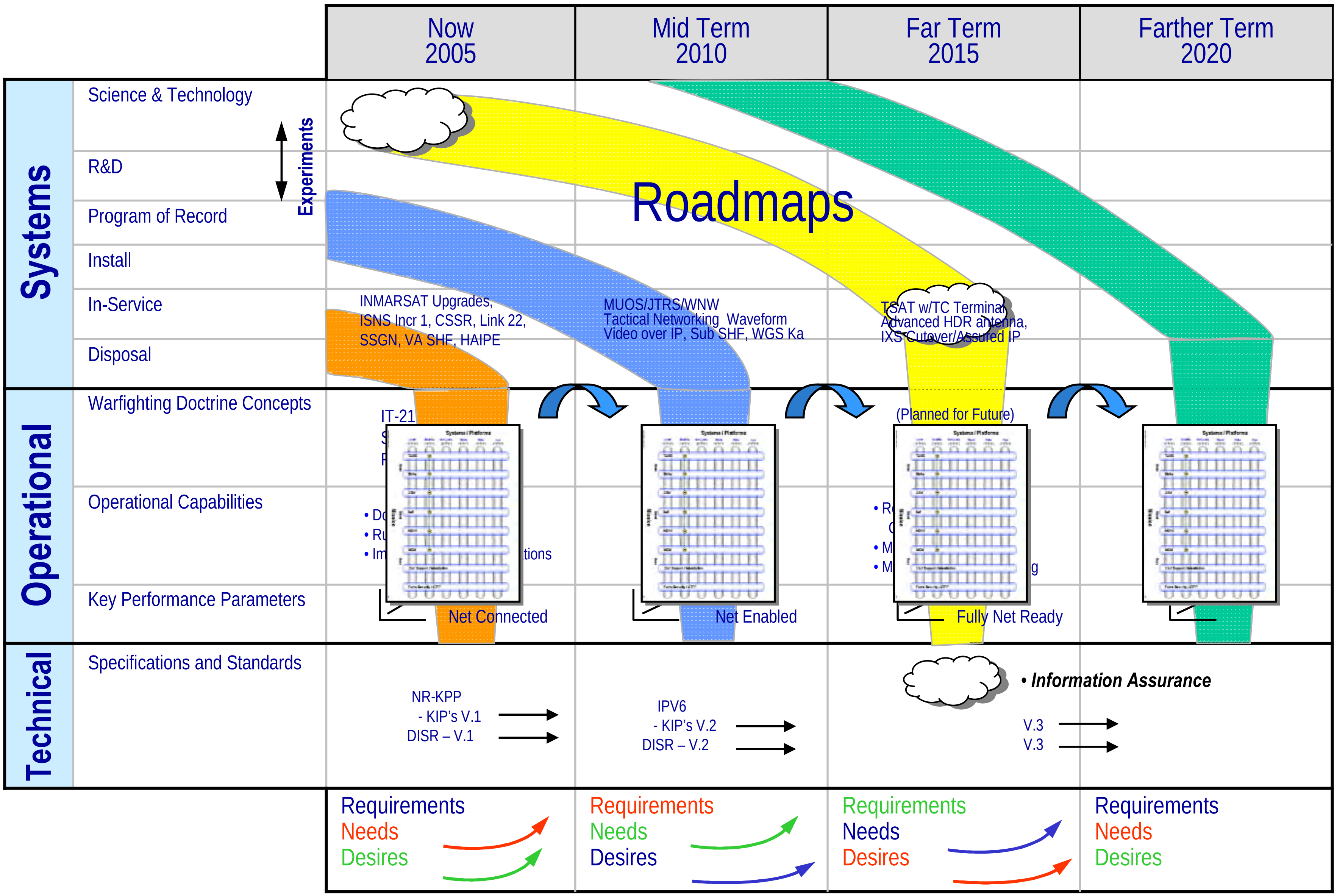
Framework for the "Plan"



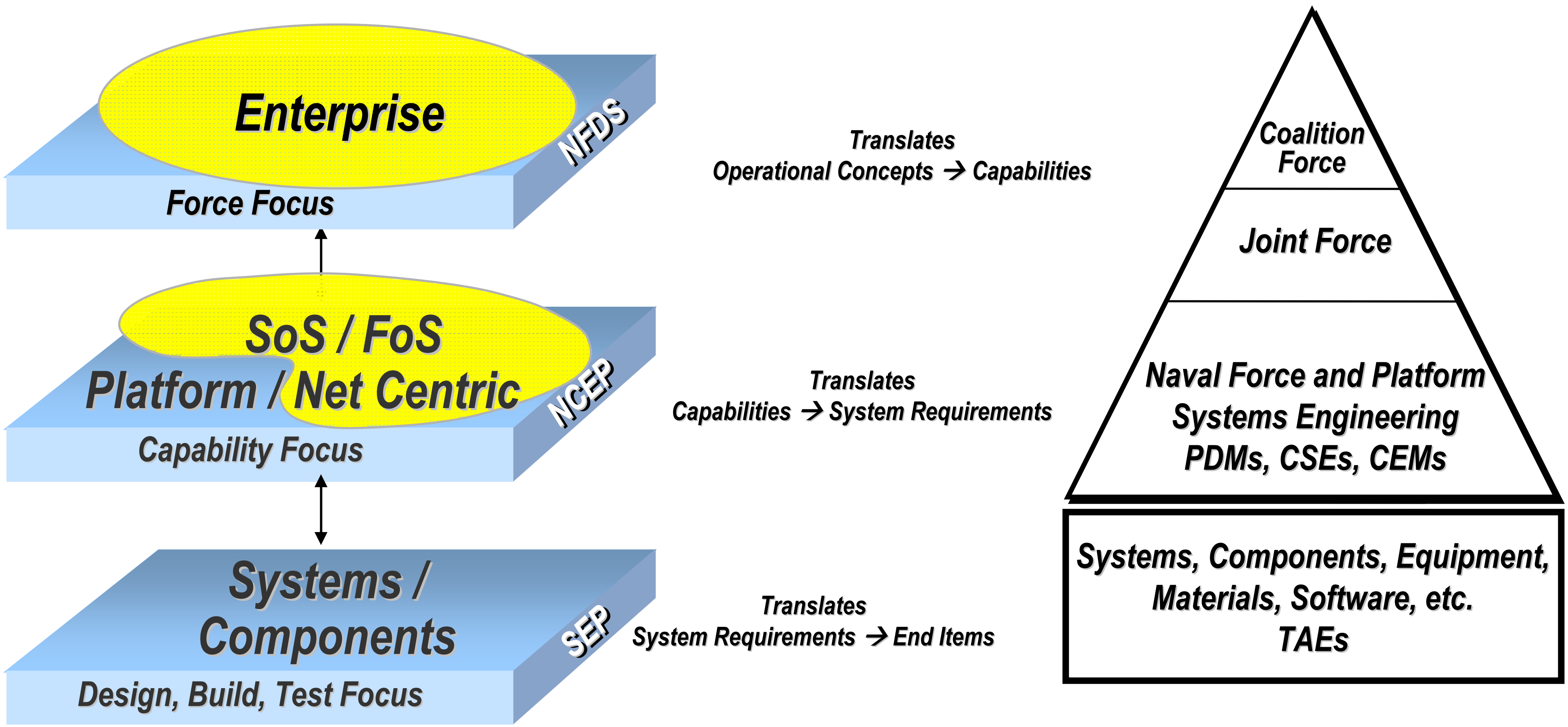
Framework for the "Plan"



Executing the "Plan"



Capability-Based System Engineering



Requires Alignment of Multiple Processes, Process Owners and Products

Backup

8th Annual NDIA Systems Engineering Conference
October 24-27, 2005, San Diego, CA

Track 3: Involving Test & Evaluation in Systems Engineering

Interweaving Test and Evaluation *throughout the* Systems Engineering Process

Josh Tribble
MILITARY ANALYST, AVW TECHNOLOGIES

Phone: 757-361-9587
E-mail: tribble@avwtech.com
860 Greenbrier Circle, Suite 305
Chesapeake, VA 23320
http://www.avwtech.com

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

AVW TECHNOLOGIES

Agenda

- Corporate and personal background
- The problem-- state of systems acquisition
  - Impact of JCIDS, systems complexity, acquisition reform, push for integrated T&E, and the impact of PPBE and CAIV
- Integrated T&E within systems engineering tasks
  - T&E activities and support for and from each of the tasks in the engineering process
- Integrated T&E interwoven throughout the acquisition life cycle
  - T&E activities in context of major acquisition milestones and impact on systems engineering
- Conclusion & recommendations
- Q&A

Company Profile

Professional Engineering Services

ORD, ICD, CDD, TEMP, Systems Engineering, Systems Integration, M&S Management

Test and Evaluation Support

TEMP, DT/OT, Test Management, Test Plans, Execution, Data Collection, Analysis

Shipbuilder Engineering Management Consulting

Systems Engineering, Systems Integration, M&S Management

Contract Vehicles:

Obtained GSA PES schedule CY04
NAVSEA MAC member thru JJMA and CSC
NAVSEA Seaport

Corporate Highlights:

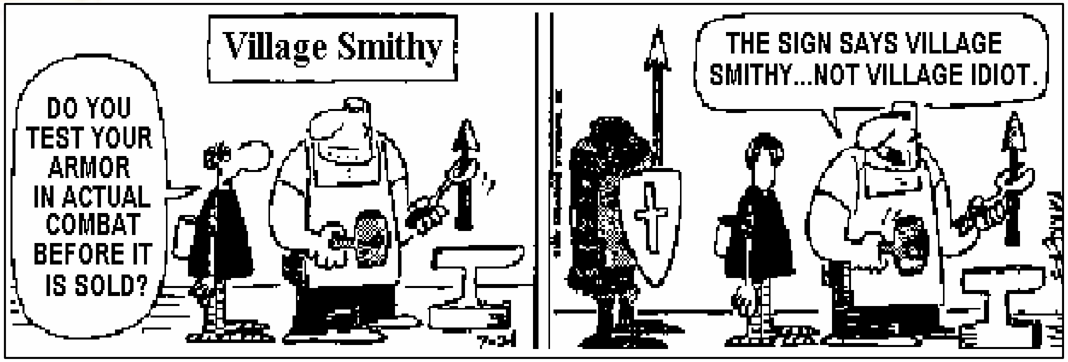
Total Ship / System of Systems Focus
Expeditionary Warfare Expertise
Mission Focused Systems Engineering and Analysis
Matrix support leverage full corporate capabilities
30 military analysts and IT/admin support
Small veteran owned business since 2002
Headquartered in Chesapeake, VA

Author Bio

- Former active duty Naval Officer
  - Surface Warfare qualified /ship driver
  - Tomahawk, AEGIS combat system, Anti-submarine warfare, gas turbine engineering management
  - COMOPTEVFOR Operational Test Director, Level II DAWIA Cert in T&E
  - USNA ’96, BS Aerospace Engineering
- Serving in Navy Reserve as officer in charge of embarked security detachment
- AVW experience
  - LPD-17 air defense (P_{RA}) M&S management.
  - Amphibious ship combat systems T&E
  - Sea Base-to-Shore connector JCIDS assessment & ICD development
  - OT&E management (EOA, IOT&E planning, M&S and total ship test management) for DD(X) + CVN, LHA-6, LPD 17
  - 5+ years T&E management supporting/involved in OT&E, DT/CT, Program Management/Systems Analysis, LFT&E

AVW TECHNOLOGIES
Josh Tribble
Military Analyst
Phone: 757-361-9587
E-mail: tribble@avwtech.com
860 Greenbrier Circle, Suite 305
Chesapeake, VA 23320
http://www.avwtech.com

Acquisition Culture?



The Problem—State of Systems Acquisition

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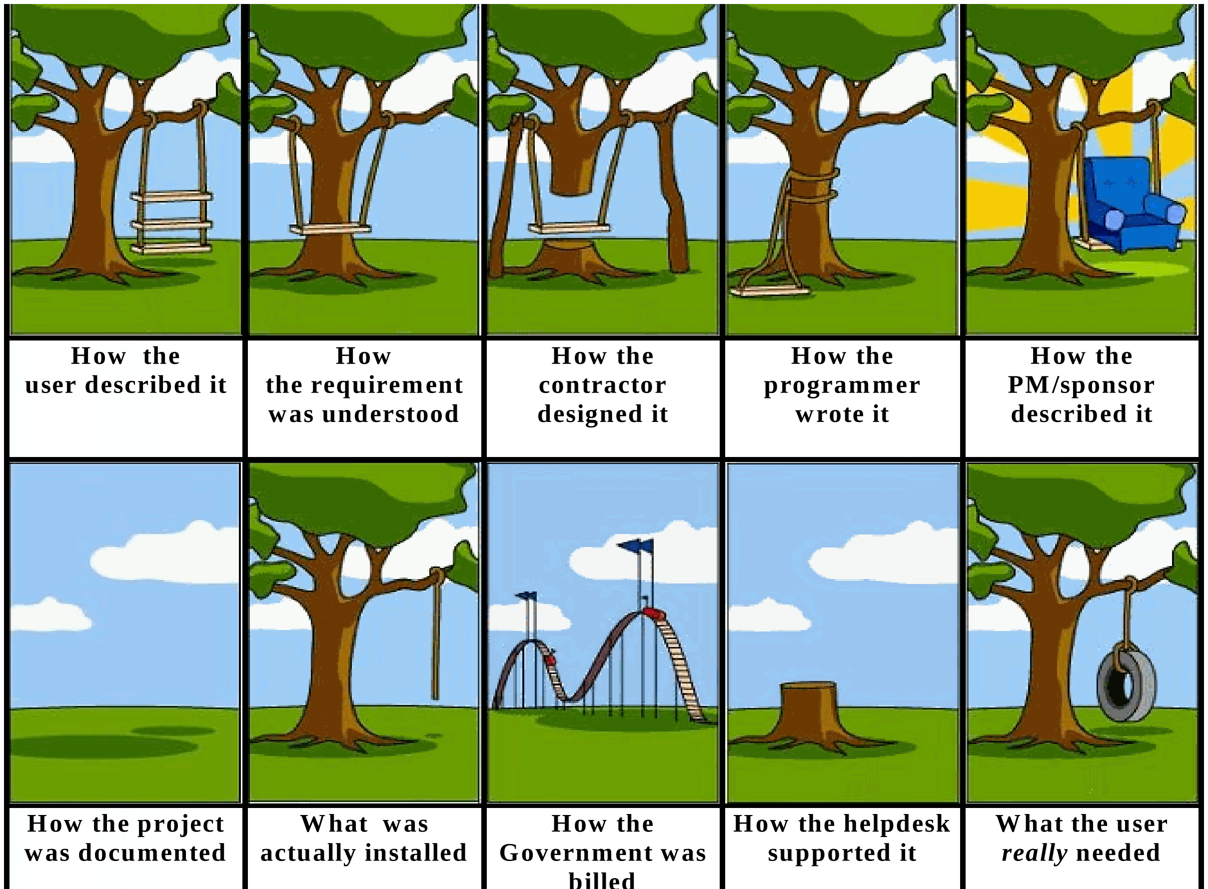
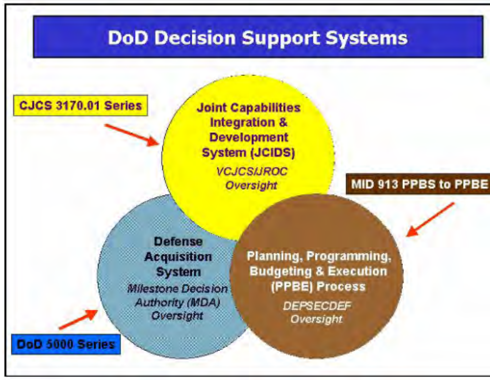
Acquisition Conundrum



Although a humorous exaggeration –

How can T&E & systems engineering help fix this in a Joint, FoS/SoS, CAIV environment?



We must transform to deliver the right product, that is on time, that works, and that is affordable and sustainable

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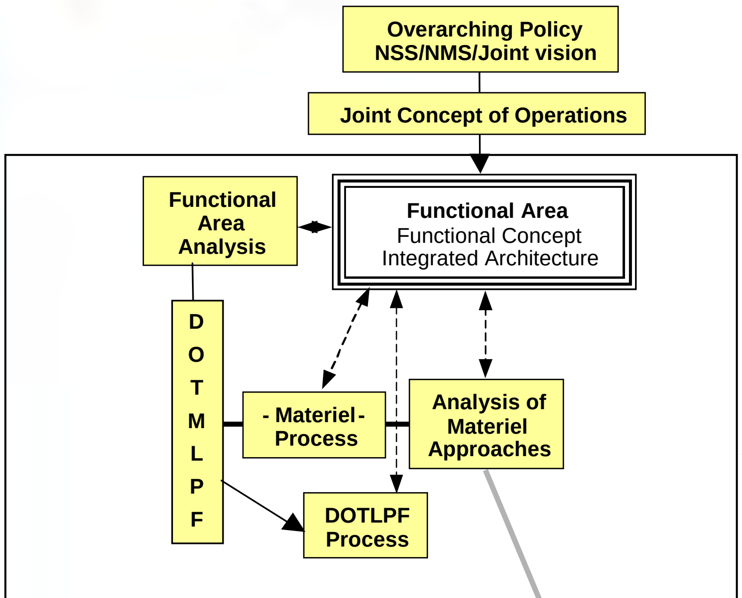
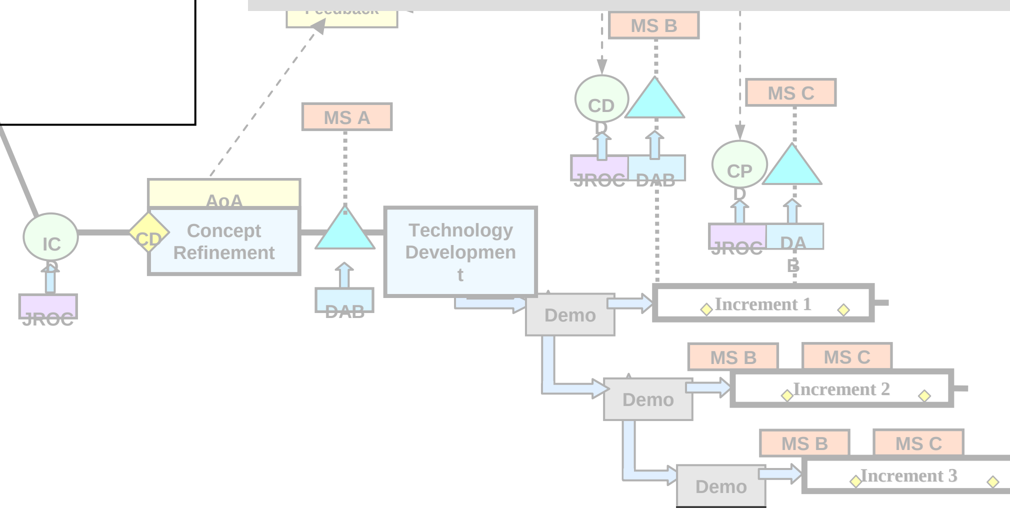
JCIDS Capabilities and Requirements input to the Acquisition Process



Better articulated requirements traced to Joint Capability Areas with mission context and driven by the warfighter top-down, but...

- *reqs flowdown still inflexible*
- *lacks traceability and context down the road*
- *too much grandfathering*

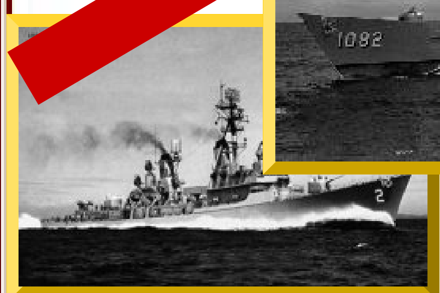


Requirements

Acquisition

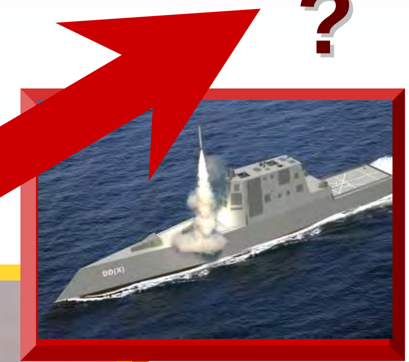
Complexity Challenge

- •Open Architecture/Systems
- •Complex C4I—FORCEnet/GiG
- •Joint Interoperability
- •Emerging Technology & Materials

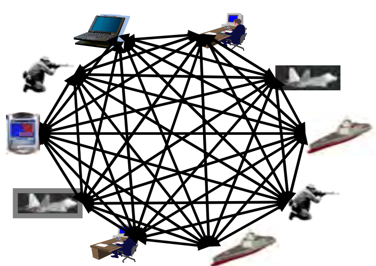
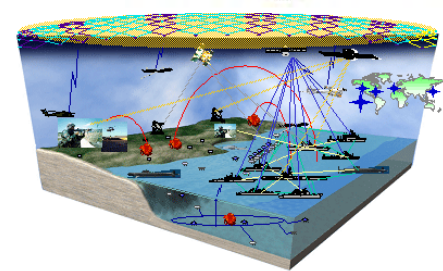






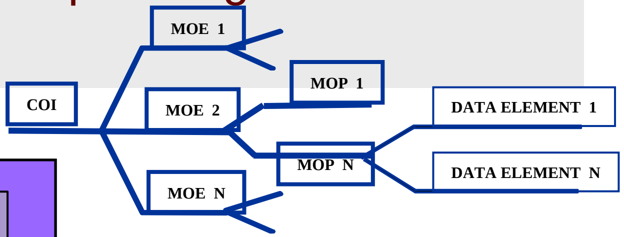


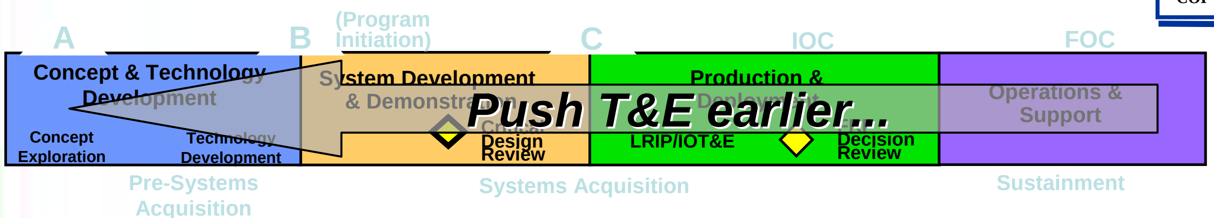
- •More difficult to develop
- •More difficult to test
- •Compressed timelines
- •Compressed budgets
- •***MORE RISK…& HIGHER COSTS***

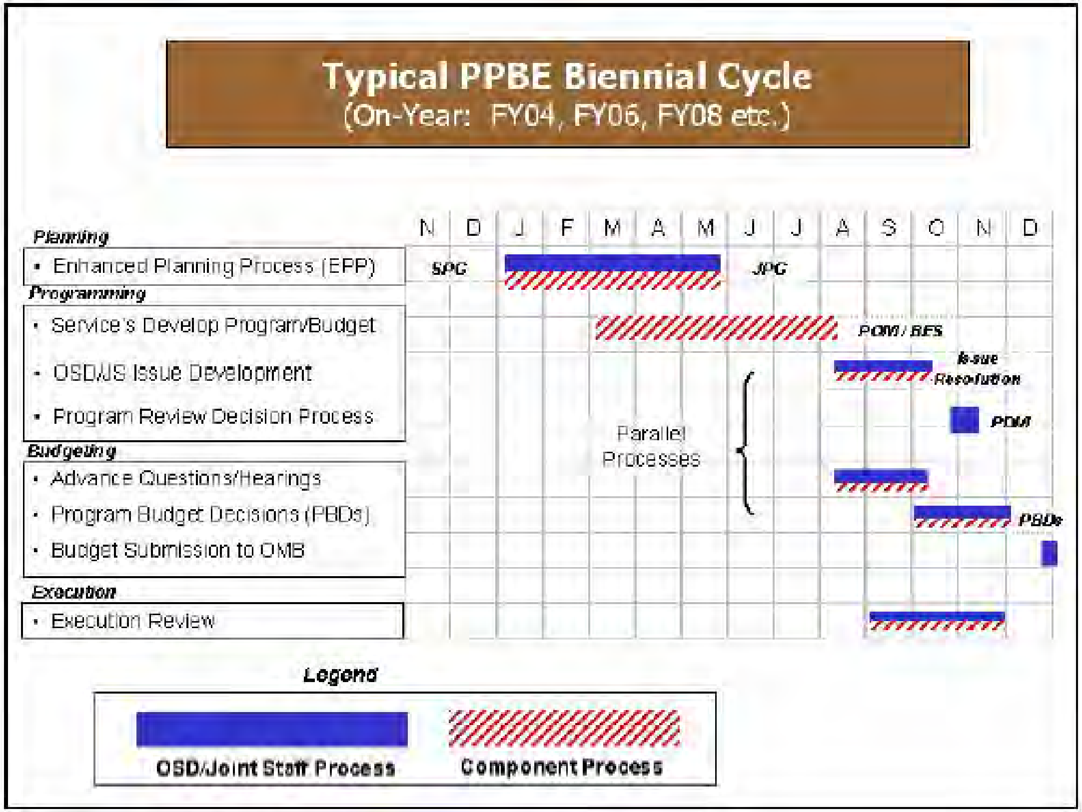
Status of T&E

- **Integrated T&E required by new DoD 5000 series**
- **Need to change focus on program success, delivery of capabilities – not mere oversight & reporting on pass/fail**
- **Push for early tester & engineer involvement during JCIDS**
- **Push T&E to the left in the cycle**
- **Numerous other areas to reduce costs and effectiveness of T&E support for programs:**
  - political and business climate
  - combined use of test resources, M&S, etc.
  - advanced analytical methods including design of experiments
  - proper understanding of requirements, context, intent
  - process maturity and improvement (CMMI, Six Sigma, etc.)
  - more systems engineering methodology in test planning
  - testing to support risk management





Harsh Reality of PPBE



- Programs including systems engineering and T&E are driven by CAIV.
- Calendar driven process can conflict with event driven engineering/tests
- Design issues found in systems engineering can be downplayed due to perceived need to shield program from scrutiny during POM cycle
- T&E can be seen as place to rob funding to pay for overruns

T & E Funding vs. RDT&E / Total Program Costs

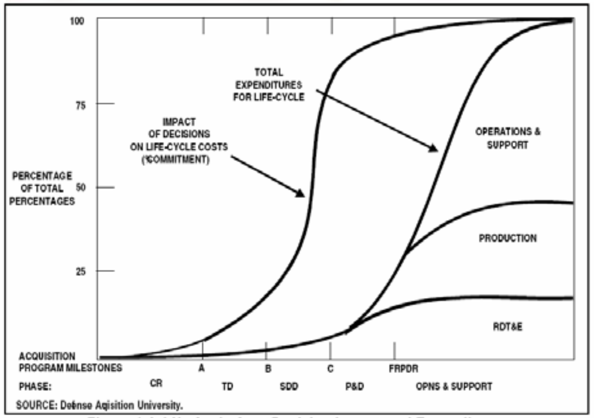
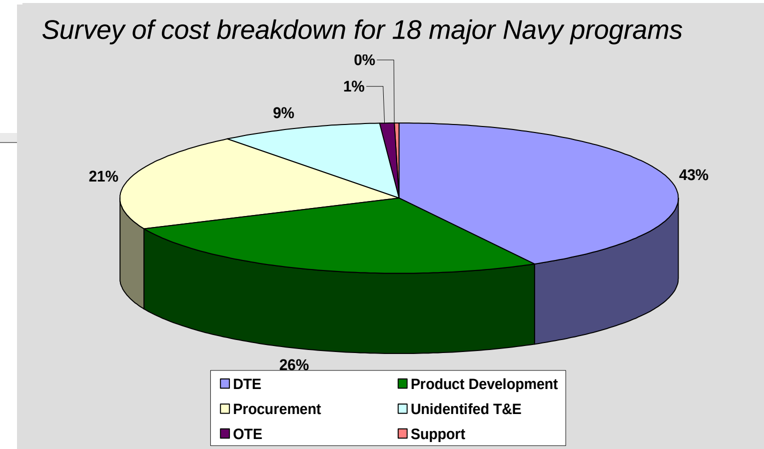
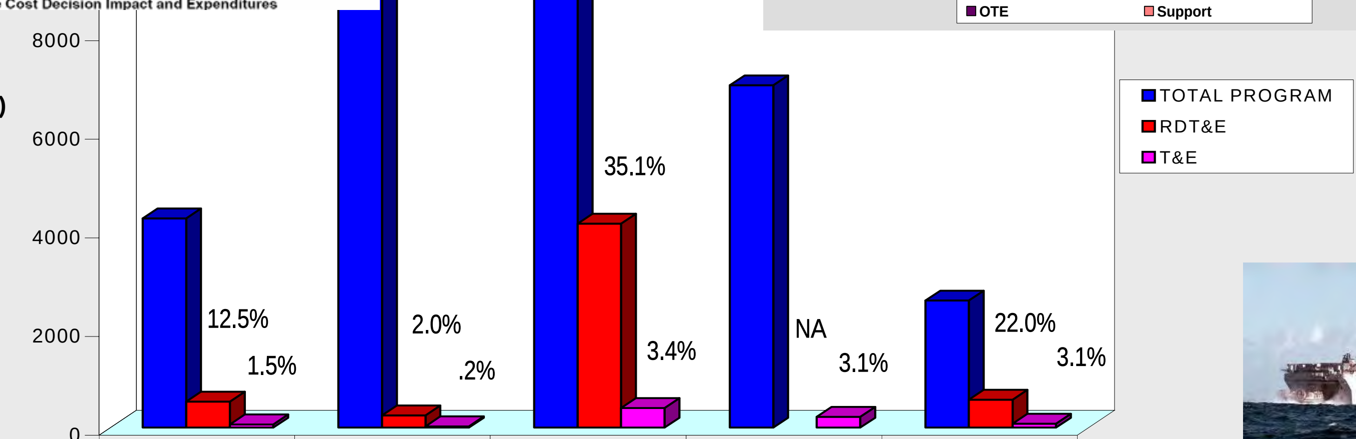


Figure 1-2. Life Cycle Cost Decision Impact and Expenditures

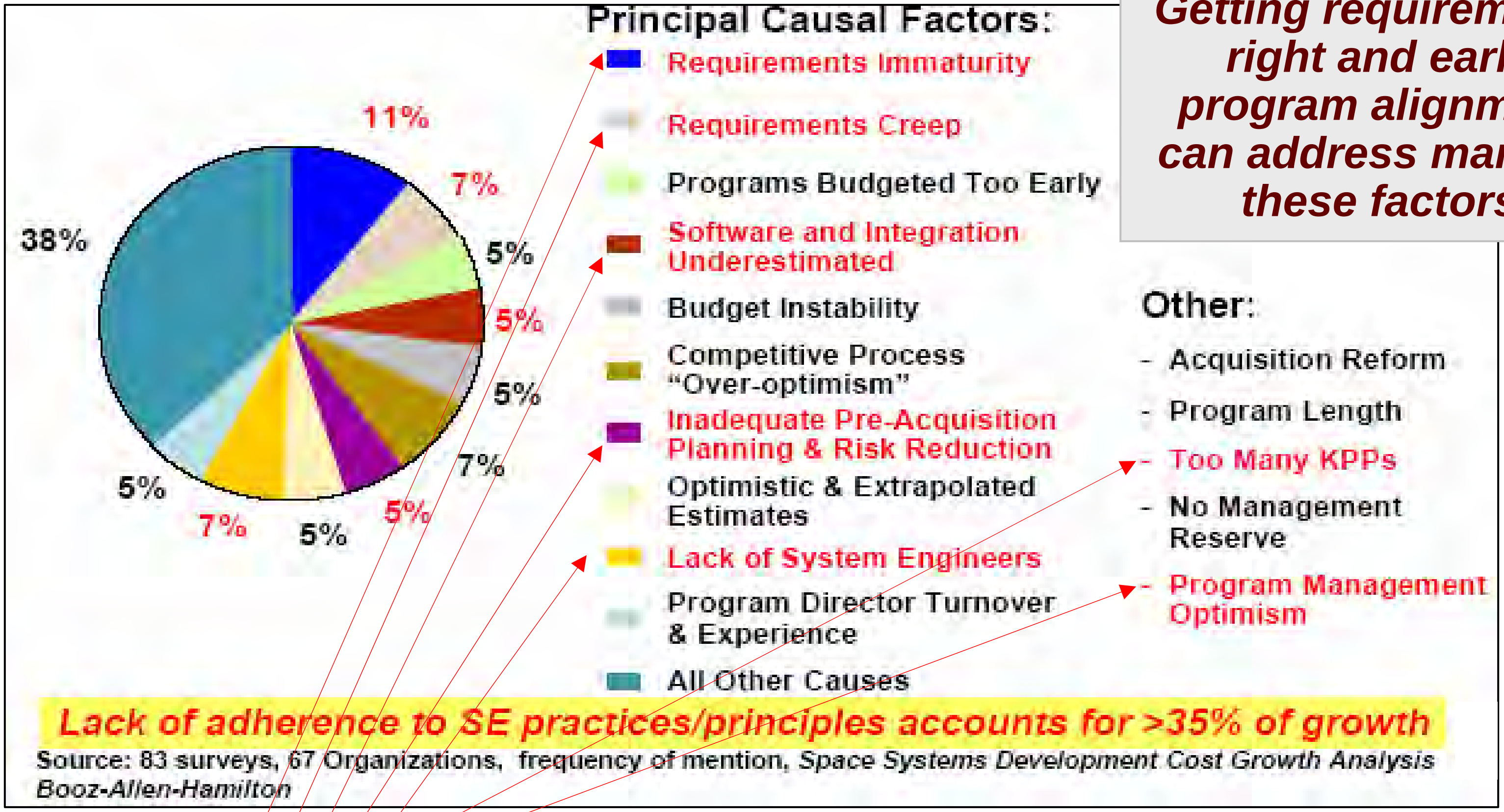




Analysis of total, RDT&E, and T&E costs for various Army PORs

T&E is a *much* smaller fraction of RDT&E than development costs both of which are far overshadowed by life-cycle costs – thus, **T&E reduces program risk while adding little to overall program cost**

Causes of Development Growth

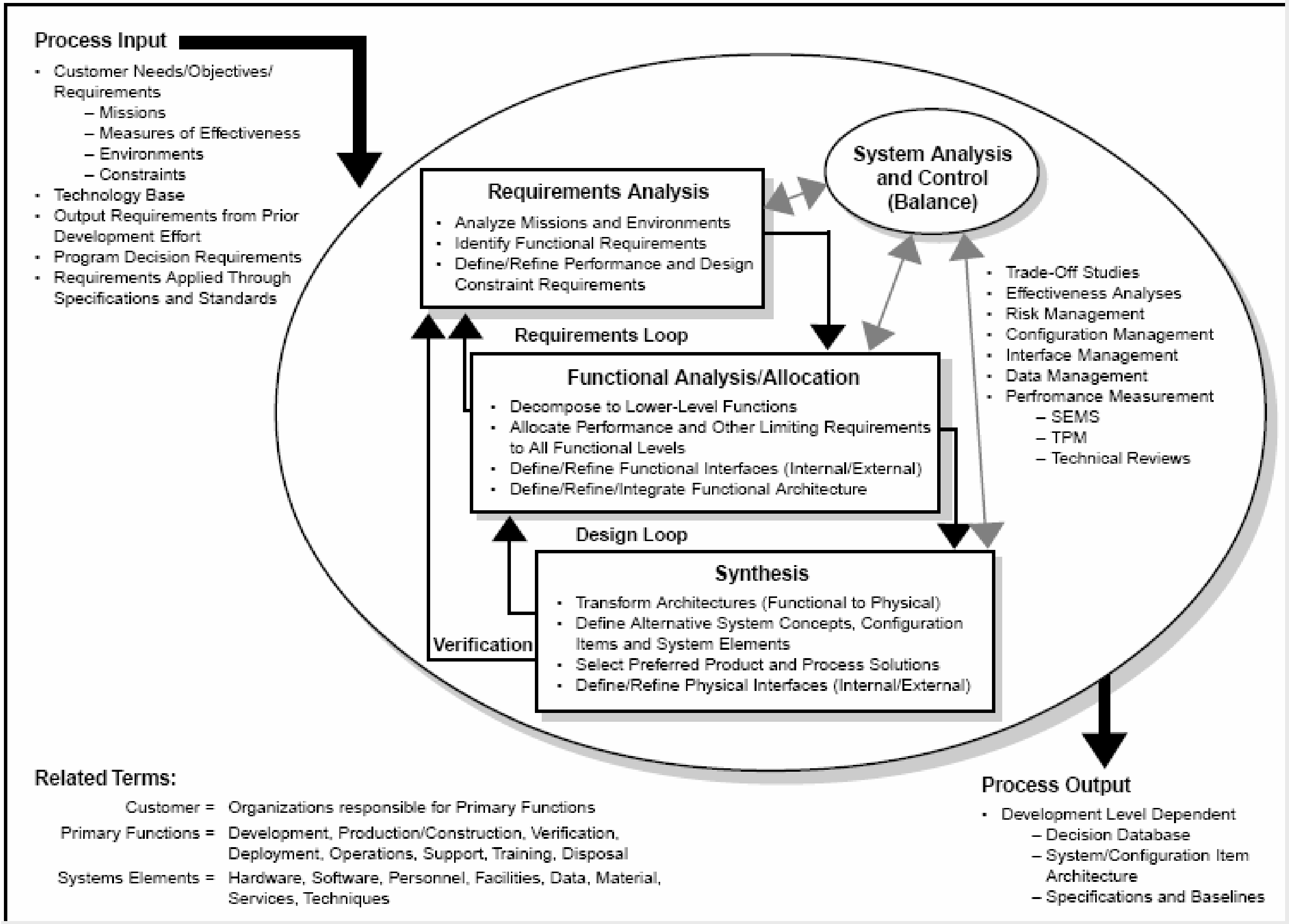


Getting requirements right and early program alignment can address many of these factors

Testers and systems engineers can influence many of these tasks to reduce risk and total program cost growth

Integrated T&E Within Systems Engineering Tasks

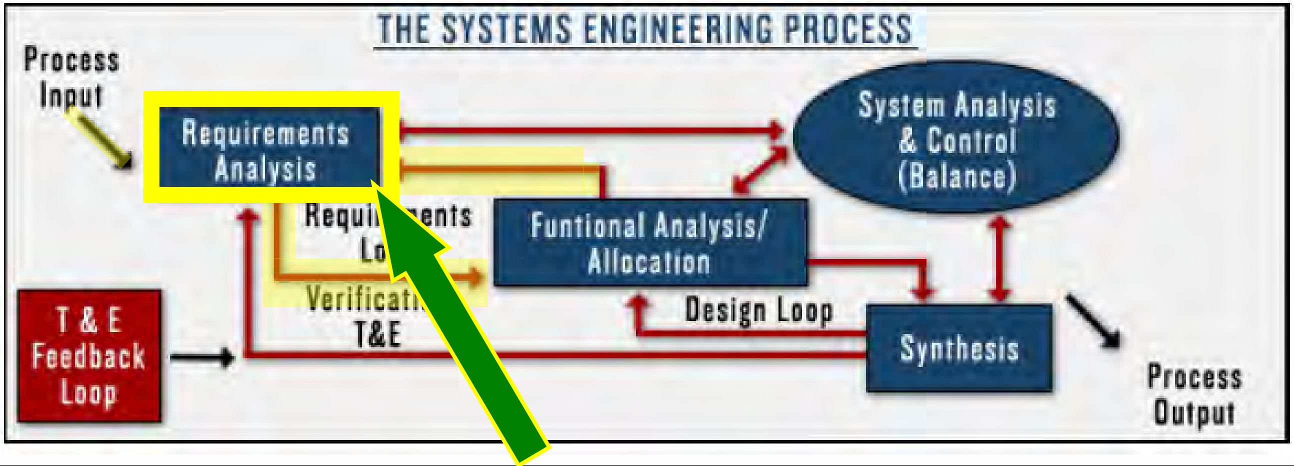
T&E During Sys Eng Tasks



Involves testers, engineers, & managers from PMO, Design Agent, Subcontractors, OTAs, gov't certification agencies, SYSCOM, etc.

- Testers can support each of the tasks, not just validation
- T&E is supported by each process task and by sys engineers

T&E During Sys Eng Tasks (Cont')



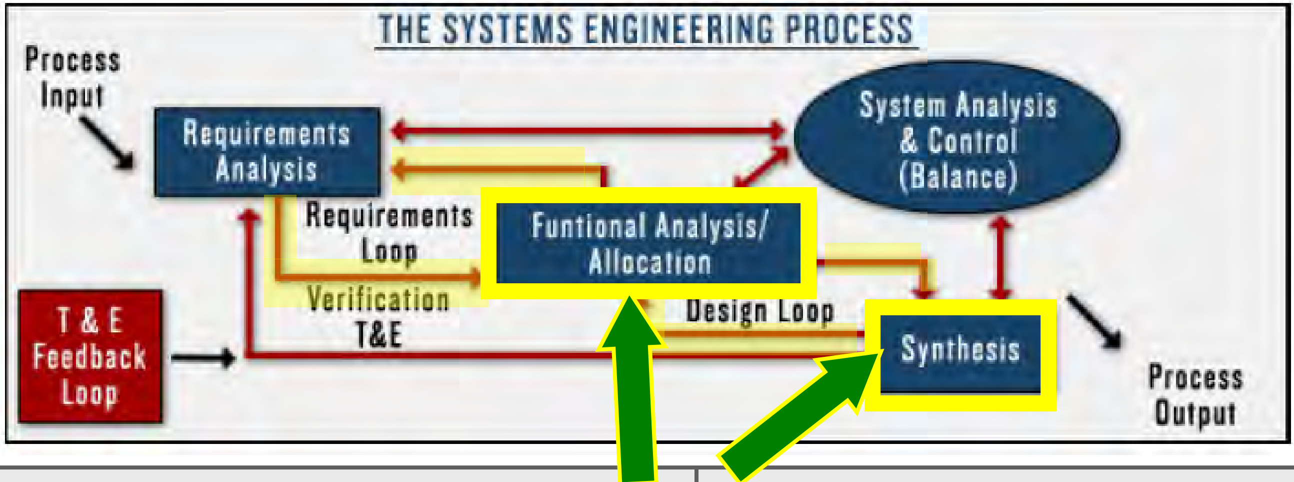
Testers support by influencing:

- Measurable, objective, meaningful reqs
- Reqs context & op scenarios
- Bounding system (technical/operational)
- Assisting mission / functional breakdown
- TPM selection
- Influencing HSI
- Prioritization of reqs (critical / need / want)
- IV&V of reqs flowdown + delivered technical and operational capabilities

T&E is supported by insight into various aspects of project to facilitate efficient test planning:

- Customer expectations
- Project & external constraints (CAIV…) Reqs context and intentions
- Life cycle support planning
- HSI planning/design
- Physical / logical architecture drivers
- Prioritization of requirements

T&E During Sys Eng Tasks (Cont')



Testers support by influencing:

- Consistency in reqs/functional flowdown based on original intentions and op context
- Influencing HSI in detailed design including user reviews of HCI & functionality
- Verification of requirements implementation through limited component level tests
- Interface definition
- Prioritization of lower level requirements
- IV&V of reqs flowdown + delivered technical and operational capabilities
- M&S planning/development

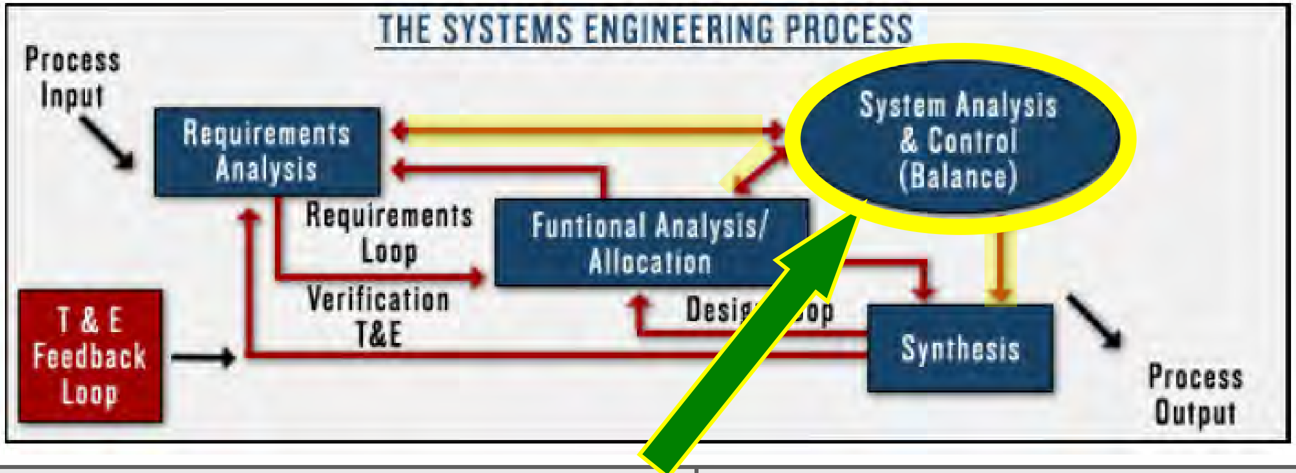
T&E supported by insight (which improves test planning efficiency) into:

- Detailed reqs flowdown and prioritization
- Detailed life cycle support planning
- HSI planning/design
- Detailed architecture drivers

& early collection of evaluation data:

- Life cycle planning
- HSI design implementation
- Software eng. process assessment
- M&S V&V
- SCI/Component & interface test data

T&E During Sys Eng Tasks (Cont')

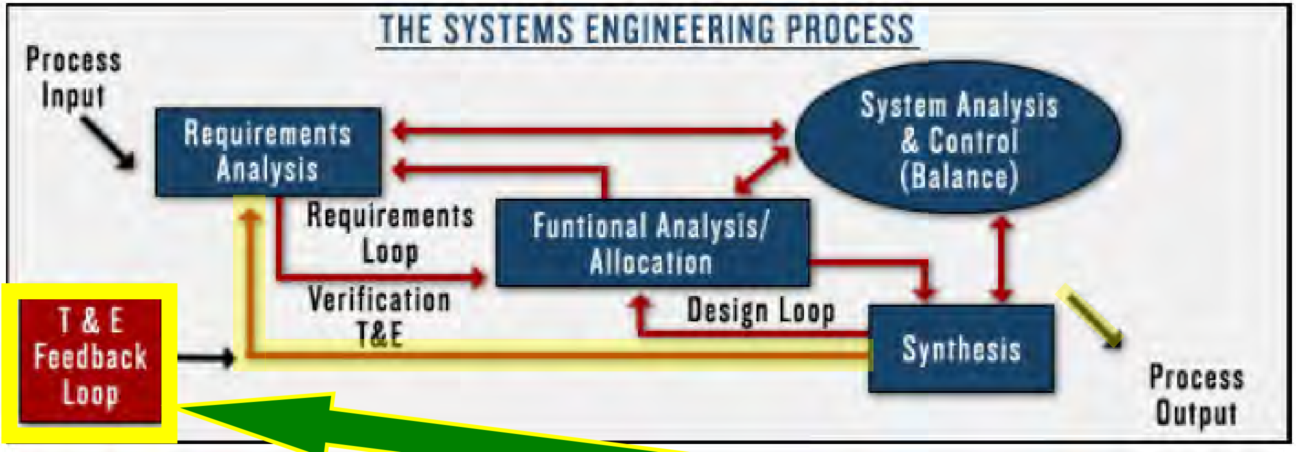


Testers support by influencing:
- M&S analysis planning
- Monitoring M&S development
- Assisting in M&S analysis execution
- Independent evaluation of analysis results
- Evaluation of systems and software engineering process/process improvement
- Independent review of risk management and input of T&E issues as new/updated risks
- Objective TPM tracking
- Design for safety, life-cycle, interoperability, & survivability (instead of merely testing)

T&E is supported by insight into:
- Capabilities and limitations from analysis that points to need for live testing
- Pre and post-test predictions
- Test design and noise factors selection (design of experiments), sensitivity studies
- System & component trade-offs

& collection of evaluation data:
- Analytical and M&S based evaluation of system performance
- M&S V&V

T&E During Sys Eng Tasks (Cont')



Testers support by:

- Planning and executing tests to verify requirements and validate functions and mission capabilities (+ M&S V&V)
- Giving engineers insight into performance of system
- Independent internal and external agencies evaluation of the system

[traditional T&E – with greater participation from systems engineers & increased use of standard engineering methodology for planning efficient tests

T&E is supported by systems engineers:

- Interpretation of technical results
- Determining impacts on HSI, life-cycle planning, IA, etc.
- Categorization of issues and problems

T&E supports accurate decision making:

- Proceeding with output to next acquisition phase, or
- Proceeding to next phase of testing, or
- Repeat of previous tasks while holding at this point in the acquisition cycle

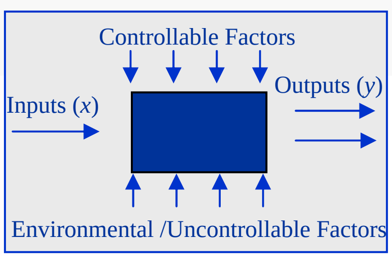
~~DT vs. OT~~ → IT

DT:

- Test to specs.
- Limited test environment often done in laboratory.
- Focused on a specific set of criteria.
- Test threshold values not capability.
- Integration testing designed around minimum performance criteria and interface spec.
- May not address all threats or missions.

OT:

- Operational environment & threat
- Operated by users
- End – to end mission & support
- Production representative; system of systems
- Test overall capability of an item to meet mission needs.
- Test value added for mission accomplishment.
- Test the limitations and capabilities of an item so that:
- Employ and assess doctrine/TTP
- Title X mandated independent IOT&E

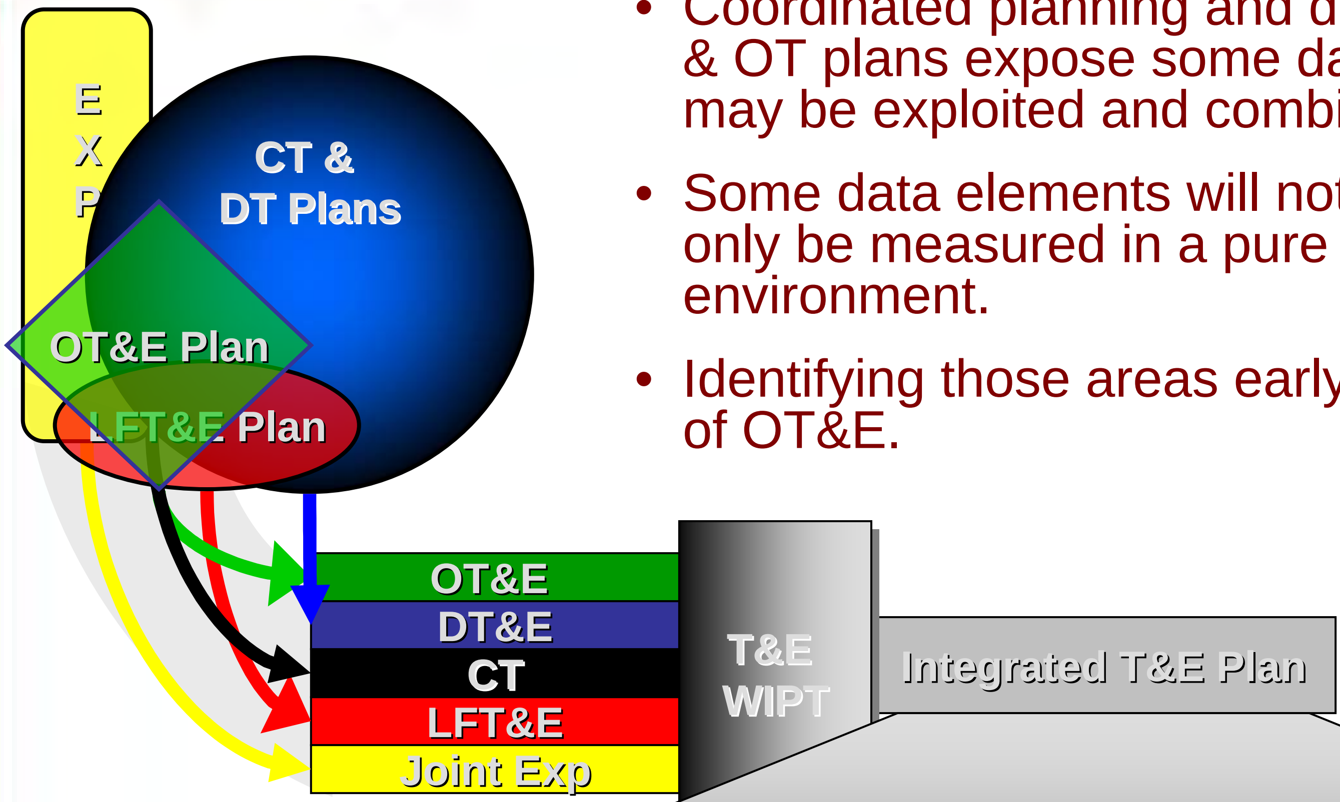


THIS MUST TRANSFORM INTO A <u>CONTINUUM OF INTEGRATED TESTING</u>

- **DT can address some OT objectives for risk reduction**
- **OT is much more than IOT&E**
- **Fit in CT, LFT&E, Experimentation, M&S, logistics audits**

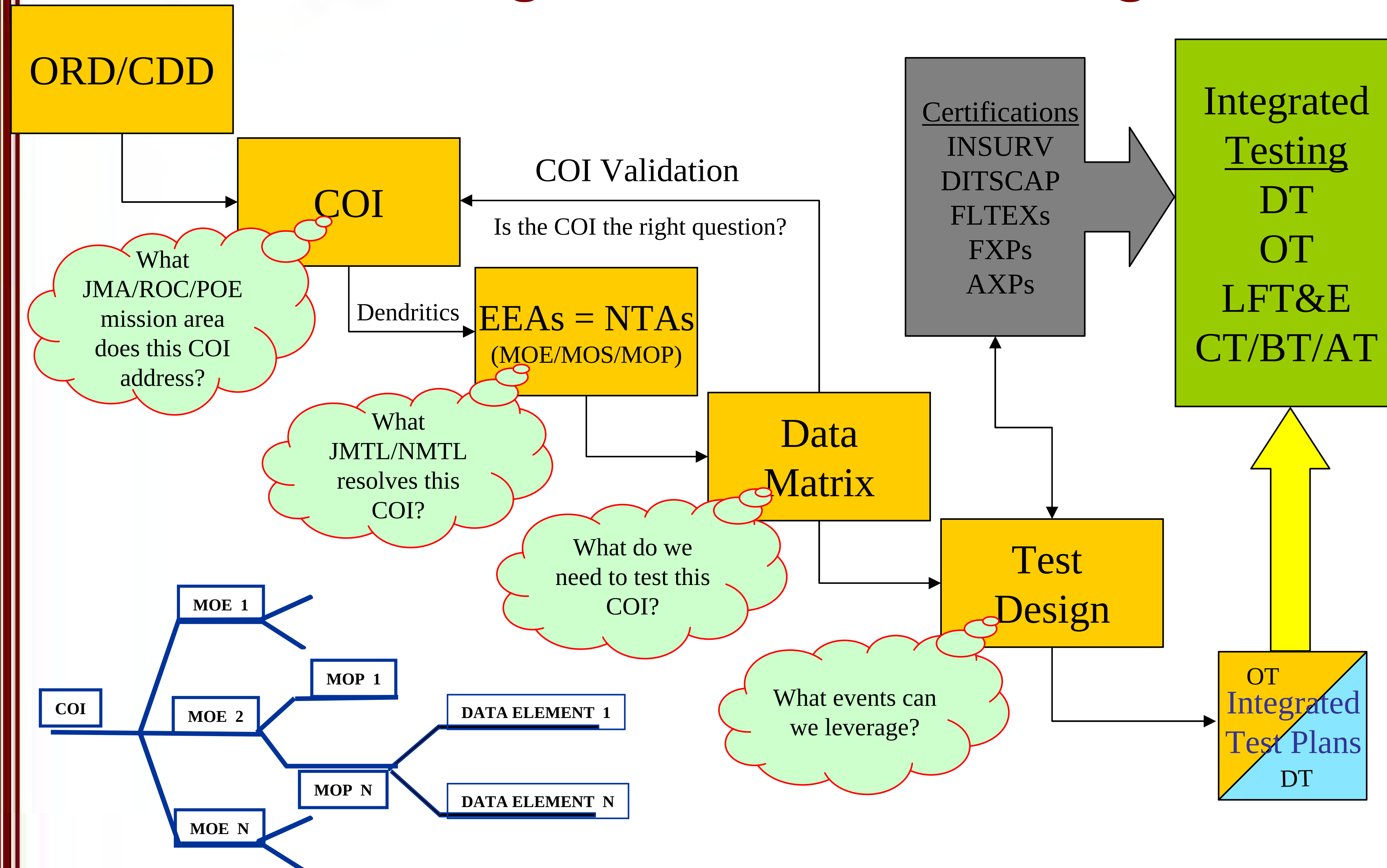
Integrated T&E

- Coordinated planning and development of DT & OT plans expose some data similarities that may be exploited and combined.
- Some data elements will not overlap and can only be measured in a pure OT&E environment.
- Identifying those areas early defines the scope of OT&E.



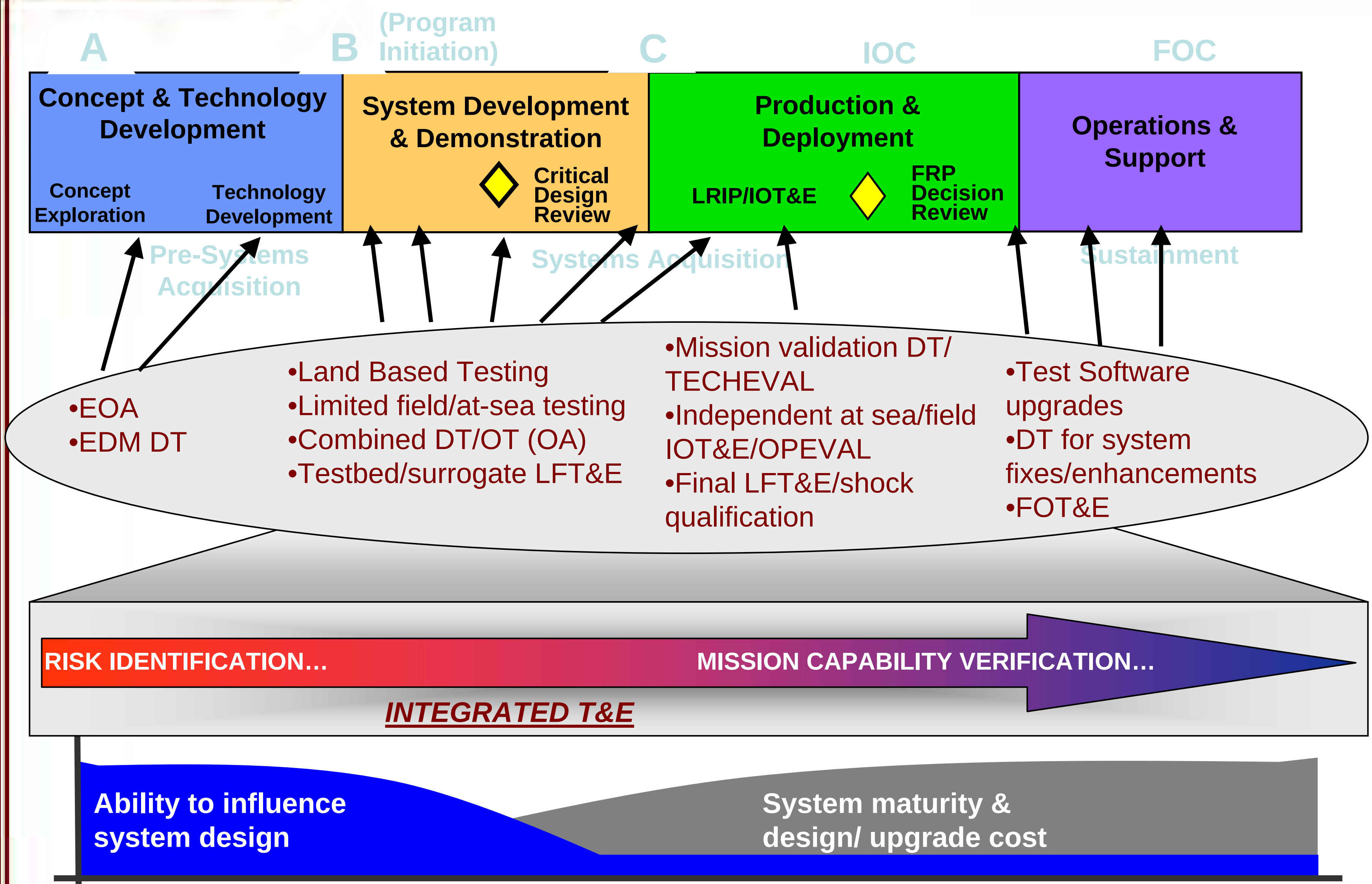
$$T\&E_{integrated} \int_{\text{Program Start}}^{\text{System Disposal}} = (CT, DT, OT, LFT\&E, \text{Joint Exp}, M\&S, \text{Analysis, etc.})\, dt$$

Total Ship Integrated Test Design



Integrated T&E Interwoven Throughout the Acquisition Life Cycle

T&E within the Acquisition Life Cycle



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Systems Engineering + T&E within the Acquisition Cycle

A | B (Program Initiation) | C | IOC | FOC

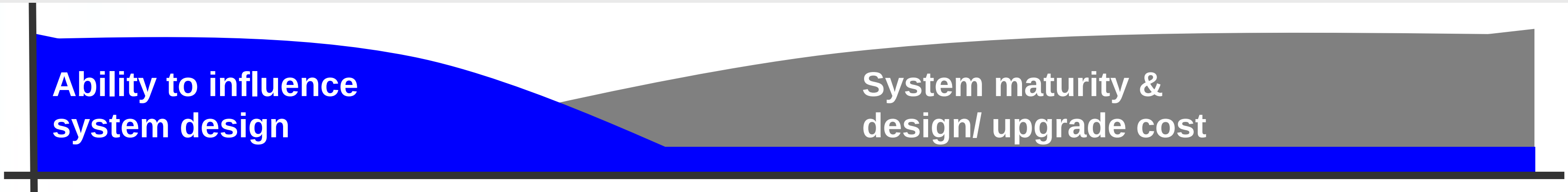
Concept & Technology Development	System Development & Demonstration	Production & Deployment	Operations & Support
Concept Exploration / Technology Development	Critical Design Review	LRIP/OT&E / FRP Decision Review	

•Requirements te •Concept studies •CONOPS devel •Mission/Functio •Joint Experimentation/	•Technology Feasibility •EDM DT •Design Review •EOA •M&S	•Detailed Desig •Design OA •Detailed CON •User reviews •TTP developm •Trade studies	•Lab/Land Based Te •Limited field/at-sea •Testbed/surrogate L •Supportability analy •RAM analysis & test •Certification process	•Production Readiness R •Detailed CONOPS •Production H/W, S/W re •Detailed TTP review/ref •Production in-process re w/ users & verification te	•Federated Simulation Tes •Production acceptance + validation DT & OT •HSI, Manpower, Personn •System LFT&E & Shock Q •Final Independent Logisti	•TTP refinement •Software/System prob characterization & trac •Upgrade/ P3I / spiral development requirem analysis	•Testing software upgrades •M&S/DT/FOT&E for system fixes / upgrades / new increments •RAM & supportability data collection •Additional LFT&E/shock qual

MORE THAN TESTING ... CONTINUOUS EVALUATION

RISK MANAGEMENT… MISSION CAPABILITY DELIVERY…

INTEGRATED T&E & SYSTEMS ENGINEERING

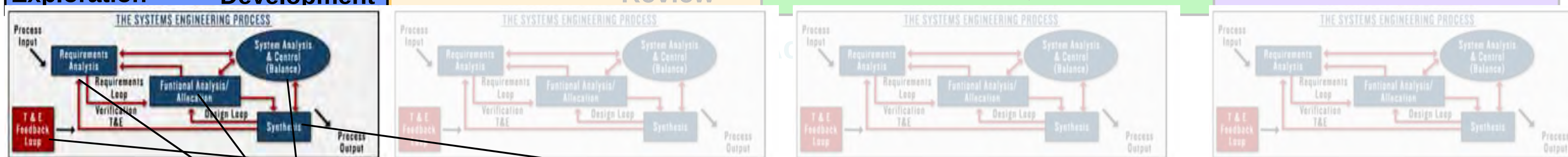


AVW TECHNOLOGIES

Systems Engineering + T&E within the Acquisition Cycle

A B (Program Initiation) C IOC FOC

Concept & Technology Development	System Development & Demonstration	Production & Deployment	Operations & Support
Concept Exploration; Technology Development	Critical Design Review	LRIP/OT&E; FRP Decision Review	



T&E ACTIVITIES DURING C&TD PHASE			
	•Requirements testability review •Concept studies and analysis •CONOPS development •Mission/Functional analysis •Joint Experimentation/ACTD/ATD	•Technology Feasibility •EDM DT •Design Reviews •EOA •M&S	***Testers & sys engineers (industry) not involved enough in this phase***

RISK MANAGEMENT… MISSION CAPABILITY DELIVERY…

INTEGRATED T&E & SYSTEMS ENGINEERING

AVW TECHNOLOGIES

Systems Engineering + T&E within the Acquisition Cycle

A | B (Program Initiation) | C | IOC | FOC

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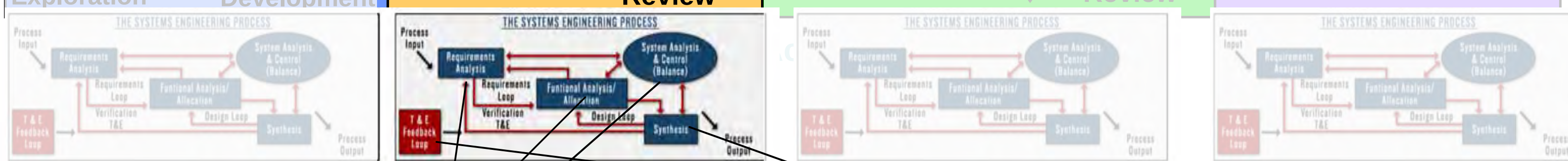

T&E ACTIVITIES DURING SDD PHASE

- Detailed Design Rvw
- Design OA
- Detailed CONOPS
- User reviews
- TTP development
- Trade studies

- Lab/Land Based Testing & M&S
- Limited field/at-sea testing & usability testing
- Testbed/surrogate LFT&E
- Supportability analysis/ initial logistics audit
- RAM analysis & testing (reliability growth)
- Certification process

Inadequate linkage to C&TD mission and reqs analyses

RISK MANAGEMENT… MISSION CAPABILITY DELIVERY…

INTEGRATED T&E & SYSTEMS ENGINEERING

Systems Engineering + T&E within the Acquisition Cycle

A | B (Program Initiation) | C | IOC | FOC

Concept & Technology Development	System Development & Demonstration	Production & Deployment	Operations & Support
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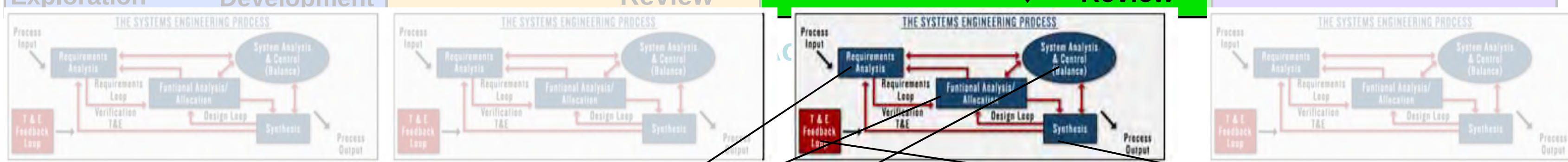

Need to push as much of this to the left as possible

T&E ACTIVITIES DURING P&D PHASE

- Production Readiness Reviews
- Detailed CONOPS
- Production H/W, S/W review
- Detailed TTP review/refinement
- Production in-process review w/ users & verification team
- Federated Simulation Testbed
- Production acceptance + mission validation DT/TECHEVAL and IOT&E
- HSI, Manpower, Personnel, Trng Eval
- System LFT&E & Shock Qual
- Final Independent Logistics Audit

RISK MANAGEMENT… MISSION CAPABILITY DELIVERY…

INTEGRATED T&E & SYSTEMS ENGINEERING

Systems Engineering + T&E within the Acquisition Cycle

A — B (Program Initiation) — C — IOC — FOC

Concept & Technology Development	System Development & Demonstration	Production & Deployment	Operations & Support
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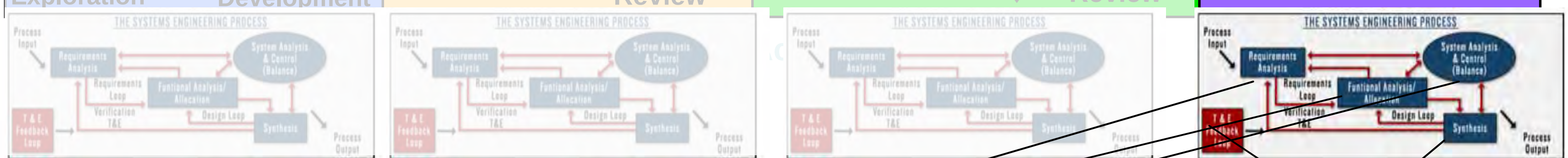


Upgrades/ increments need better tie to req capability & tech maturity

T&E ACTIVITIES DURING O&S PHASE

- TTP refinement
- Software/System problem characterization & tracking
- Upgrade/ P3I / spiral development requirements analysis
- Testing software upgrades
- M&S/DT/FOT&E for system fixes / upgrades / new increments
- RAM & supportability data collection
- Additional LFT&E/shock qual

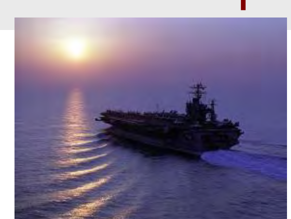
RISK MANAGEMENT… MISSION CAPABILITY DELIVERY…

INTEGRATED T&E & SYSTEMS ENGINEERING

Conclusions & Recommendations (cont')

Systems engineering and T&E recommendations:

- *Implement IT&E top down from DOT&E and OSD-SE*
- *Pull testing to the left*
- Align TEMP, Systems Engineering Plan, Acquisition Strategy for Systems Engineering and IT&E and reformat TEMP for IT&E
- Show more clear requirements traceability in TEMP from JCIDS to MOE/MOS to CTP with mission context
- Consolidate service T&E effort under single organization to coordinate T&E among OTA, PEO, SYSCOM
- Do the same for Joint T&E
- Consider 6-Sigma/CMMI process improvement – *and implement recommendations*
- Require 1 EOA before MS B and 1 OA before MS C for ACAT I programs
- Change culture from pass-fail IOT&E to exploration of capes and lims



Conclusions & Recommendations (cont’)

Systems engineering and T&E recommendations (cont’):

- Expand education for T&E planning using systems engineering methodology
- Increase priority for T&E in DAWIA courses
- Expand M&S/VV&A education and training
- Encourage use of distributed test tools
- Increase early T&E focus on suitability
- Standardize statistical methodology including Design of Experiments
- Certify organizations for T&E process
- Insert operational and environmental realism as early as possible
- Use risk management in test planning and report results to influence risk management
- *Clearly show IT&E VALUE ADDED to Program Managers*

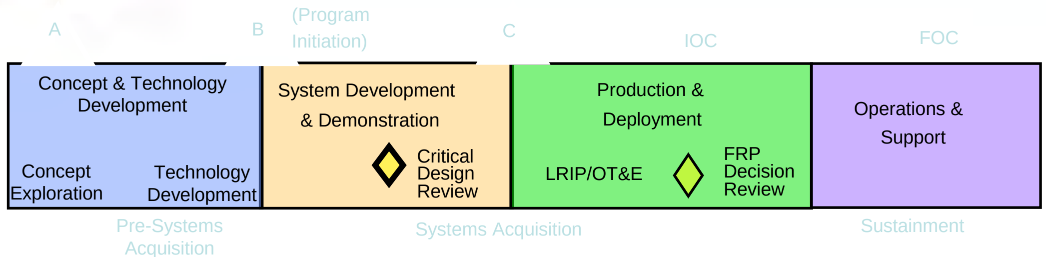
Conclusions & Recommendations (cont')

Systems engineering and T&E recommendations (cont'):

- **Most importantly, don't analyze and talk about transformation – *implement it!***

Additional recommendation for future papers...

- *Acquisition reform is happening...*
- *We've discussed transforming T&E within systems engineering*
- *Now...how do we **transform PPBE** (which is necessary to change the negative aspects of acquisition culture and business practices.)*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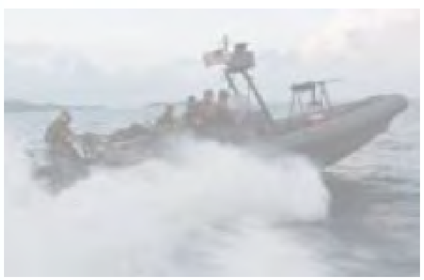
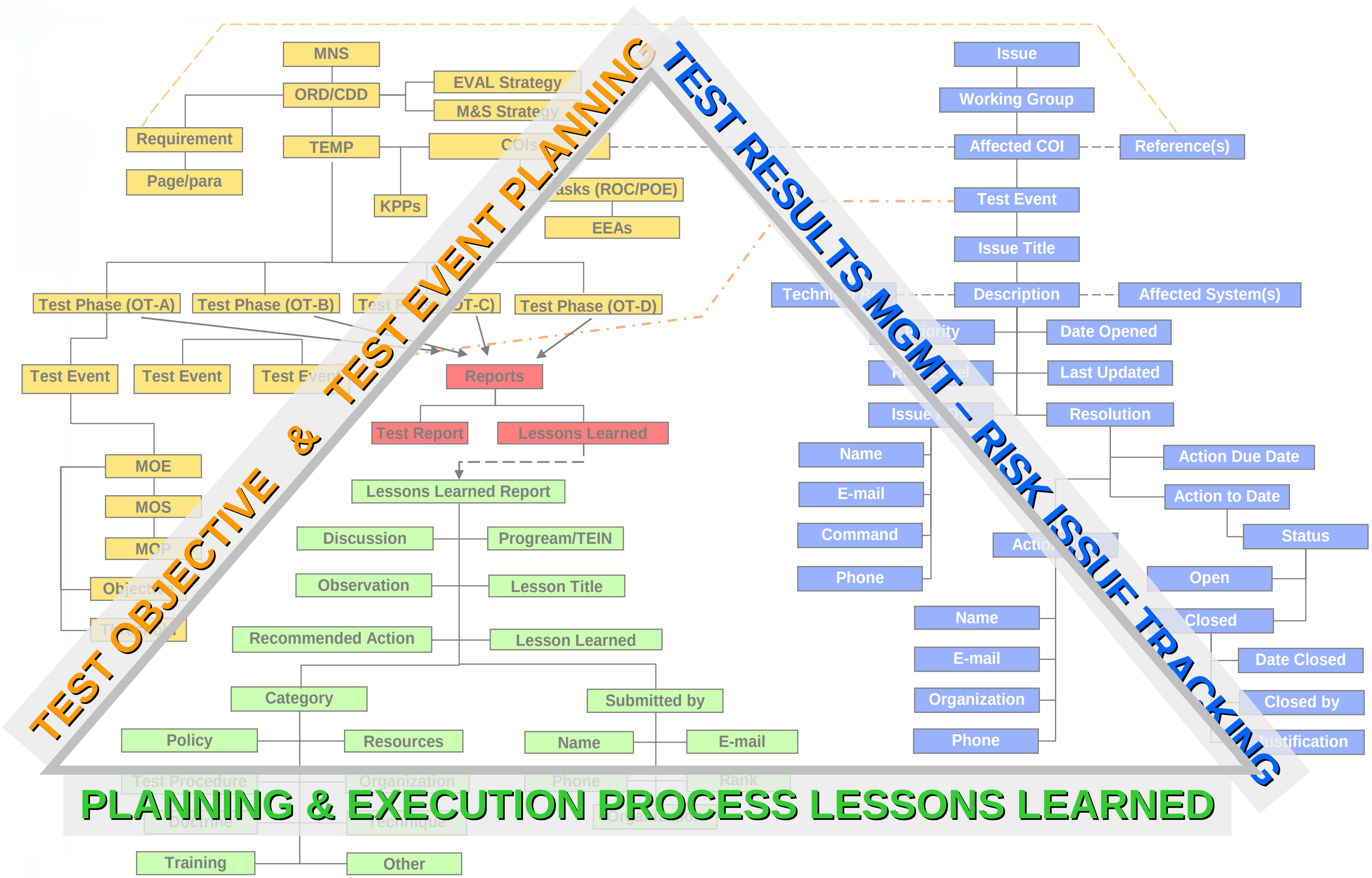
LRIP/OT&E
FRP Decision Review
Operations & Support
Pre-Systems Acquisition
Systems Acquisition
Sustainment

Questions?



Backups

AVW T&E
Database Structure



8th Annual NDIA Systems Engineering Conference
October 24-27, 2005, San Diego, CA

Track 3: Involving Test & Evaluation in Systems Engineering

Interweaving TEST AND EVALUATION *throughout the* SYSTEMS ENGINEERING PROCESS

Josh Tribble
Military Analyst
AVW Technologies
http://www.avwtech.com

AVW TECHNOLOGIES

NDIA
NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

ABSTRACT

Legacy acquisition processes bias test and evaluation (T&E) towards final design verification through segmented contractor, developmental, live fire, and operational testing. With increasingly complex systems and greater cost constraints, T&E must transform into a continuum of integrated objectives interwoven throughout the systems engineering process.

T&E activities can influence each iteration of this process. Starting with requirements generation, testers can help ensure those requirements are testable, technically feasible, and operationally realistic. During subsequent steps of functional allocation and synthesis, T&E can conduct early test resource budgeting, perform rigorous mission-task oriented test planning with support by systems engineers, and support early risk mitigation through interim evaluation of technologies and testing of components. As synthesis progresses towards completion, system testing supports interim assessment and final verification of the baseline product.

This process is carried out in greater complexity throughout the program, and is supported similarly by integrated T&E. Concept studies and system definition can involve testers in early design tradeoffs, technical and operational requirements reviews, concept of operations development, user input and interface evaluation, systems analysis, supportability assessments, and prototype component testing. T&E involvement progresses from analysis and assessment to include more comprehensive element and system level technical and operational testing focusing on integration as the baselines mature into preliminary and final design. T&E culminates in mission verification of the final product baseline after low-rate production articles are completed.

T&E Working Integrated Product Team (WIPT) coordination of these processes can drive early and cost efficient identification of risks and containment of system defects which are easier to correct. By pushing testing "to the left," integrating objectives, and interweaving T&E into all aspects of systems engineering, the required capabilities can be delivered to the warfighter more efficiently and rapidly.

INTRODUCTION

T&E can be seen as a process or series of activities within the greater context of systems engineering. Legacy practices within DoD acquisition and throughout the defense industry still tend to bias testing towards final design verification through segmented contract testing (CT), developmental test and evaluation (DT&E), operational test and evaluation (OT&E), and live fire test and evaluation (LFT&E). T&E can be shown to fulfill a much greater role by study of the various tasks within the overarching systems engineering process and the acquisition life cycle. In fact, defense transformation and evolutionary acquisition tenants demand such an expanded role and level of integration.

Recent changes in defense acquisition policies have been driven by systems complexity and cost constraints. These seek to transform the triad of components of the defense acquisition system. The Joint Capabilities Integration and Development System (JCIDS) shifted requirements generation to a capabilities based, top-down, joint-focused process. Acquisition policy brings spiral development ("evolutionary acquisition") and capabilities delivery into the systems engineering realm, balancing required capabilities with acquisition and life cycle costs and other constraints. The third member of the triad, the planning, programming, budgeting, and execution process (PPBE) has not seen much reform, however. Cost as an independent variable (CAIV) in a highly constrained environment places considerable strain on the system and shapes some of the cultural barriers to overall transformation of this complex acquisition process. Many organizational changes and realignments have occurred or are planned at DoD, joint, and service levels to implement these policy changes.

Within the acquisition leg of triad, there is an ever-increasing focus on disciplined systems engineering and integration of the various types of testing within DoD and service level acquisition policies. Organizations, policies, procedures, and assets must be further aligned to achieve the required level of integration. In particular, T&E must transform into a truly integrated continuum of requirements verification, technology maturation, risk management, capabilities validation, and support assessment. This continuum must itself be interwoven at each iteration of the systems engineering process throughout the acquisition life cycle. The goal of this paper is to indicate areas in T&E methodology and processes where this may occur.

STATE OF SYSTEMS ACQUISITION

Program managers are being tasked to provide capable systems to the user faster, with fewer resources, in compliance with more regulatory and statutory requirements, and ever-expanding complexity. As military transformation and evolutionary acquisition reforms continue, a concerted and concurrent effort must be undertaken by all members and elements of the greater acquisition community to not merely reform or evolve, but to transform the T&E community. These efforts must support long-term transformation, with a net effect of reducing total ownership costs while enabling more rapid fielding of needed capabilities through intelligent risk management. In short, the acquisition system need to transform to deliver the right product on time that works that is affordable and sustainable. The JCIDS, acquisition, and PPBE system form a triad that shapes the overall defense acquisition system. Each of these components must transform to meet the needs of our future military. Challenges within each will be addressed below, however, the focus of this analysis will be on T&E working within systems engineering as part of the acquisition component of this triad.

JCIDS

Transformation to JCIDS, coupled with more flexible, responsive, and innovative acquisition process is intended to produce better integrated and more supportable military solutions that address joint capability gaps. This top-down approach is designed to produce a better-prioritized and logically sequenced delivery of capability to warfighters. JCIDS specifically informs the acquisition process (and in turn systems engineering and T&E) by identifying, assessing, and prioritizing joint military capability needs for families of systems (FoS), systems of systems (SoS), and individual systems.[1] JCIDS is a tool used by joint staff and service warfighters and combatant commanders with input in some cases from government acquisition stakeholders, and in limited cases, industry to shape the force capabilities. Maturation of military critical technologies by various national laboratories, service research laboratories, academia, and industry feeds into both JCIDS and acquisition. Systems engineers and testers are less involved at this stage, although can play a key role in defining requirements and ensuring proper context for the flow-down of requirements during later design and testing.

JCIDS is an important step in transformation of the cumbersome acquisition system that results in better articulated capabilities required for systems tied to joint warfighting needs. However, additional work must be done to support the speed, flexibility, and complexity of future systems. Requirements flow-down for concept studies, engineering, testing, and tactics/doctrine development all must link together with engineers and testers playing a vital role at the onset of concepts before they mature into programs of record. Adequate mission context, traceability, and prioritization are needed throughout the acquisition life cycle. Additionally, many systems attempt to "grandfather" themselves, work around this process, or circumvent the intent of the top-down capabilities analysis.

Systems Acquisition

OSD and service level briefings on acquisition and systems engineering indicate a number of critical challenges facing government and industry. These include:

- shifting focus from platform requirements to capabilities (for individual or groups of systems) and system solutions
- in turn, a shift to fielding of system of systems and family of systems
- demand for joint interoperability and network centric capability in turn driving much higher levels of integration
- architectures both functional and physical far more complex with many more layers of system and hardware requirements
- organizational and process changes to align with JCIDS, evolutionary acquisition, and other aspects of military transformation.
- greater reliance on modeling and simulation (M&S) for engineering and T&E.[2]

Systems acquisition including systems engineering and T&E disciplines must undergo transformation themselves and integrate to deliver what the warfighters need. This includes integrated strategies and plans for engineering and T&E using risk management, M&S, analytical methodology, and other tools to achieve common goals. Engineers, testers, and their processes and insight must be leveraged far earlier in acquisition, from the beginning of JCIDS assessments to traditional design activities until disposal of the system decades into the future. Involvement and interaction must become persistent and continuous.[3]

Systems Engineering Complexity

Figure 1 below, from the Defense Acquisition University curricula, depicts a summary of the systems engineering process, showing input of traditional test and evaluation.

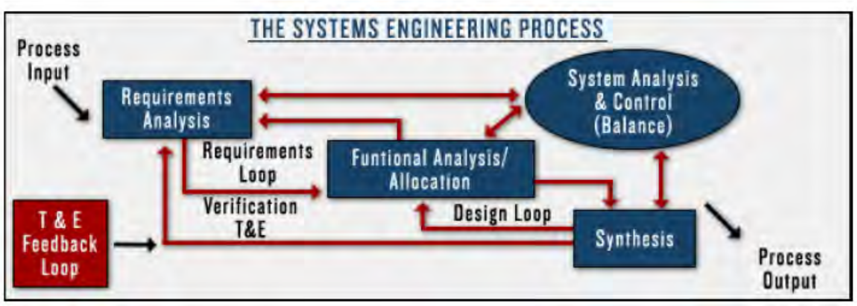


Figure 1: Systems Engineering Process Summary[4]

The ever increasing complexity requires more iterations of this process through multiple iterations during each phase of the acquisition life cycle. This requires additional analysis, testing, and other verification and validation activities due to greater chance of inducing errors and/or misconstrued requirements during the iterations of this engineering process.

Joint Interoperability

The implementation of net-centric operations and net ready key performance parameters highlights this ever-challenging aspect of systems engineering, depicted in figure 2 below.

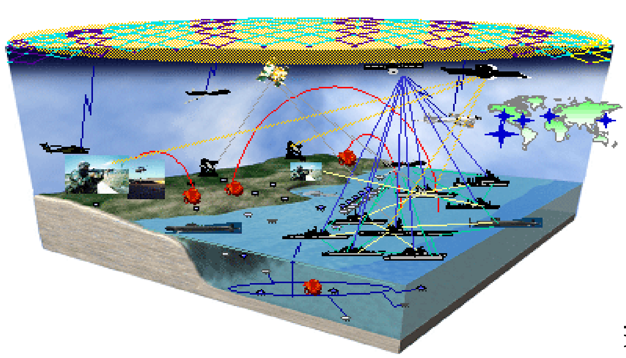


Figure 2: Challenge of Joint Interoperability and Net Centric Operations

Test and Evaluation

Based on these complexities, testers must become more committed to program success regardless of organization. Operational test agencies, government laboratories supporting developmental testing, industry design engineers, program managers, logisticians, and users must all cooperate to achieve cost efficient solutions. Testers must shift their outlook and approach (particularly OT&E), from one of oversight and reporting to early insight into risks and capabilities.

DoD Directive 5000.1 states that T&E should be integrated throughout the defense acquisition process and structured to provide accurate and timely information on risks and capabilities to decision makers.[5] The directive also states, "the conduct of [T&E] integrated with [M&S], shall facilitate learning, assess technology maturity and interoperability, facilitate integration into fielded forces, and confirm performance against documented capability needs and adversary capabilities as described in the system threat assessment."[6] Although a variety of organizations play roles in this integration of T&E, the program manager is tasked first and foremost with this daunting responsibility.[7] The Defense Acquisition Guidebook elaborates on the philosophy of integrated T&E in describing how separate industry and government developmental and operational testing can be combined as well as M&S and other activities.[8]

T&E expertise must be included during program conception so that problems are identified and addressed early, rather than exposed in a test report released too late for meaningful and cost-effective changes to be made. T&E must become an integrated continuum of supporting activities for systems engineering verification and operational capabilities exploration in realistic threat and environmental conditions. [9] Systems engineering and test and evaluation master plans (SEP and TEMP) can be aligned with JCIDS documents to describe this integration. The focus of individual tests, testing organizations, and recipients of their reports may be different, but the end goals should align towards expeditious introduction of cost effective capabilities to the warfighter. Whenever feasible, DT&E and OT&E events as well as LFT&E and other activities should be combined to gain optimal use of resources, if that supports technical and operational test objectives. The user community should also be involved early in test planning to ensure the capabilities are delivered as intended.[10]

Analysis of T&E and acquisition processes has shown that there are a number of influential, though seldom analyzed, factors affecting the value of T&E in a given acquisition program. Though changes are being implemented, success is still largely seen as timely entry into the next milestone, culminating in full rate production and fielding.[11] Other influential factors impacting value of T&E including constantly changing requirements, difficulties in testing due to inadequacies in facilities and infrastructure, diminished resources/budgets, changes due to evolutionary acquisition, and acquisition cultural climate (including a "success or perish mentality.[12] Specific drivers include:

- Human decision maker drivers such as risk tolerance, professional experience, personal goals, and effectiveness at decision making
- Business practices and cultural drivers including focus on maintaining viability of the program and of their organization
- Political drivers due to numerous economic, social, popular, legislative, executive, and military culture including impact of perceptions and prejudices

Technical drivers including maturity, risk, focus on exit criteria of passing a test or fielding a system (vice delivery of needed capabilities), and many other engineering factors.[13]

Related to these factors, numerous studies including a COMOPTEVFOR led study to address CNO tasking to reduce T&E costs by 20 % have concluded that: [14]

- T&E must be driven by a single agency, a current challenge for the Navy, and less so for other services, the Army in particular
- lean 6 sigma and other process analysis and improvement techniques must be implemented
- co-located test resources and facilities must be combined as well as greater cross-leverage between government and industry
- increasing visibility of costs as well as the value added nature of T&E to the program and to the warfighters is essential
- closely managing systems upgrades and assessing level of regression testing
- reduction of excessive testing costs due to:
  - redundant testing and certification activities
  - inadequate leverage of T&E disciplines, experimentation, and training exercises
  - use of differing analytical methods to maximize test assets including design of experiments, reduction in pressures to achieve high statistical confidence, and greater use of M&S (particularly for expensive live weapons firings)
  - inadequate risk mitigation in preparation for operational testing
  - poorly written or misunderstood requirements
  - inadequate early software testing and process maturity
- drive to maintain cost and schedule may result in reduction of capabilities and/or reduction in testing to determine those capabilities (although testing, shown below in figure 3 is a small fraction of the budget).

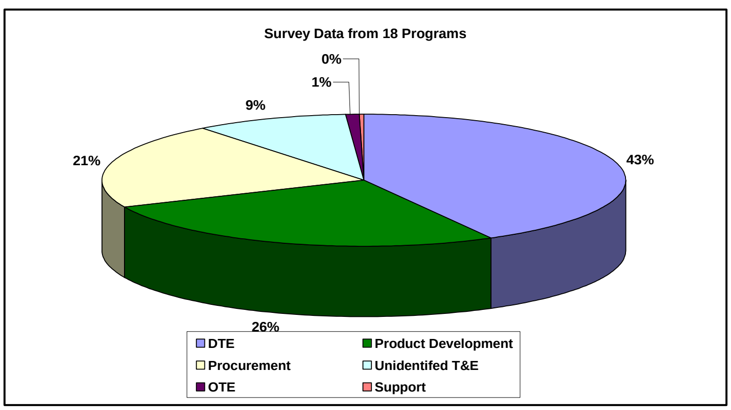


Figure 3: Research, Development, Test, and Evaluation (RDT&E) cost breakdown survey results[15]

- acquisition, T&E, JCIDS, and other process documents and guidance are not fully aligned particularly at the service levels
- T&E integration within Systems Engineering is gaining more emphasis

"To lessen the dependence on testing late in development and to foster a more constructive relationship between program managers and testers, GAO [recommended in a July 2000 report on best practices] that the Secretary of Defense instruct acquisition managers to structure test plans around the attainment of increasing levels of product maturity, orchestrate the right mix of tools to validate these maturity levels, and build and resource acquisition strategies around this approach."[16] The most telling of many of these studies is that volumes of information on acquisition and T&E reforms and best practices are available but many are not implemented, often due to political and business culture drivers.

PPBE

Although mostly beyond the scope of this analysis on T&E, the effect on business culture of CAIV and cost constraints managed under PPBE cannot be ignored. From a Navy perspective, this is highlighted for testers in the CNO's guidance for 2004 that set a goal to "streamline our [T&E] processes through a collaborative effort among Navy, [OSD], and contractor entities, using [M&S] where appropriate, with the goal of reducing the cost of T&E by 20 percent."[17] This goal was laid out as part of the Sea-Trial aspect of the new concept of Sea-Power 21 and other naval transformation strategies. Figure 3 above cited from the COMOPTEVFOR study shows the cost breakdown of T&E, particularly OT&E, as a smaller fraction within RDT&E costs for a sampling a Navy programs. Figure 4 below from various OSD systems engineering briefings shows a similar study on RDT&E cost breakdown.

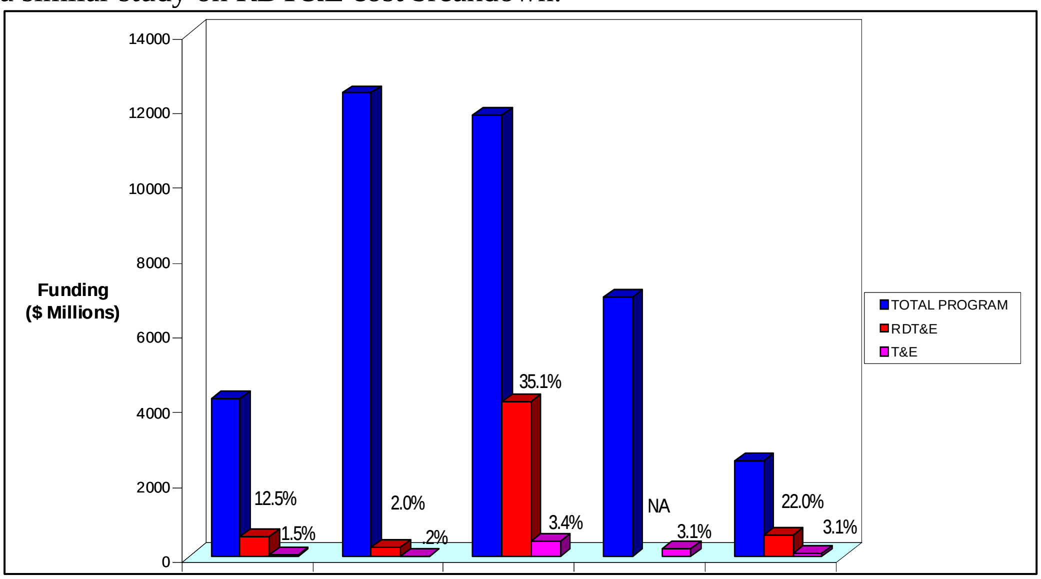


Figure 4: Selected Army Programs RDT&E Cost Breakdown

Related to these RDT&E cost breakdown graphs is figure 5 below showing relative life-cycle costs for a program.

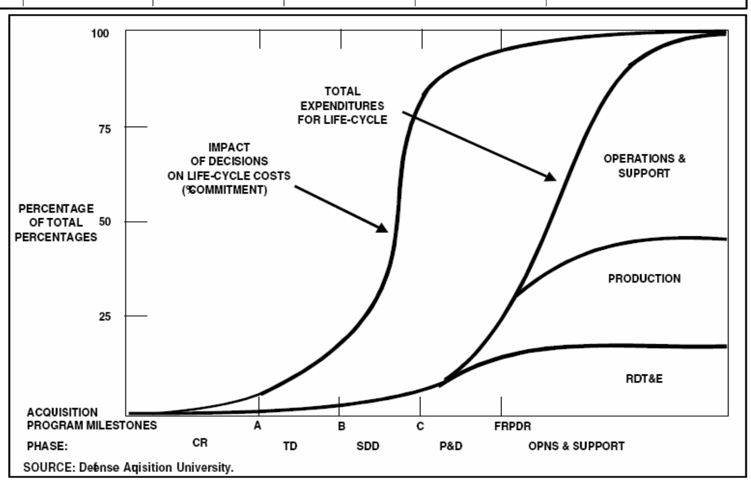


Figure 5: Relative Life Cycle Cost Breakdown[18]

The cumulative effect of these facts combined with discussion of early and integrated T&E above shows the relative low cost of T&E within the total program compared to its value added. Various other OSD studies indicate a number of systems engineering and T&E driven areas that directly impact cost including the most obvious which is immaturity and instability of requirements along with many other areas.

T&E WITHIN SYSTEMS ENGINEERING PROCESS TASKS

T&E activities can influence each iteration of this process. Starting with requirements generation, testers can help ensure those requirements are testable, technically feasible, and operationally realistic. During subsequent steps of functional allocation and synthesis, T&E can conduct early test resource budgeting, perform rigorous mission-task oriented test planning with support by systems engineers, and support early risk mitigation through interim evaluation of technologies, design products, and testing of components. As synthesis progresses towards completion, system testing supports interim assessment and final verification of the baseline product.

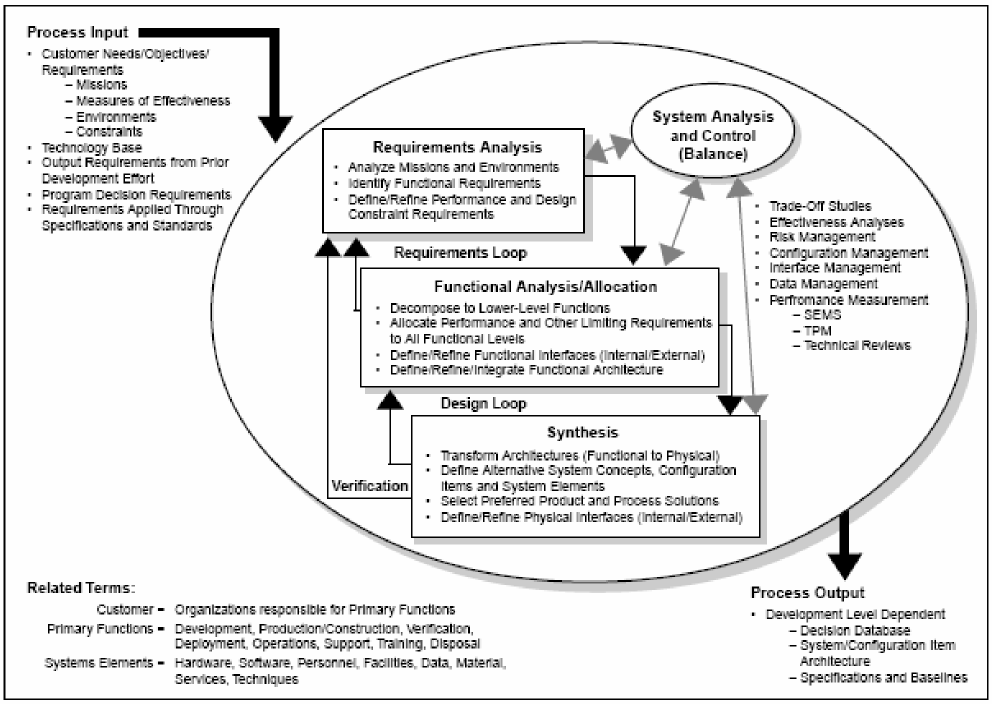


Figure 6: Detailed Systems Engineering Process[19]

This Defense Acquisition University graphic depicts the standard systems engineering process with similar terminology in a number of legacy and emerging standards including the Software Engineering Institute's Capability Maturity Model Integration® (CMMI^{SM}), recognized for systems and software engineering process improvement.[20] Many of these standards delineate use of T&E throughout these various tasks from requirements verification to design validation and the role of the Integrated Product Team in their proper execution.[21] Testers support systems engineering and are aided in their tasking by systems engineers and engineering products in numerous ways described below.

Requirements Analysis

During this beginning phase of systems engineering, testers and T&E early involvement supports a number of critical activities. They can assist in generating meaningful requirements that are measurable, objective, based in an operational mission context, correctly prioritized, and are traceable from JCIDS. Based on understanding of technical and operational functions of the system and/or related systems, testers can assist in analyzing threats and environments, bounding constraints of the system, and aiding in the functional breakdown. Additionally they are suited to selection of technical performance measures, identifying potential technical and operational risks, and influencing human systems integration (HSI).[22]

A key to this stage is a proper understanding and prioritization of requirements, which can be categorized in the following areas:

1. Capability that is desired.
2. Capability and performance mandated by external constraints liable to change, such as Government regulations, etc.
3. Capability and performance mandated by external constraints that are unlikely to change, such as the laws of physics, etc.
4. Capability that does not matter to the user one way or the other, and the development contractor is notified of that situation.
5. Capability that does not matter to the user one way or the other, and the development contractor is not notified of that situation.
6. Capability that is not desired.
7. Capability that is desired but the customer does not know that it can be provided.
8. Capability that is desired but cannot be provided.
9. Capability that is irrelevant to the equipment to be acquired. [23]

Most requirements fall somewhere in one of the first five of these categories. A proper prioritization of each user requirement/capability is essential along with traceability down to the final design. In many cases, requirements are treated simply as pass/fail and all mandatory, with the only distinction for Key Performance Parameters (KPP), which are used more for acquisition decision making. Priorities and risks must be tied to each of the requirements.

Conversely, T&E activities themselves, later in the acquisition cycle, are supported by early tester involvement. Insight into areas such as customer expectations, project cost and other constraints, life cycle and HSI design, and understanding of the actual context and intentions of requirements can significantly improve test planning (both in allocation of limited resources as well as focusing priority in the most necessary areas). This level of involvement is iterated through the requirements loop between functional allocation and requirements analysis.

Functional Allocation and Synthesis

Similar activities are conducted through the more detailed steps of functional analysis/allocation through the design loop with synthesis tasks. Testers support proper breakdown of the system functions and requirements, helping maintain consistency and context with the mission, and definition of interfaces. Greater emphasis can be placed on HSI, life cycle planning, and development of adequate M&S that will support systems analysis, systems design, and T&E verification and validation of requirements and capabilities. T&E may be conducted in the form of early component testing as well as design reviews to assess risks to mission effectiveness and support, particularly with warfighters and operational testers involved. This stage can also support early development of tactics and doctrine.

Conversely, the long term goals of T&E to verify requirements and validate capabilities are supported through involvement in these tasks, even early in the acquisition life cycle. As stated above, there should be adequate data during the design process to being identifying and aiding in program risk identification and management. Long term T&E planning can be made more efficient through tightly coupling planning with design activities so that testing is conducted when components and systems are ready and the proper aspects are tested or evaluated.

Additionally, early assessment of life cycle, HSI, software functionality, and other factors can aid in design maturity and provide further insight for T&E to support program success.

Systems Analysis

Systems analysis involves support of the requirements allocation and design through conduct of studies via analysis and M&S. Many of the tools, processes, and results from systems analysis scan directly support early T&E, particularly Early Operational Assessments (EOAs) prior to Milestone B and Operational Assessments early during the System Development and Demonstration (SD&D) acquisition phase. Development, verification, and validation of M&S tools and analytical results can also directly support filling in gaps in actual testing or supporting limited live test resources. Testing itself can also support systems analysis by providing needed performance data for M&S validation and correction of errors. M&S from analysis can support pre-test and post-test predictions and assist in design of cost effective live testing. In certain areas such as interoperability, survivability, and lethality M&S tools are critical in evaluation of requirements. In short, T&E must work in conjunction with systems analysis for adequate early identification of problems and to supplement testing with credible M&S based analytical results.

Verification and Validation

The major role of T&E has always been to determine the capability of "as-delivered" equipment in terms of how well requirements have been met or exceeded (verification), capabilities to conduct warfighting missions have been delivered (validation), as well as additional capabilities, characteristics, and properties of the system (independently or interacting with other systems).[24] T&E supports verifying that the system requirements are being properly interpreted and allocated during the design processes, verifying that the output of the process meets those requirements, and providing feedback to managers as well as the next iteration of the systems engineering process. "Peer reviews are an important part of verification and are a proven mechanism for effective defect removal... An important corollary is to develop a better understanding of the work products and the processes that produced them so defects can be prevented and process-improvement opportunities can be identified."[25] Besides peer review, verification can take the form of analysis, requirements review, user design reviews, and limited component testing. While verification focuses on correct production per specified requirements, validation, working hand in hand with verification using many of the same processes, products, and personnel, determines that the system "will fulfill its intended use", and "can be applied to all aspects of the product in any of its intended environments."[26]

Evaluation of results in T&E to aid in decision-making must itself transform to express system capability in terms of mission accomplishment, not just failing, meeting, or exceeding requirements.[27] Evaluation itself can be used to identify where requirements are exceeded to the point where capabilities can be trimmed to cut costs (while meeting the requirement). In addition, evaluation can identify added capability that although unplanned, provides significant and cost effective improvement in warfighting performance. "The importance of this role of T&E is that it provides the user with information about the additional capability of the equipment which then allows the user to develop additional missions or uses that may not have been present in the original concept of operations for the equipment."[28] Thus T&E serves many roles in development, fielding, and support of the system.

Critical to understanding of T&E as a whole is the concept of integrating the various aspects and types of T&E while preserving the important and distinct roles. DT&E focuses on specifications, controllable conditions, integration to scripted criteria, and threshold values. DT&E can be conducted across a range of venues from laboratory component tests to system of systems technical interoperability measurements. Capabilities are addressed, however they may not be explored to the extent that OT&E may desire. Operational testers focus more on mission accomplishment, value added to the warfighter, and capabilities and limitations of the system – not necessarily verifying specific requirements and technical specifications. For the final OT&E before fielding, the production system must be evaluated in scenario driven testing in realistic environments as much as possible. With this said, many objectives and resources can be combined between the two, particularly during the SD&D phase where prototype or near production systems may be available and can provide both technically and operationally relevant and credible data supporting mutual test objectives. LFT&E objectives must also be melded into the integrated continuum of testing, with significant overlap in survivability requirements and capabilities objectives common with DT and OT. Additionally, Systems analysis including M&S, early joint experimentation, and other events may also provide credible data to support the variety of integrated test objectives. The key is melding the distinct and important viewpoints of T&E and test objectives from the various organizations into a common integrated test program with the minimal expenditure of costly test assets.

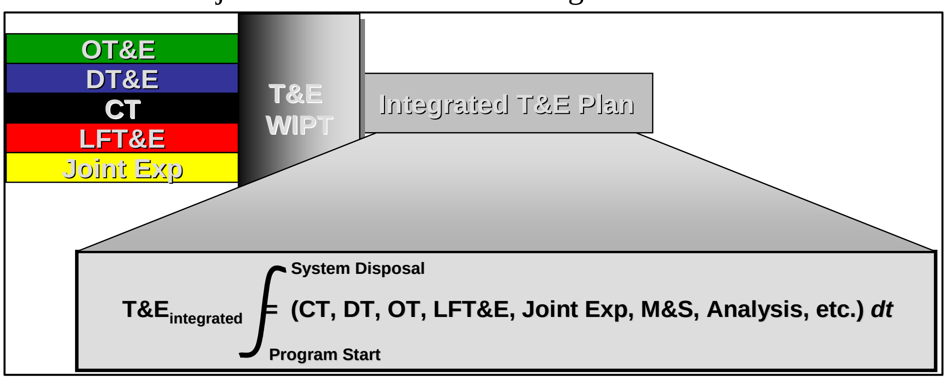


Figure 7: IT&E Concept

Within the Navy's Operational Test Agency, COMOPTEVFOR, the command is implementing an integrated T&E (IT&E) process. This new policy pulls tenants of early involvement, the CNO T&E cost reduction mandate, and the need to pull testing "to the left" together with a dendritic approach to mission area decomposition using standard systems engineering methodology referred to in the Defense Acquisition Guidebook. The focus is early and continuous evaluation of systems, resolving specific OT&E objectives earlier in the acquisition cycle, and reducing redundant testing (to reduce costs). Challenges in implementation include obtaining the necessary buy-in from program managers, adapting joint and service tasks lists for conduct of mission analysis (as well as deriving criteria from the myriad of joint and service doctrine and instructions), implementation of test design methodology including design of experiments, proper breakdown of suitability issues across mission areas, and developing risk based reporting criteria.[29] In addition to these challenges, a suitable software tool or set of tools including databases must be procured or developed to enable documentation of mission analyses, test objectives, and required test resources as well as tracking accomplishment of those objectives and providing metrics on reduction in separate OT&E costs and time.

T&E must involve systems engineers during all verification and validation activities to aid in conduct and analysis of test data/results and categorization of risks and to allow them insight into performance characteristics of the system in operation. These activities are familiar to testers, although these can be conducted far earlier in the acquisition cycle than has been done in the past. This involves T&E early in systems engineering process iterations, not just final Technical Evaluation (TECHEVAL) and Operational Evaluation (OPEVAL) of the system.

IT&E INTERWOVEN THROUGH ACQUISITION LIFE CYCLE

The T&E and systems engineering tasks in the process described above are carried out in increasing complexity throughout the acquisition life cycle. Concept studies and system definition can involve testers in early design tradeoffs, technical and operational requirements reviews, concept of operations development, user input and interface evaluation, systems analysis, supportability assessments, and prototype component testing. T&E involvement progresses from analysis and assessment to include more comprehensive element and system level technical and operational testing focusing on integration as the baselines mature into preliminary and final design. T&E culminates in mission verification of the final product baseline after low-rate production articles are completed.

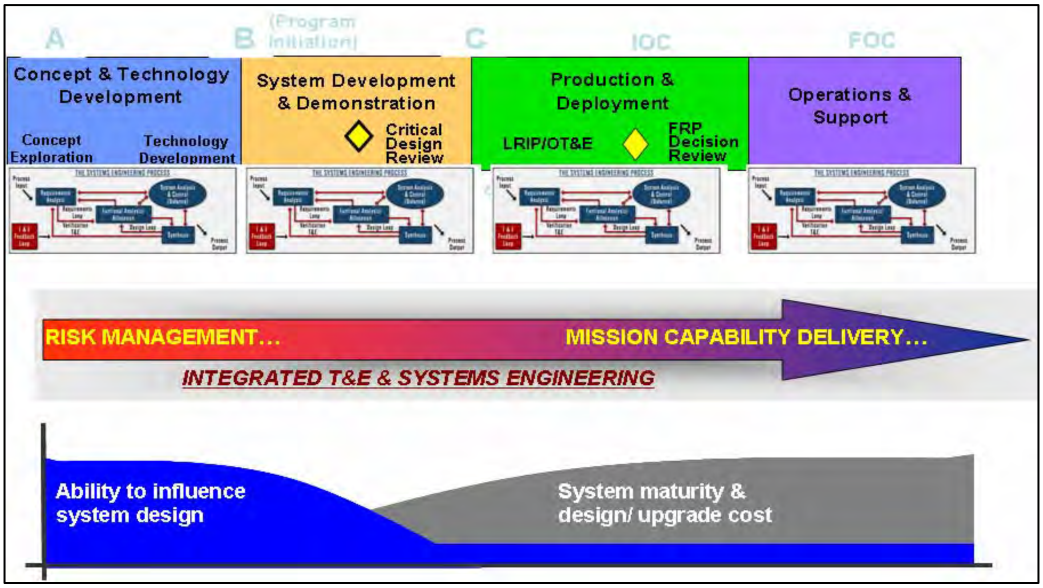


Figure 8: Life-Cycle Integrated T&E and Systems Engineering Summary

Concept and Technology Development

During these activities (prior to milestone B), laboratory testing and M&S are conducted by the contractors and the development agency to demonstrate and assess the capabilities of key subsystems and components based on JCIDS documents. Along with technology maturity assessment, the program develops T&E Strategy, Technology Development Strategy, and many key documents driving the program through the life-cycle.[30]

Many of the tasks described in the previous discussion of the systems engineering process, specifically under requirements analysis, are appropriate to this phase; however all of the tasks are conducted to some degree at this early stage prior to establishment of the actual program of record. Testers and engineers can participate in the JCIDS analysis itself, provide feedback on testability of requirements, aid in concept of operations (CONOPS) development, and collect data from advanced technology demonstrations and joint experimentation. T&E activities supporting this phase include technology feasibility studies, DT&E conducted on engineering development models (EDM), design reviews with user/warfighter representatives including EOAs, and analysis (with or without M&S). Involvement by testers and engineers as early as

possible in this phase, including during the JCIDS capability assessment, is essential for long term program success.
Evaluation of technologies undergoing maturation in this phase is critical to long term success and can be provided in particular by EOAs. The variety and magnitude of new technologies for programs such as DD(X), Future Combat System, and Joint Strike Fighter including platform level computing and software integration incur considerable risks that can be addressed through EOAs and OAs. Their value particularly for ship acquisition programs is often understated since the costs for correcting major issues in ship design increase exponentially once past milestone B into detailed design and ship construction. Typical EOAs provide an overall assessment of risks for the program in the following areas:

- Probability of meeting requirements in the Operational Requirements or JCIDS Capabilities documents
- Likelihood of the system being able to counter threats identified in DIA and service intelligence agency threat reports
- Adequacy of requirements and capabilities descriptions
- Level of risk for each critical operational issue/mission area
- Significant trends noted in development efforts, programmatic voids, and test resource shortfalls
- Ability of the program to support adequate OT&E (including adequate test resources) and successfully demonstrate required capabilities for Initial OT&E.

Use of an EOA as a significant tool for risk mitigation in total-ship acquisition programs has been very successful in the recent past. The LPD 17 Program used this tool to identify numerous potential design deficiencies such as obstructions, interferences, traffic choke points, night vision device compatibility, and weapons engagement blind spots. The Strategic Sealift Program EOA identified significant weaknesses in space and deck arrangement, the capability to conduct self-sustained operations, cargo flow paths, and compatibility with ramps and lighterage. CVN-21 EOA surfaced many issues with sortie generation rate KPP assessment, flight deck layout, warfare systems integration and other areas. DD(X) EOA addressed numerous issues in this highly complex program of new technologies, automation/HSI for an optimal size crew, and risks in executing needed transformation of shore support and maintenance.

Of all the phases of a program, this phase and perhaps the beginning of the next phase, SDD, have the most profound impact on long term viability of the program and military success. However, testers and engineers usually have the least input and involvement, while, as shown above they can have the most impact with the least cost. Ensuring proper requirements, CONOPS, and planning for system development is far superior to waiting till a system is fully matured, tested, and a number of critical issues are raised far too late to correct without serious cost overruns.

System Development and Demonstration

During the SDD Phase, concepts approved for prototyping form the baseline used for detailed test planning of the full system that is matured through the design process. DT&E is conducted to aid engineering design, system development, risk identification, and to evaluation of the growth of technical maturity and performance to reach intended level supporting desired capabilities for fielding. DT and CT may be conducted in laboratory tests of components, software qualification tests, and prototype system engineering tests. At the exit from SDD, engineering is primarily complete including survivability/vulnerability, compatibility, transportability, interoperability, reliability, maintainability, safety, human factors, and logistics supportability factors. Multiple OAs conducted similar to the EOA and/or integrated with DT and CT support identification and mitigation of risks in support of the overall program risk mitigation strategy. The early T&E program is accomplished in an environment containing limited operational realism that may affect viability of OT&E results; however, this information is essential as early in the program as possible. Some of the most important products are user assessments of system maintainability, supportability, human factors, and safety issues. Integrated T&E should address each of those areas along with growing data for estimation of long-term reliability, availability, and maintainability (RAM). IT&E must support decision to proceed into low-rate-initial production.[31]

The continuum of design and analysis support from T&E personnel include review of detailed designs, user evaluations as discussed above, assessment of CONOPS viability, liaison with military doctrine commands for development of tactics and doctrine, assisting with trade studies, and conduct of EOAs and OAs. Products of the SDD phase are verified and validated through a range of IT&E activities including lab, testbed, and field/flight/at-sea testing on prototypes and surrogate platforms. Survivability (including shock qualification) and/or lethality evaluation may be conducted in this phase, although the may not be completed until early in the next phase just prior to fielding. User commands and certification agencies can help address various life cycle support and other issues including information assurance and spectrum management. Each of these activities brings a certain lens with which to view the program, and if properly integrated within the systems engineering process, can aid in delivery of a final product ready for production, qualification, and introduction into military use.

Adequate requirements generation and flow-down and subsequent risk reduction conducted in the first phase, concept and technology development, is most critical to program success. However, program success hinges on continued focus in SDD on risk mitigation and completing requirements traceability (with correct intent and mission context) and verification to support entry into production, IOT&E, and delivery with a system of adequate maturity.

Production and Deployment

Production and IOT&E mark the key points in the first portion of this phase. T&E consists of more traditional verification and in particular validation events. TECHEVAL and IOT&E/OPEVAL are conducted to resolve critical technical parameters and operational issues and determine mission capability. However, this cannot be the primary source of information on a system. A majority of issues should be surfaced during SDD with testing in this phase conducted primarily to confirm mission capabilities in a production representative system prior to fielding. In addition to traditional final TECHEVAL and OPEVAL/IOT&E, IT&E can still pull in other activities from this phase including:

- production readiness reviews and in-process reviews
- independent logistics audits
- information assurance certification and accreditation
- spectrum certification
- review of final doctrine and tactics

- implementation of life cycle support plans including maintenance demonstrations
- crew/user training and qualification
- command/fleet/field exercises and training employing the system(s)
- M&S testbed analysis for complex systems integration (such as ship's combat systems)
- final LFT&E including shock qualification/trials and/or lethality evaluation

Periodic feedback on results from IT&E must support early risk reduction. Where possible, these activities must begin in SDD with final validation conducted in this phase. Neither OPEVAL nor TECHEVAL should be the first time that some of these key program areas is addressed.

After the Full Rate Production Decision Review, T&E activities continue to provide important insights into performance of the program. T&E coupled with systems engineering can support Production Acceptance T&E and monitoring long-term RAM characteristics. As the systems are fielded, the program transitions into operations and support where upgrades are fielded and tested among many other activities.

Operations and Support

As adequate numbers of systems are fielded to full operational capability, the program must transition to this phase. When necessary, T&E can confirm need to improve support or upgrade systems to maintain RAM and mission effectiveness. T&E is used in similar processes during SDD and Production and Deployment phases prior to introduction on pre-planned improvements and new spirals. Where appropriate JCIDS documents are updated with similar involvement by testers in requirements analysis as discussed in the concept and technology demonstration phase above. With the advent of spiral development and evolutionary acquisition, there may be multiple iterations of the acquisition life-cycle, each with multiple iterations of systems engineering and T&E as previously described. IT&E must continue to support needs of follow on OT&E, DT&E, LFT&E, certifications, and life-cycle support and maintenance. As capabilities are increased or added, new and/or improved doctrine and tactics must be developed and tested, bringing doctrine commands into play once again. Also, as threat and operating environments change due to internal and external factors, JCIDS and requirements documents must be iterated and system upgrades implemented through the appropriate level of engineering changes, software upgrades, system overhauls/upgrades, service life extensions, development of follow-on variants, retrofit of new capabilities, or some combination. Each of these will require the same focus from T&E as previous configurations of the system throughout the life cycle.[32] Figure 9 below summarizes the myriad of system characteristics and capabilities that must be monitored and maintained by this integrated continuum of IT&E and systems engineering.

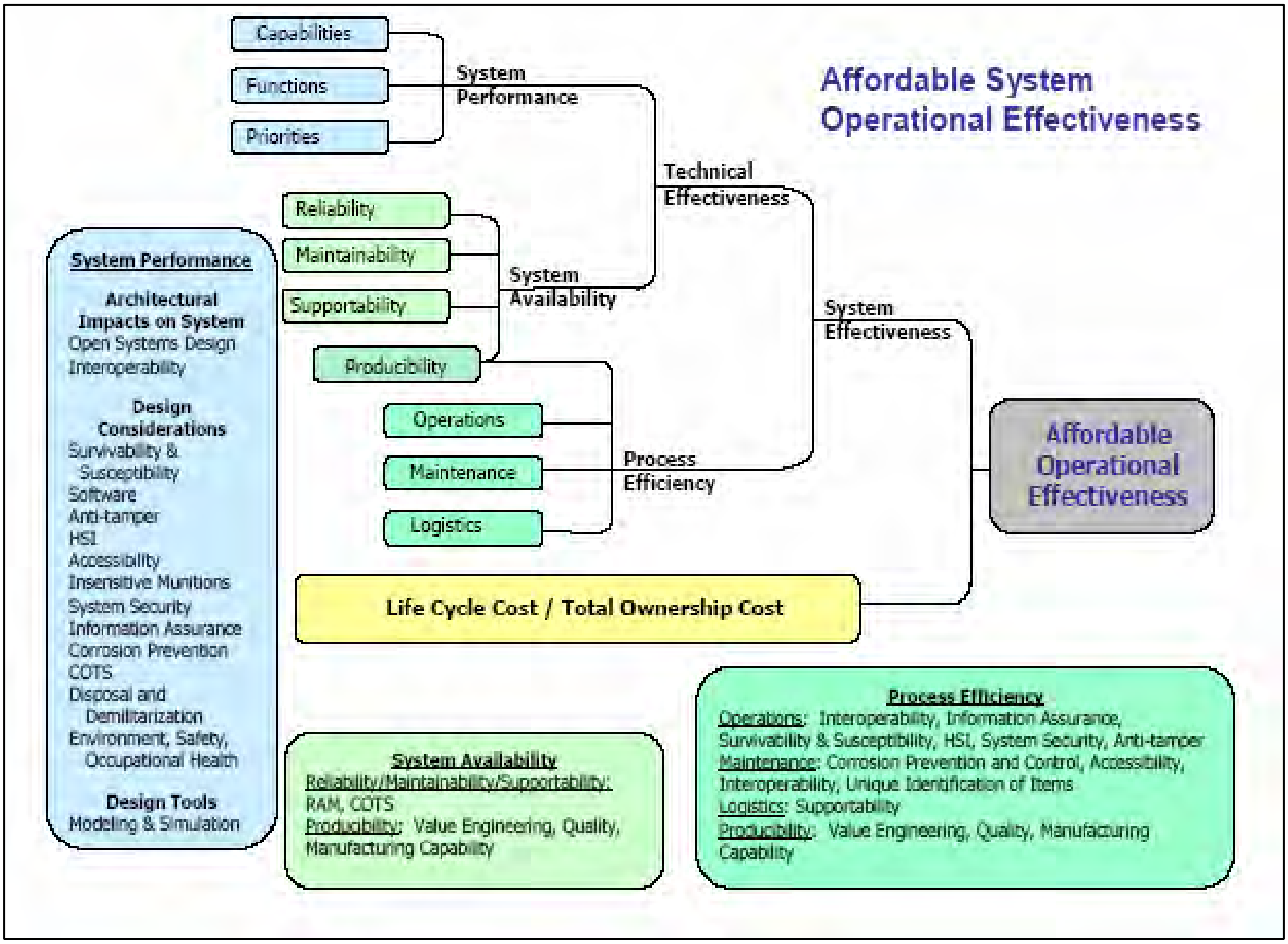


Figure 9: Life Cycle System Characteristics[33]

CONCLUSION

The traditional T&E Working Integrated Product Team must take a greater role in the program coordinating with risk management, systems engineering, and other entities. All aspects of T&E, analysis, M&S, design verification and validation, concept experimentation, and certification evaluations must be integrated and then interwoven with the appropriate systems engineering tasks through the life cycle of each increment of a program/system. All aspects of T&E must be pulled left to provide early risk mitigation and ensure proper requirements flow-down. The T&E WIPT and other key organization in the program must efficiently coordinate these processes to ensure success. If these are implemented with complete buy-in and resources provided from all stakeholders and participants, the program will be able to efficiently identify risks, contain and correct system defects prior to delivery, and provide cost effective capabilities to the warfighters when they are needed.

Specific Systems Engineering/T&E Recommendations

Based on the analysis presented, specific recommendations for further transforming systems engineering and T&E to meet these challenges are included below. Numerous studies have provided lessons learned, best practices, and recommendations for process improvement for T&E and acquisition in general, but most have not been implemented substantially in programs, including many of the recommendations discussed below. [34]

- Fully implement IT&E mandated from the OSD level jointly by OSD/SE-AS and DOT&E as well as by PEOs. Start with review of T&E WIPT processes for major programs, with oversight emphasis on implementing IT&E. Ensure full cooperation between systems engineers and testers during all phases, starting with JCIDS analysis including analysis of material alternatives and development of both the initial capabilities document and the capabilities development document (for each increment, if evolutionary acquisition).
- Pull T&E to the "left," i.e. earlier in acquisition life cycles for systems increments, addressing objectives as early as possible.
- More closely align the T&E Strategy/TEMP, Acquisition Strategy, and Technology Development Strategy/Systems Engineering Plans so each discusses the integration of all types of T&E as IT&E along with systems engineering, risk management, and acquisition.
- Include additional budgetary and other incentives for programs to fully integrate T&E
- Address T&E infrastructure shortfalls and implement database to foster collaborative use of government and industry test resources including M&S
- Restructure TEMP and T&E strategy document formats to better show alignment of all aspects of T&E, incorporating discussion of CT, Experimentation, similar systems T&E as well as DT&E, OT&E, and LFT&E.
- Incorporate additional requirements traceability information in the TEMP to show mission context for each measure of effectiveness and suitability as well as traceability to DT objectives and critical technical parameters. Include annexes for TEMPs to show derivation of test objectives for various areas of T&E.
- Standup a formal Joint T&E organization under JCS with input to TEMPs for all future Acquisition Category (ACAT) I & II programs to address joint T&E requirements.
- Increase collaboration of T&E with fleet/field training and experimentation for leverage of data with incentives for all stakeholders to foster cooperation.

- Implement more rigorous systems engineering methodology in all aspects of test planning and develop or procure adequate tools to allow management of IT&E for the program and various organizations.
- Mission fund independent operational test agencies (OTA) as the new service T&E command to execute testing, some which still require funding from the program offices—this will empower them to implement smart and efficient testing while answering directly and independently to service headquarters staff on effectiveness of IT&E; at the same time, increase visibility and independence of T&E funding from RDTE funding.
- Facilitate smarter testing by realigning OTAs and other T&E organizations for services under a common T&E command reporting to the service chief directly with oversight from DOT&E and a new Joint T&E directorate recommended above. Include in this organization test ranges, facilities, and targets management.
- In support of the previous recommendation, realign PEO and Systems Command T&E organizations with the new service T&E manager for efficient conduct and planning of IT&E.
- Collect management metrics on T&E support from service T&E organizations and PEO and SYSCOM T&E directorates for accuracy in process and reporting as well as support for early program risk reduction.
- Increase visibility of T&E within the defense workforce systems engineering work-field and implement additional or upgraded training to foster IT&E and systems engineering continuum.
- Reduce the number of programs under test by combining and integrating T&E not only within a program but also between related programs or families of systems. Develop, field, and test in parallel/together rather than separately to reduce amount of retesting whenever possible.
- Change the “Pass-Fail” mindset of IOT&E/ OPEVAL to an evaluation and exploration of operational capabilities and limitations; require OTAs to provide feedback on testing in progress, while allowing them to maintain independence. Foster more participation of OTAs in CT, DT, and joint experimentation to reduce scope of separate IOT&E events whenever possible.
- While leveraging program and contractor testing and design reviews, require at least one EOA prior to milestone B and one OA prior to milestone C for ACAT I programs or when recommended by DOT&E.
- When possible, link all T&E stakeholders into program design database for complete visibility into requirements analysis and allocation to enable inputs and to aid in rigorous test planning with full traceability.
- Increase education and training within systems engineering and acquisition program management on proper use of M&S for analysis, T&E, and design including proper implementation of verification, validation, and accreditation processes. Increase focus on not just credibility of the M&S tools, but in execution of the analysis and interpretation of the results.
- Increase the use of distributed test tools and networking that enable ease of design, testing, and fixing systems in complex programs.
- Increase CT, DT&E, design engineering, and program management focus on life cycle support, HSI, and other factors above and beyond technical performance and mission effectiveness.

- Coordinate use of standard statistical methodology for T&E and analysis of probabilistic measures of effectiveness, suitability, performance, and technical parameters to ensure common results. Incorporate design of experiments where practical and process improvement tools such as six-sigma and CMMI to address program and system performance as well as efficiency of test planning.
- Stabilize T&E and systems engineering within programs to mitigate military billet turnover through adequate documentation.
- Implement certification for T&E processes and organizations including process improvement metrics collection, analysis, and implementation (including quality, utility, and timeliness of information provided to decision makers, users, and other stakeholders).
- "Use Physics of Failure as a tool to predict and analyze system performance and shortfalls."[35]
- Begin inserting operational realism, scenarios, and realistic environments and threat surrogates as early as possible.
- Ensure T&E supports baseline of capabilities with current systems
- Address level of testing, statistical confidence levels, resource cost expenditures on addressing risks in terms of mission consequence to capabilities if projected failures occur and probability of failures occurring during testing and operations. Consider ACAT level and other factors in resourcing for tests. Similarly, address results of testing in the design based on the same standard risk metrics to align all aspects of T&E into program/system risk management. Table 1 presents tailored risk chart for testing management.

Table 1: T&E Planning Risk Matrix[36]

Consequence / Probability of Occurrence	1	2	3	4	5
A – Frequent occurrence during tests/operations (probability approaching 1.0)	I	I	II	II	III
B – Probable to occur during tests/operations	I	I	II	II	III
C – Occasional- - likely to occur during tests/operations (probability near 0.5)	II	II	III	III	IV
D – Remote – less likely to occur during tests/operations	II	II	III	IV	IV
E – Improbable – extremely unlikely to occur during tests/operations (probability approaching 0)	III	III	III	IV	IV

Consequence:

1 – prevents primary mission or serious safety violation
2 – significant primary mission degradation or secondary mission failure/degradation with no work-around
3 – significant impact to any mission but work-around is available
4 – minor degradation/adverse impact to missions
5 – no degradation but operator annoyance or recommended enhancement

Level of testing based on risk or priority of trouble report based on risk:

I Very High Risk – resolve ASAP
II High Risk – immediate resolution desirable
III Manageable Risk – resolution can be delayed
IV Low Risk – resolution not required

Additional Recommendations to Consider

Beyond the scope of systems engineering and T&E, transformation is necessary in other areas, particularly PPBE. This system drives many of the negative aspects of the acquisition culture that reacts to budget competition and CAIV constraints. PPBE must transform along with acquisition, systems engineering, and T&E disciplines to enable the triad of JCIDS, PPBE, and acquisition to field systems that provide needed warfighting capabilities on time and on budget.

About the Author

Mr. Joseph "Josh" Tribble is a Military Analyst for AVW Technologies. He is total ship test manager COMOPTEVFOR OT&E of DD(X) with over 5 years of T&E experience across numerous disciplines. Mr. Tribble has also supported T&E planning for amphibious ship class combat systems; total ship testing for DD(X), CVN 21, LHA 6, and LPD 17; modeling and simulating management for self-defense combat systems; and JCIDS analysis for the Sea Base to Shore Connector. He graduated from the US Naval Academy in 1996 with honors in aerospace engineering and completed numerous military education and training courses. During his active duty naval career he served multiple sea tours with experience in Aegis combat systems, Tomahawk, and engineering systems management. He attained surface warfare qualification among numerous other positions. He also served as an Operational Test Director for naval gun and fire support programs for COMOPTEVFOR and attained level II certification in T&E career field. He continues to serve in the Navy Reserve as an officer in charge of a naval coastal warfare embarked security detachment. Contact info:

Phone: 757-361-9587
E-mail: tribble@avwtech.com
860 Greenbrier Circle, Suite 305
Chesapeake, VA 23320
http://www.avwtech.com

AVW Technologies, Inc. is a small, veteran owned business that provides professional engineering services to naval acquisition programs, T&E support to COMOPTEVFOR and naval acquisition programs, and engineering management consulting services to ship builders. Corporate efforts to date have primarily been focused on surface ship acquisition, from design through production and Test and Lifecycle Management; however, we are branching into other areas of naval and joint acquisition and T&E. AVW is a recognized leader in the use of integrated data environments and digital product models to support ship acquisition, as well as the use of M&S technologies to support design, production, and T&E. AVW staff includes former COMOPTEVFOR Operational Test Directors who are well versed in distributed land based test beds and their use in design integration testing, the T&E WIPT, requirements document and TEMP development and approval process, and managing developmental and operational assessments and testing. Staff acquisition expertise and naval experience have made AVW a key member of Seabasing concept development, capabilities assessment, and acquisition planning.

NOTES

[1] Defense Acquisition Guidebook (DAG) Version 4.5, para. 1.3.
[2] "The Role of T&E in the Systems Engineering Process", Glenn Lamartin (OSD/AT&L, Director Defense Systems), 17 Aug 2004.
[3] Ibid.
[4] Defense Acquisition University Course, Acquisition 101 Lesson 18, Test and Evaluation Overview, https://oss4.dau.gov/courseware/ACQ101_6/lessons/L18/main.cfm, 11 Apr 2005, pg 3.
[5] DoDD 5000.1, 12 May 2003, para. E1.1.11.
[6] Ibid.
[7] DoDINST 5000.2, 12 May 2003, para. E.5.1.1.
[8] DAG, para 9.1.5.
[9] Ibid, para 9.3.1.
[10] Ibid, para 9.3.3.
[11] "The T&E Decision Environment", Martin Prehm and Roger Bergstrom, NUWC Keyport, Nov 1999, pg 2.
[12] Ibid, pg. 3-6.
[13] Ibid.
[14] COMOPTEVFOR letter 1000, ser 00/409, "T&E Streamline and Cost Reduction Task Final Report, Volume I," 6 Jul 2005.
[15] Ibid.
[16] GAO Report NSIAD-00-199, "Best Practices: A More Constructive Test Approach is Key to Better Weapon System Outcomes," July 2000
[17] "CNO Guidance for 2004: Accelerating our Advantage"; CNO, Jan 04
[18] DAG, Figure 1-2
[19] Systems Engineering Fundamentals, Defense Acquisition University, Jan 01, pg. 31
[20] Capability Maturity Model Integration® (CMMI[SM]), Version 1.1, Carnegie Mellon University Software Engineering Institute, Mar 2002, pg. 67.
[21] CMMI[SM], pg. 68.
[22] Systems Engineering Fundamentals, Defense Acquisition University, Jan 01, pg. 41
[23] Enhancing the Role of Test and Evaluation in the Acquisition Process to Increase the Probability of the Delivery of Equipment that Meets the Needs of the Users, Joseph Kasser, SETE2000 Conference paper, pg. 2.
[24] Ibid., pg. 4
[25] CMMI[SM,], pg. 462-463.
[26] CMMI[SM,], pg. 481-482
[27] Enhancing the Role of T&E..., pg. 4.
[28] Ibid.
[29] COMOPTEVFOR letter, 3980 ser 00/391, "Policy and Information Notice 05-1, OT&E Framework and the IT Methodology," of 28 Jul 2005.
[30] T&E Management Guide, Defense Acquisition University, Jan 05, pg. 1-4 – 1-8.
[31] Ibid., pg. 1-4 – 1-8
[32] Ibid,, Jan 05, pg. 1-4 – 1-8
[33] DAG, figure 4.5.1.
[34] DAG, para 9.8.1.
[35] Ibid.
[36] DA Pamphlet 73-1, "T&E in Support of Systems Acquisition", 30 May 03, tables 6-6, 6-7, and 6-8.

System Supportability and Life Cycle Product Support: A Systems Perspective

October 25, 2005

Dinesh Verma, Stevens Institute of Technology
Jerry Beck, ADUSD (Logistics Plans and Programs)
Tom Parry, Decisive Analytics Corporation

Current Situation
What We Need to Do Better

Requirements

- Adapting to changing conditions
- Matching operational needs with solutions
- Overcoming biases of Services and others
- Moving to transform military

PPBES

- Laying analytical foundation for budget
- Aligning budgets with acquisition decisions

Personnel and Readiness

- Treating people as a resource

Acquisition

- Acquiring systems-of-systems
- Making system decisions in a joint, mission context
- Transitioning technology
- Assessing complexity of new work and ability to perform it
- Controlling schedule and cost
- Passing operational tests
- Ensuring a robust industrial base

Sustainment

- Controlling O&S costs
- Reducing logistics tails

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Sustainment

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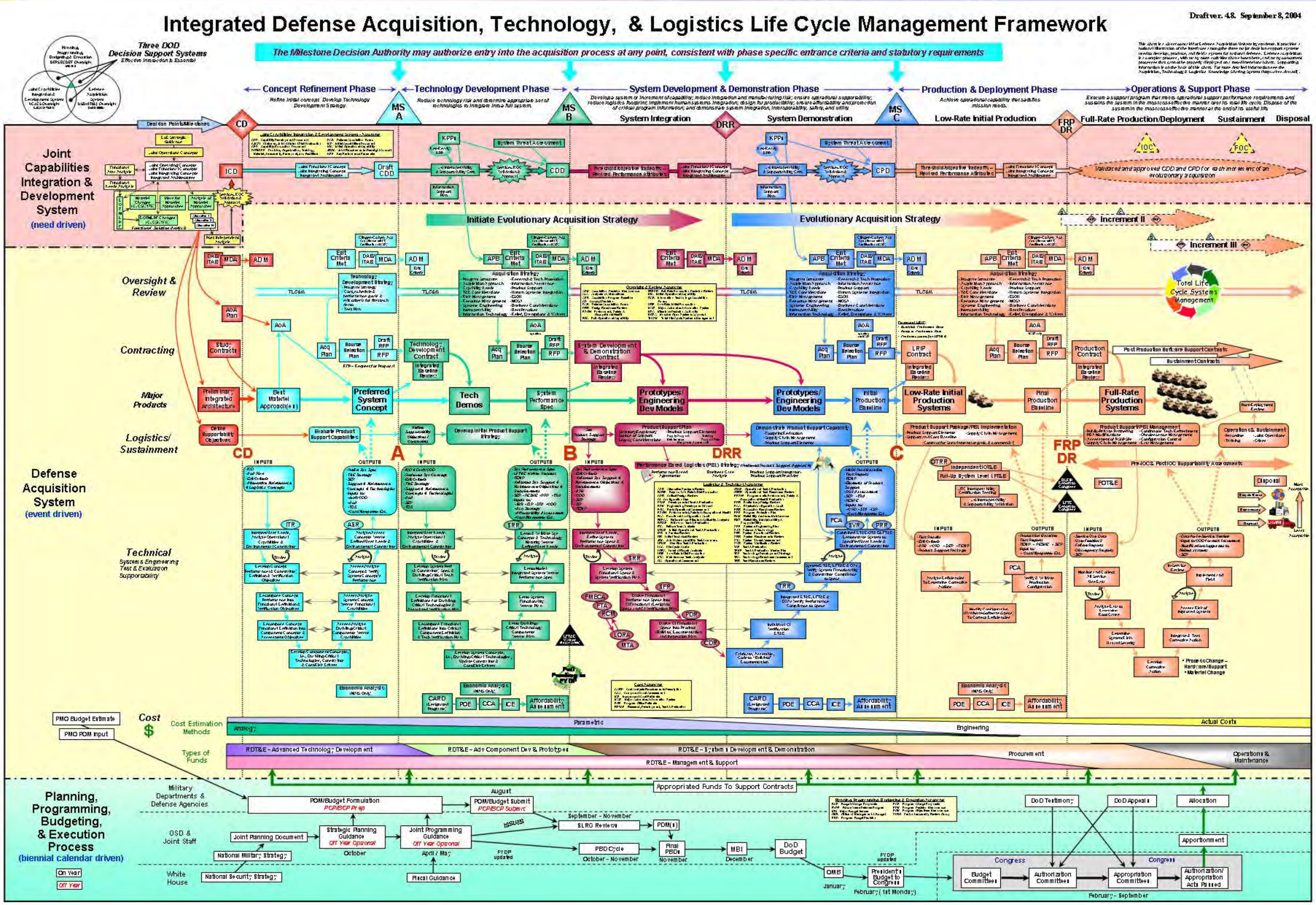
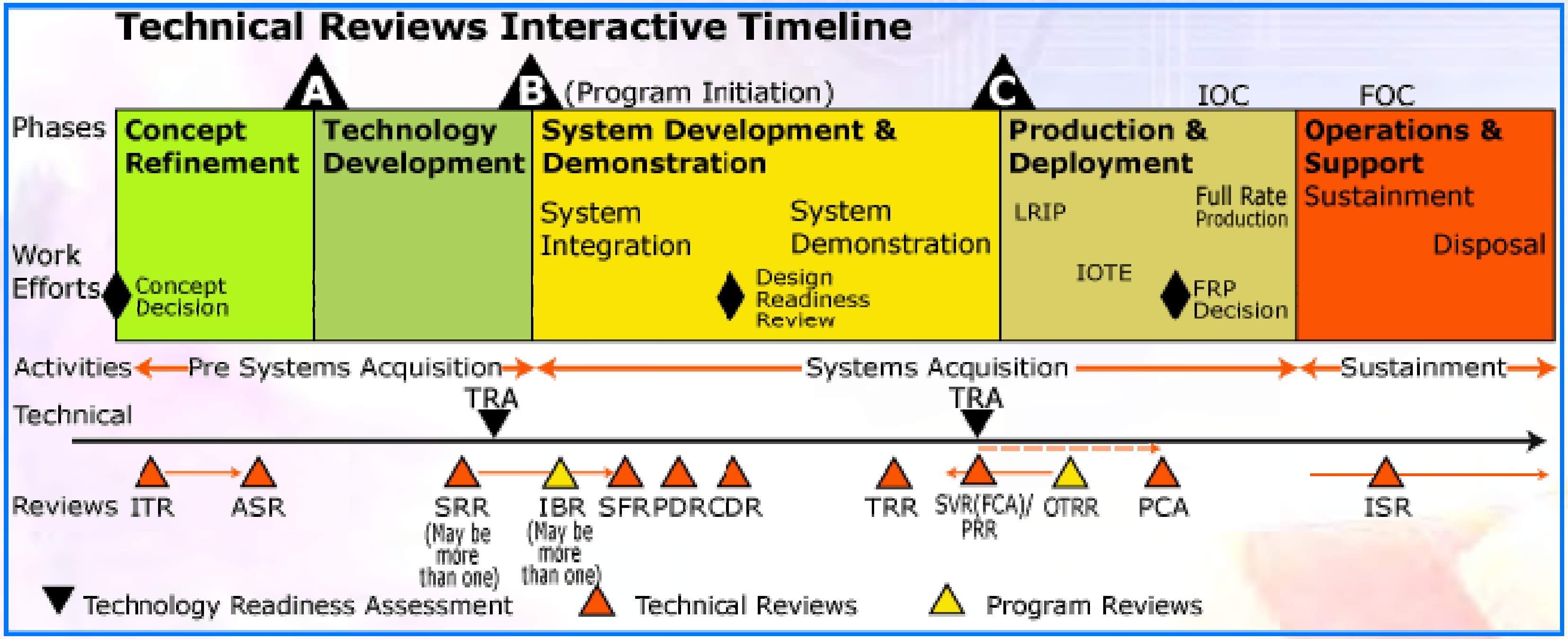
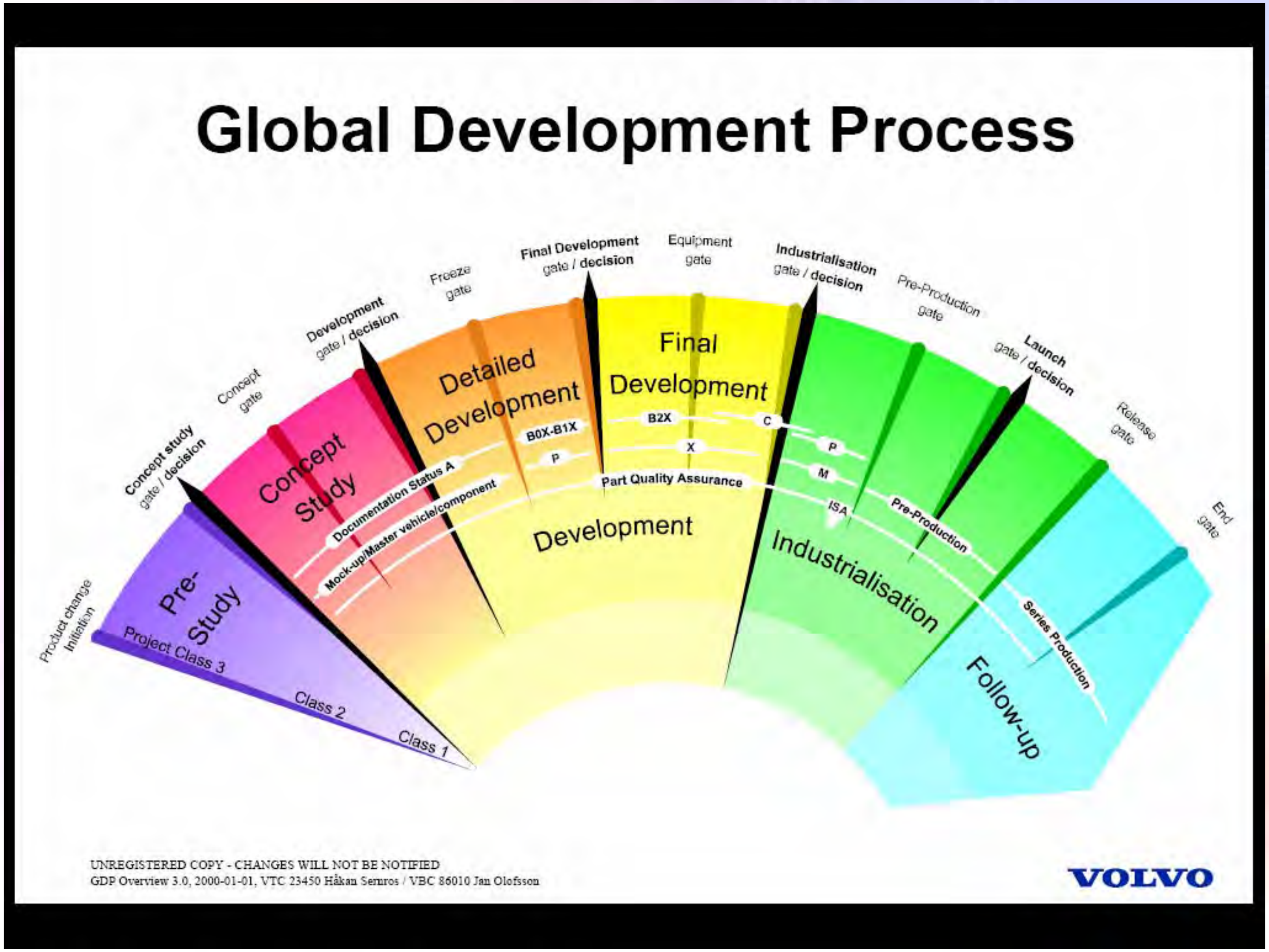
One Response



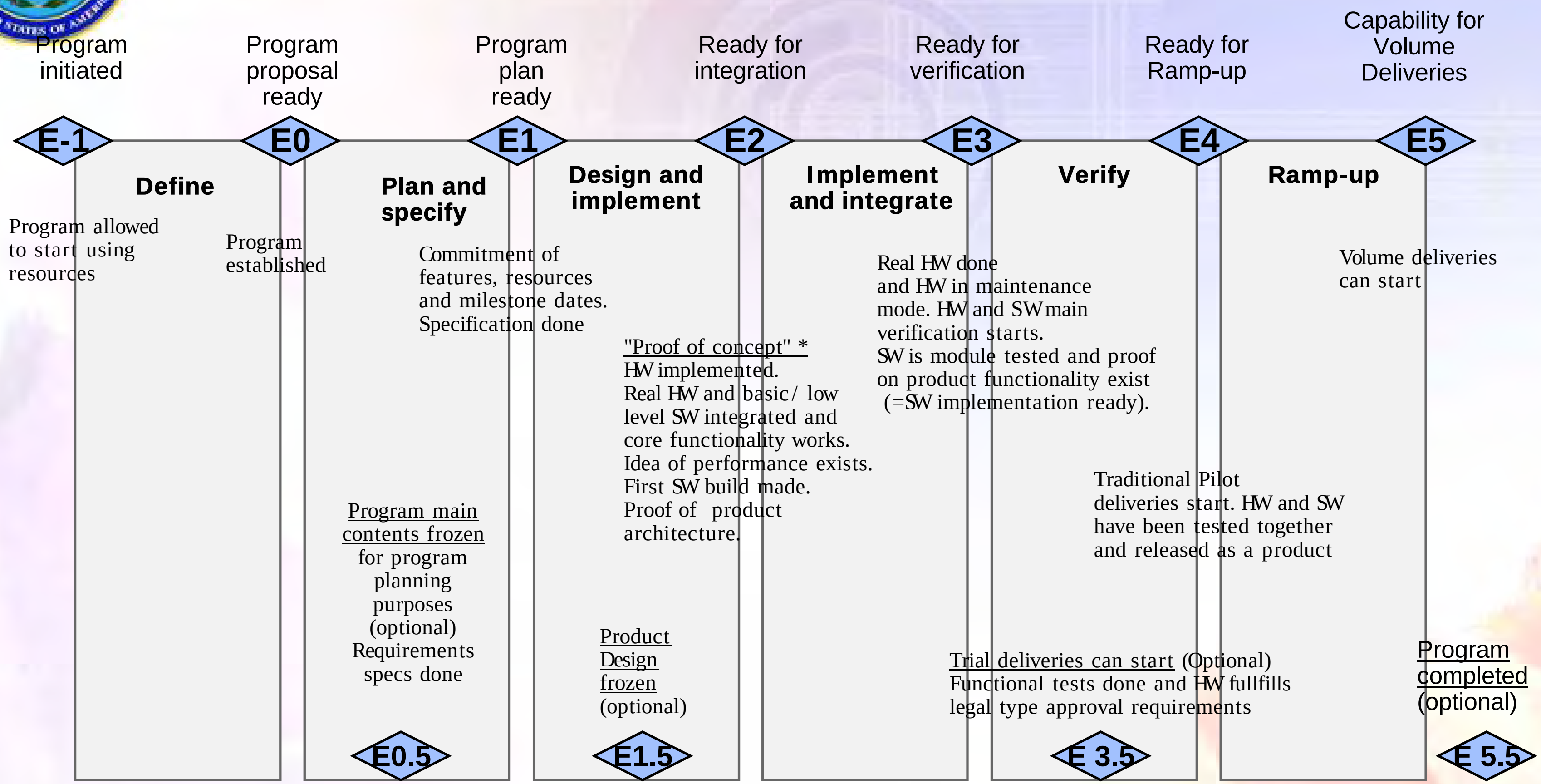
A Simpler View!



System Design Life Cycle Models:
An Automotive Example (VOLVO Car Corporation)



System Design Life Cycle Models:
A Telecom Example (NOKIA Networks)



Optional Milestones can be moved.
I.e. E1 and E1.5 dates can be the same.

* Core functionality can be I.e. control plane, signal goes through (typically not call yet). Exact contents of core functionality is need to be defined in E1

System Design Life Cycle Models:
A Workstation Example (SUN Microsystems)

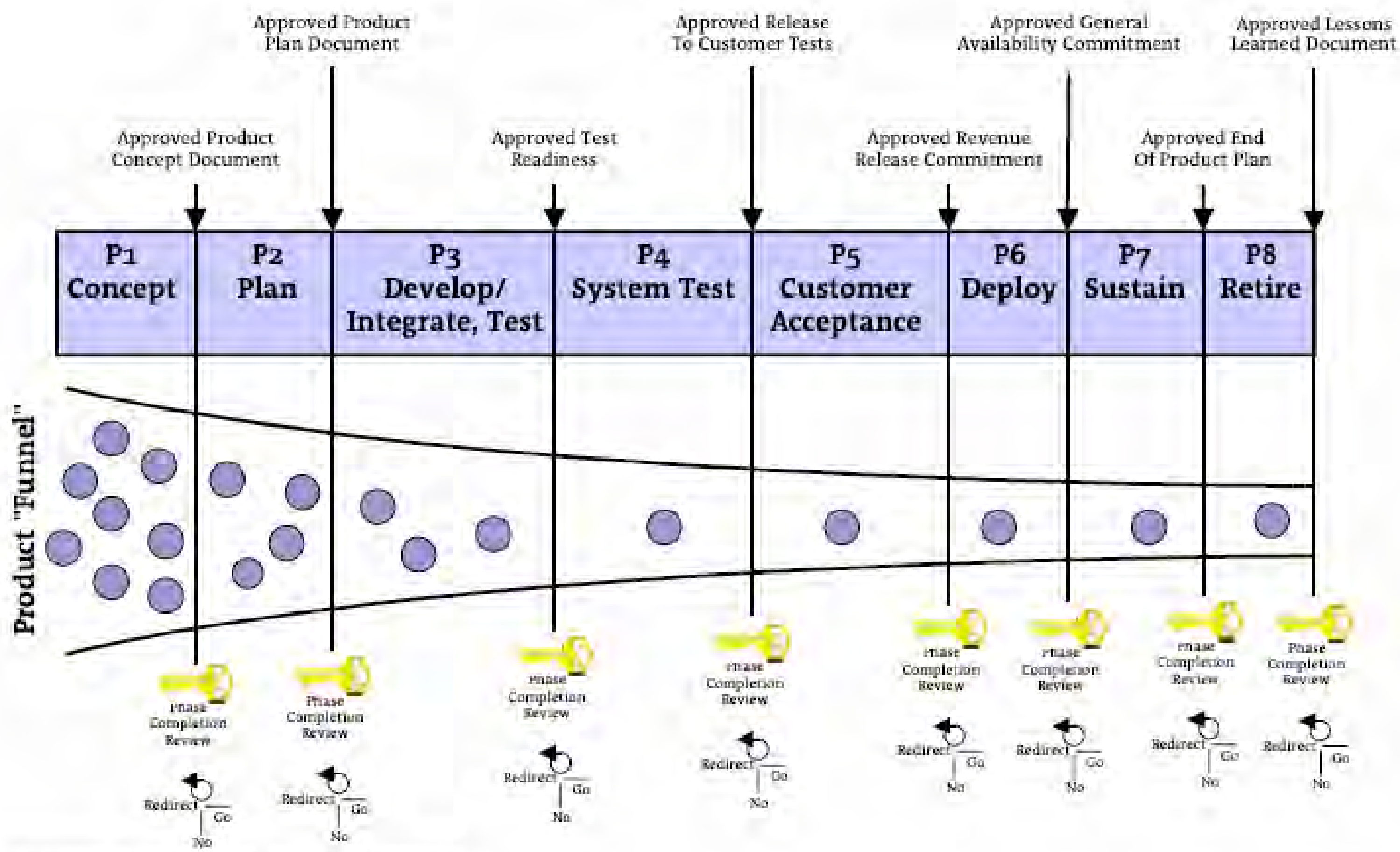
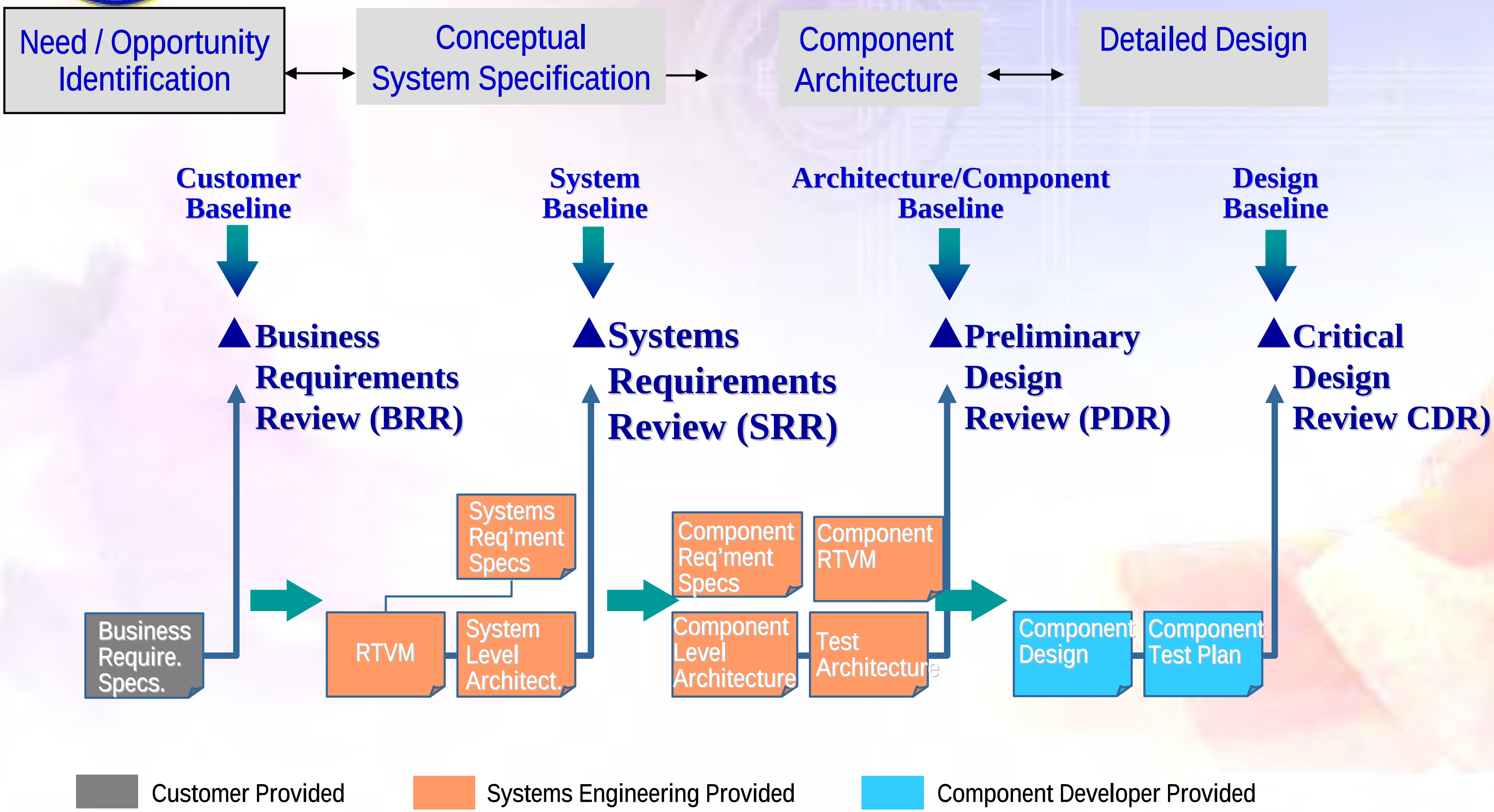


Illustration 1 - Sun PLC Process Overview

The IBM AMS Systems Engineering Process defines deliverables and a series of Reviews (I)



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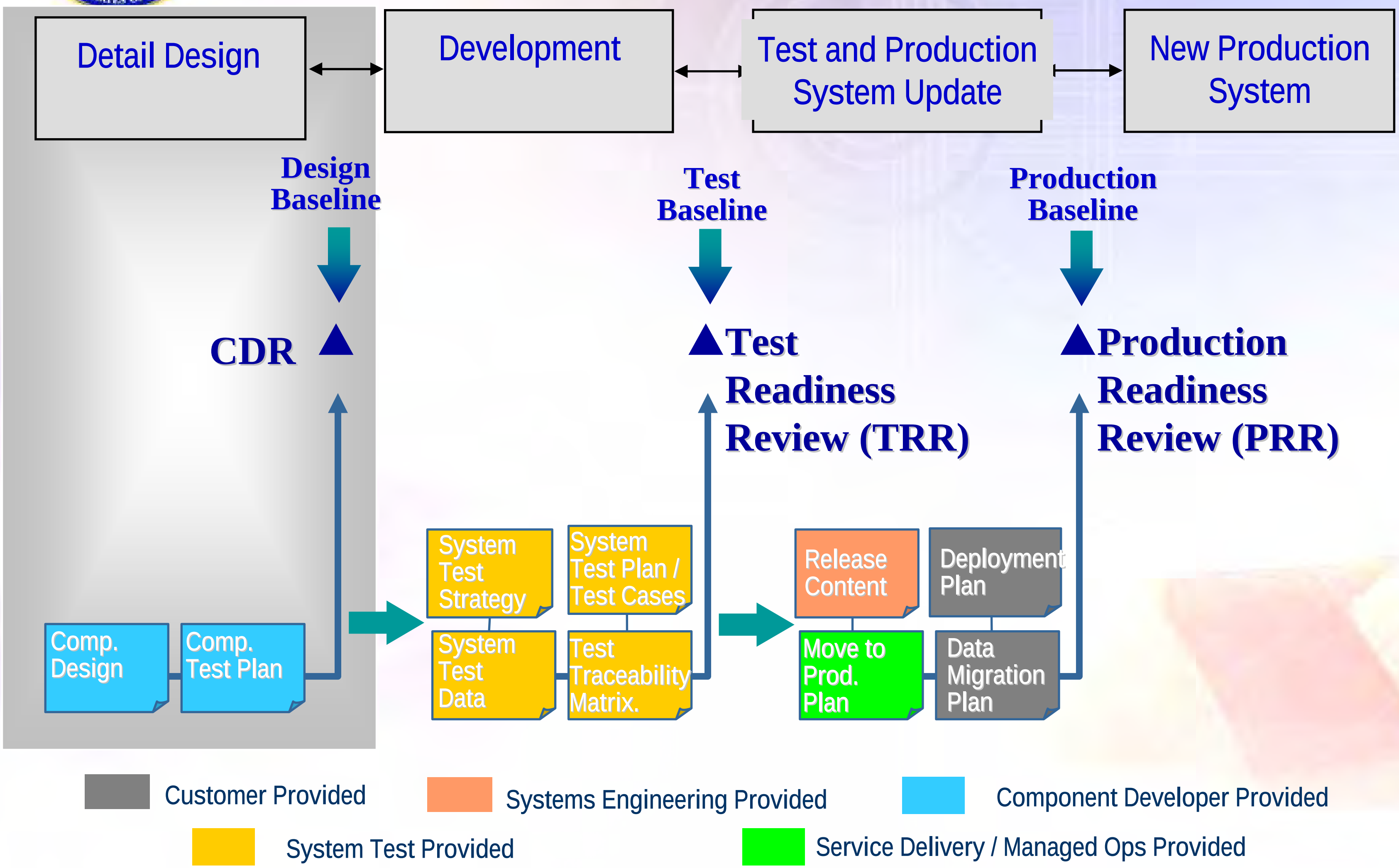
The IBM AMS Systems Engineering Process defines deliverables and a series of Reviews (II)



10

Simple Translation…

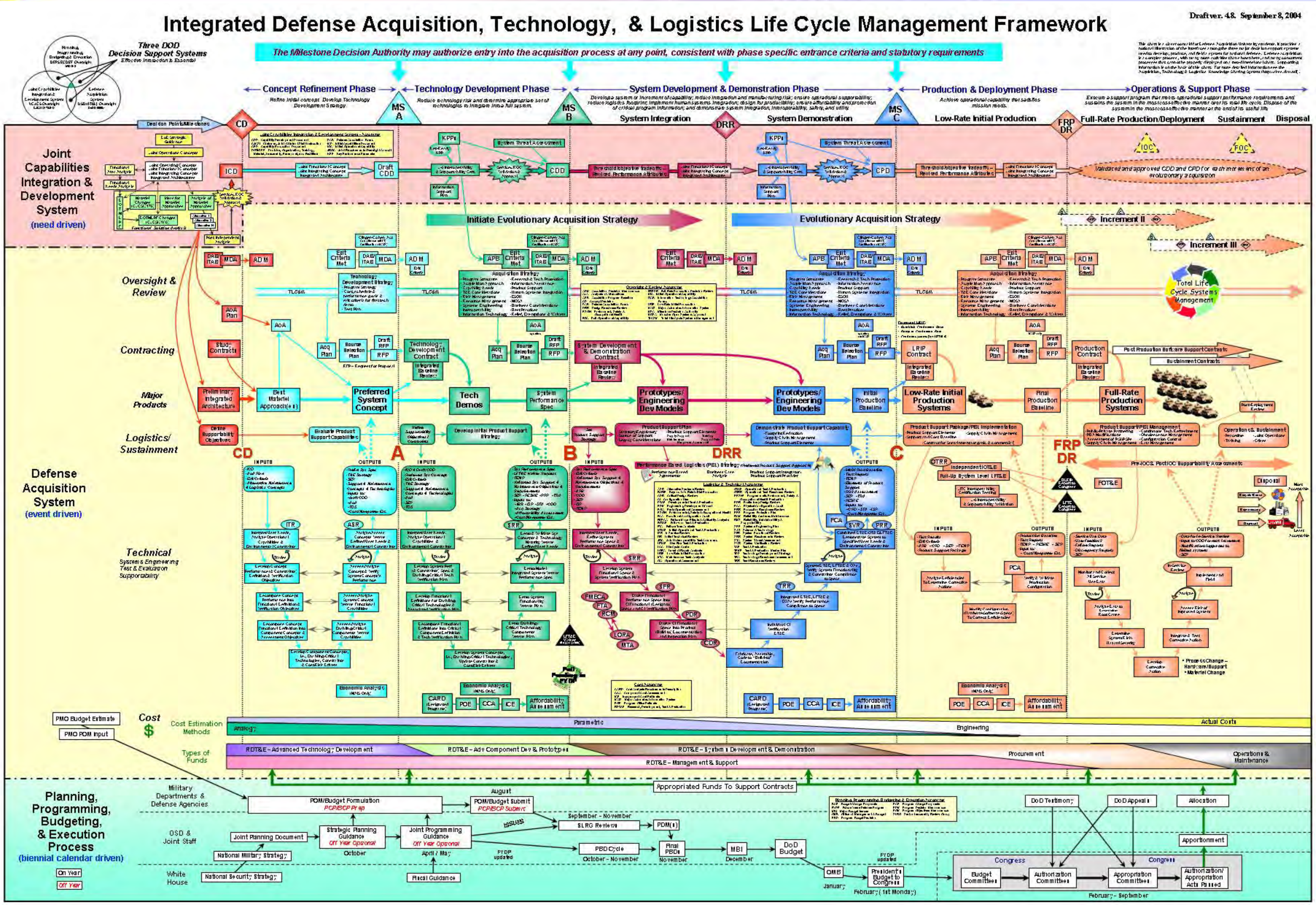
- Systems Engineering is "problem solving and solution delivery." A key pre-requisite to good "problem solving" is good "problem definition." Now this has other pre-requisites!
- Some key best practices:
  - Early phases:
    - Translating customer needs (business and technical) into key acceptance criteria - 5 to 7 critical customer requirements agreed to in measurable/testable form.
    - Identifying requirements and then managing them (and tracing them) through the subsequent development, integration, testing, deployment, and support phases.
  - Middle phases:
    - Translating the requirements into an "architecture" that becomes a "linkage" between what the customers want and what the developers will build… the concept of an architect as the linkage between the homeowner and the builder.
  - Latter phases:
    - Developing a test architecture, test plans and procedures that are traceable to the requirements for maximum focus and efficiency

Sounds very simple! A lot of organizations have developed processes that attempt to capture the above intent. But very few are able to execute it…

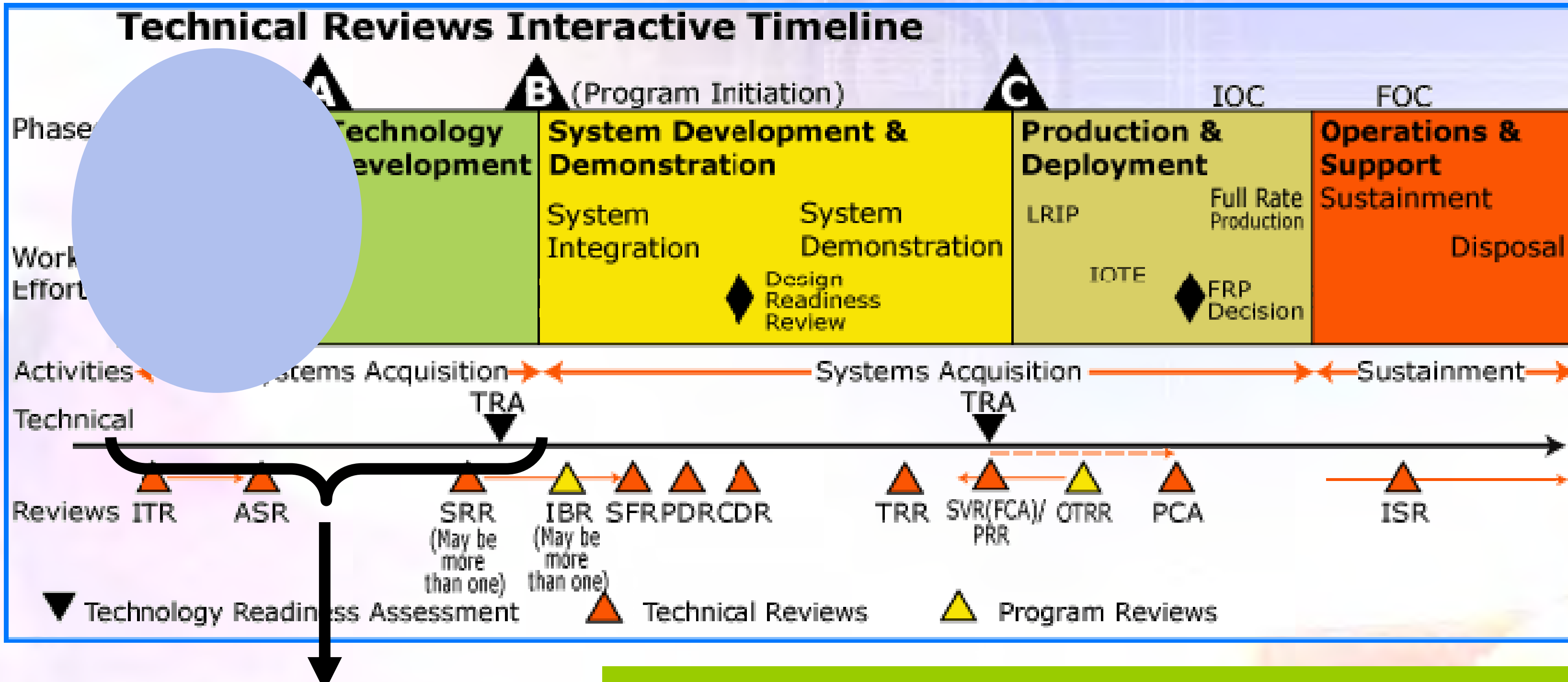
Successful implementation of SE needs...

- **The process must be "productized" for efficient implementation**
  - Globally consistent templates and processes,
  - Uniform and consistent metrics and lexicon (part of the SE culture)
- **Focus must be on the "necessary" and critical subset of the overall methodology and theory (Flexibility and Adaptability)**
  - Tailoring for time-to-market considerations
  - Tailoring for schedule and resource considerations
  - Risk tolerance must be explicitly considered in the tailoring process
- **Implementation must be organizationally supported and nurtured**
  - Linkage to strategic organizational goals is key
- **A well managed competency development program and a "community of practice**

One Response



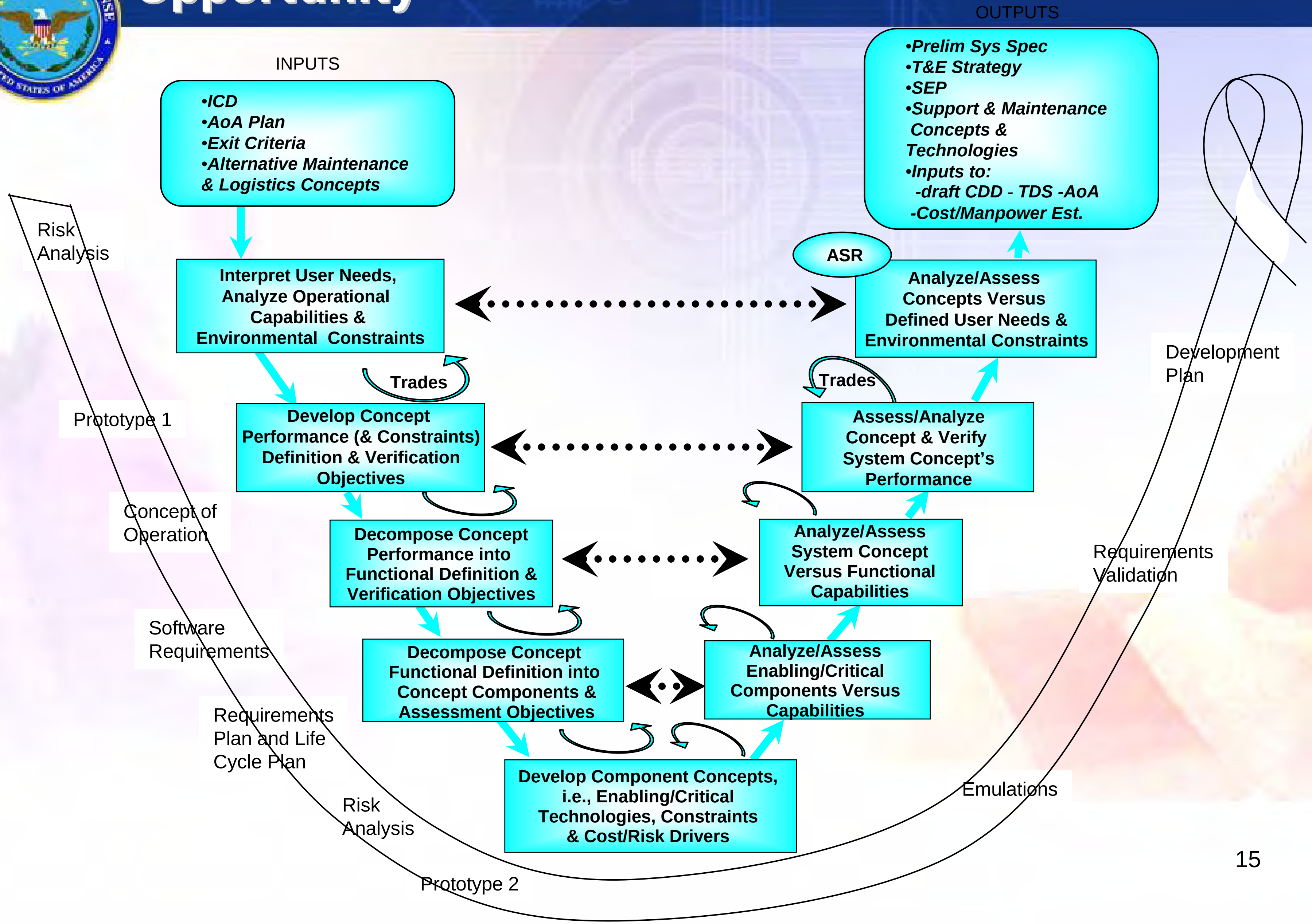
A Simpler View!



System Readiness Levels, instead of Technology Readiness Levels

TRL scale is a measure of maturity of an individual technology, with a view towards operational use in a system context. A more comprehensive set of concerns become relevant when this assessment is abstracted from an individual technology to a system context, which may involve interplay between multiple technologies. Such concerns include system-level integration and test, human factors (with an emphasis on information and data), and sustainability/**supportability**.

Concept Refinement Phase – The Initial Opportunity



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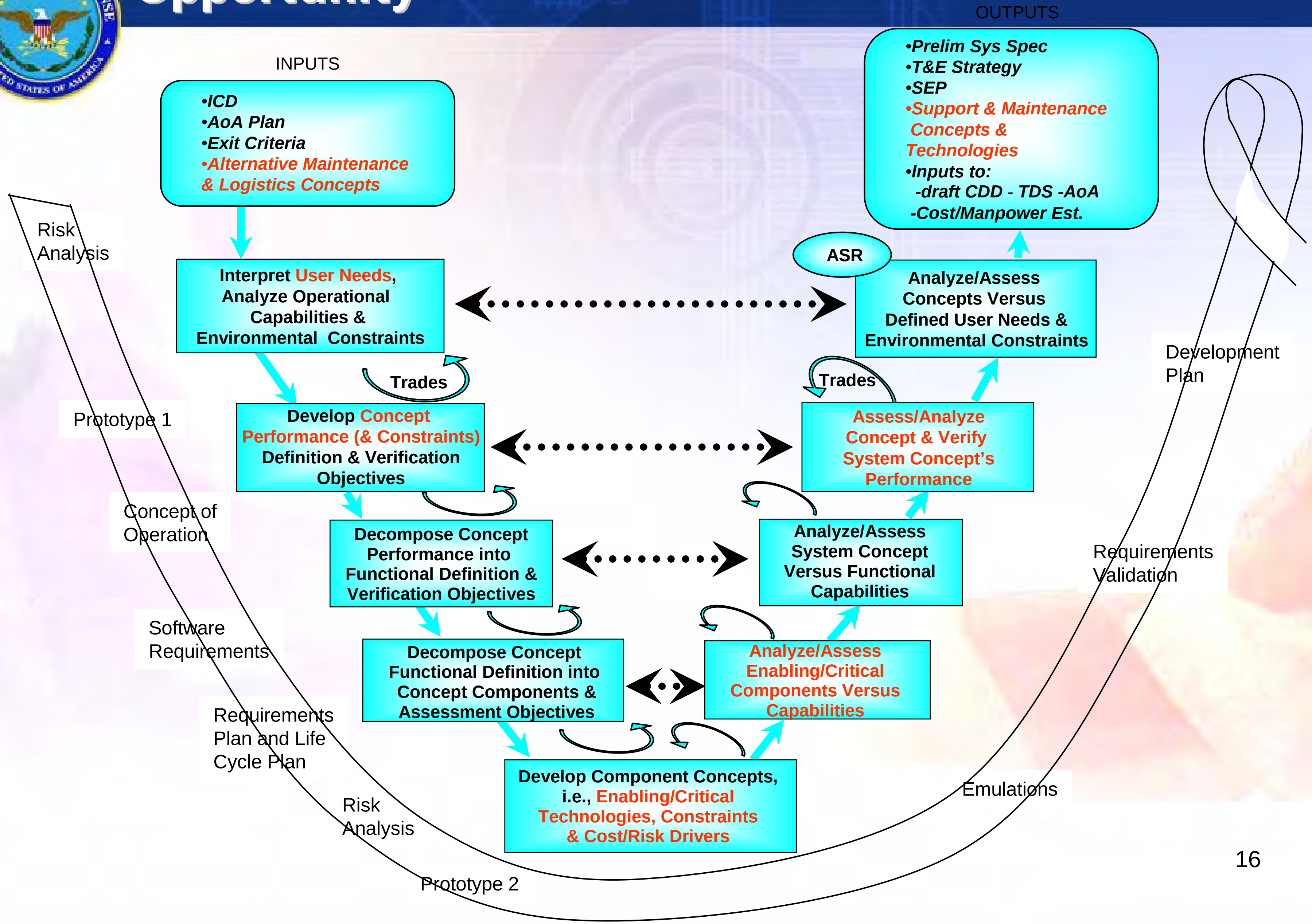
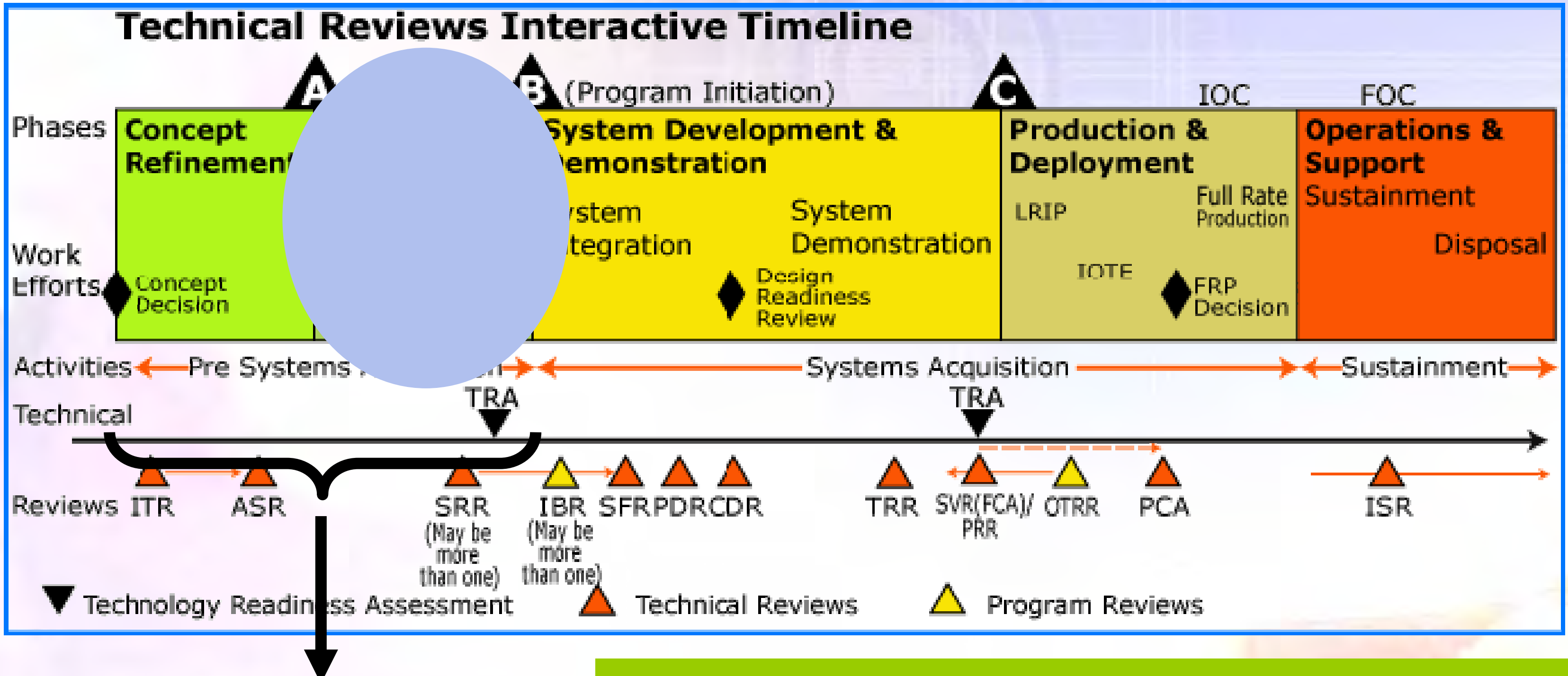


A Simpler View!



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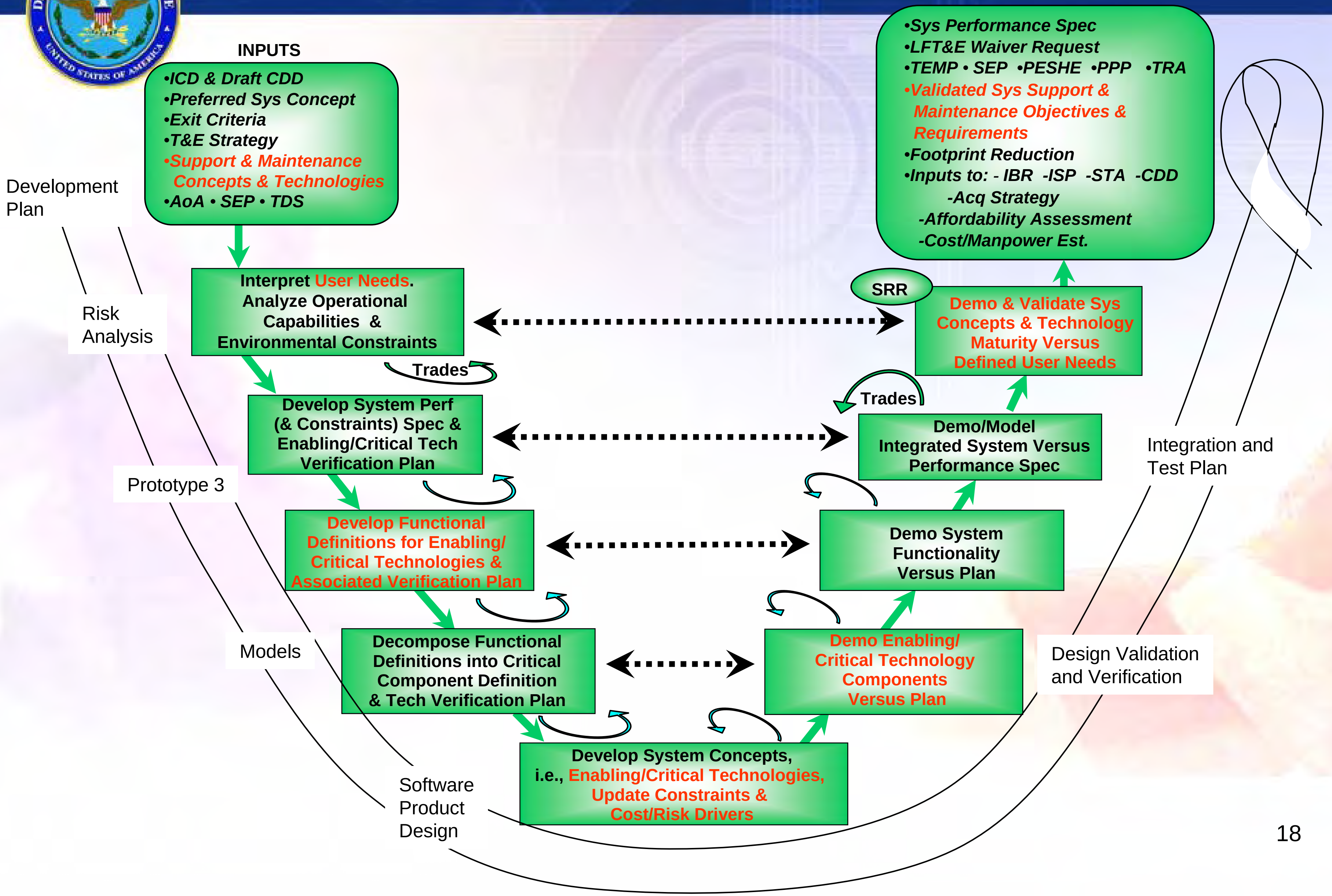
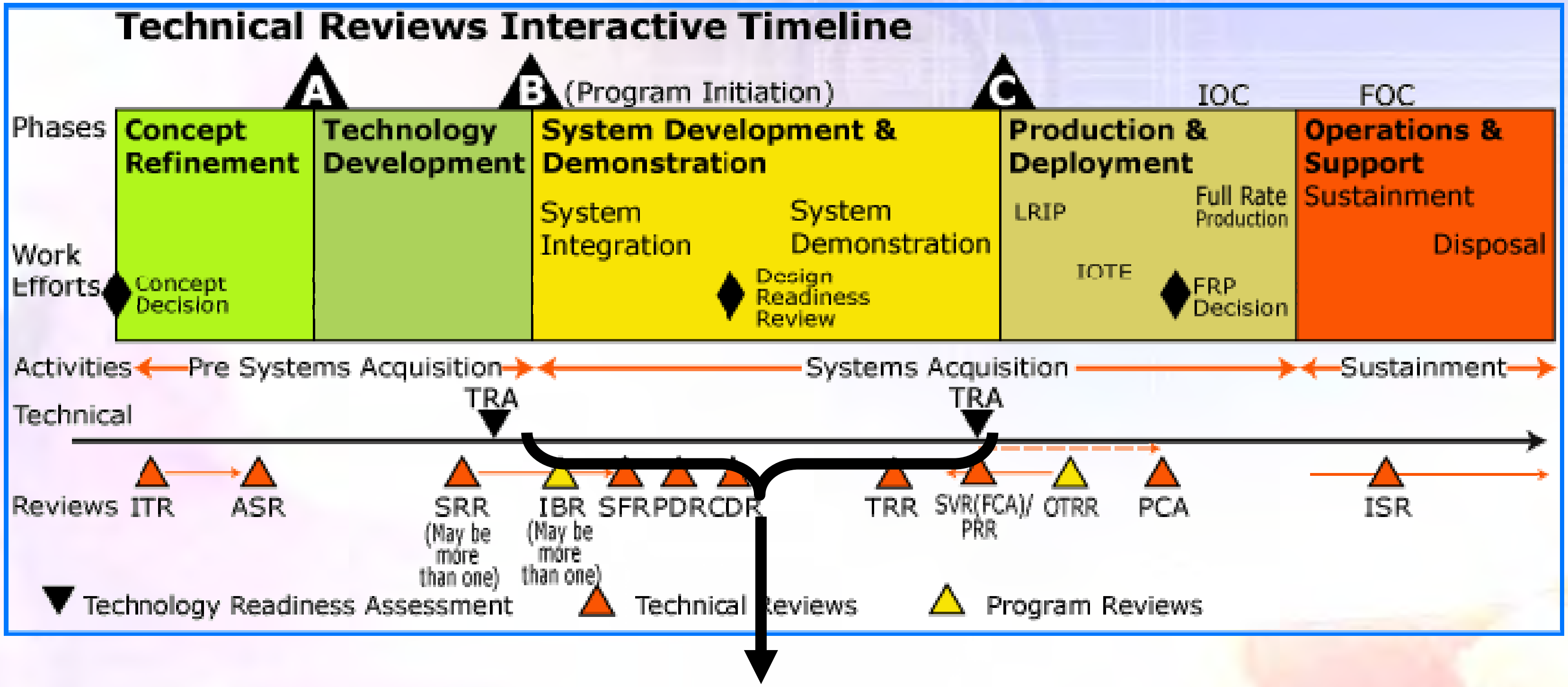
Technology Development Phase – Capitalize on the Initial Assessments



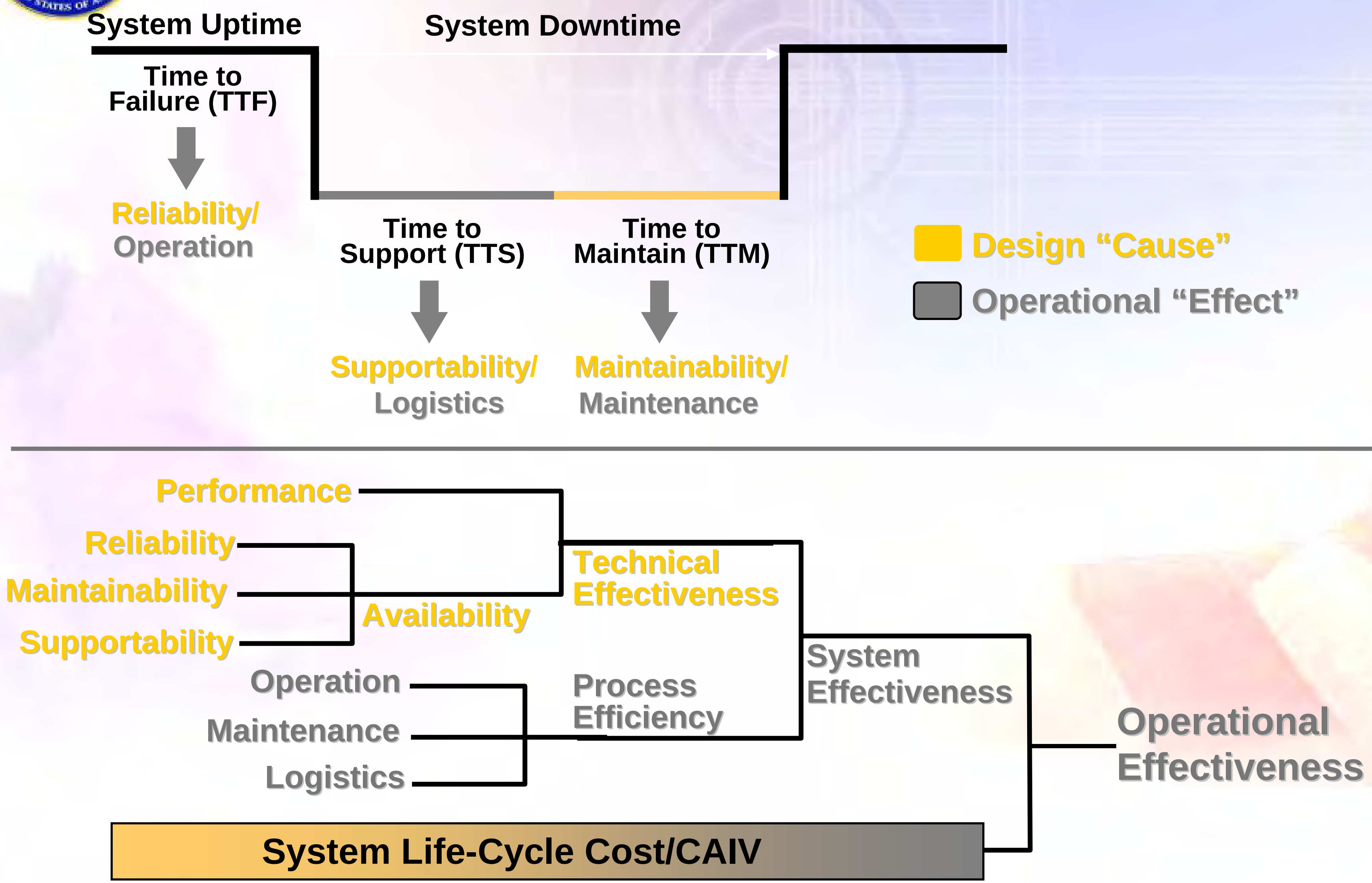
A Simpler View!



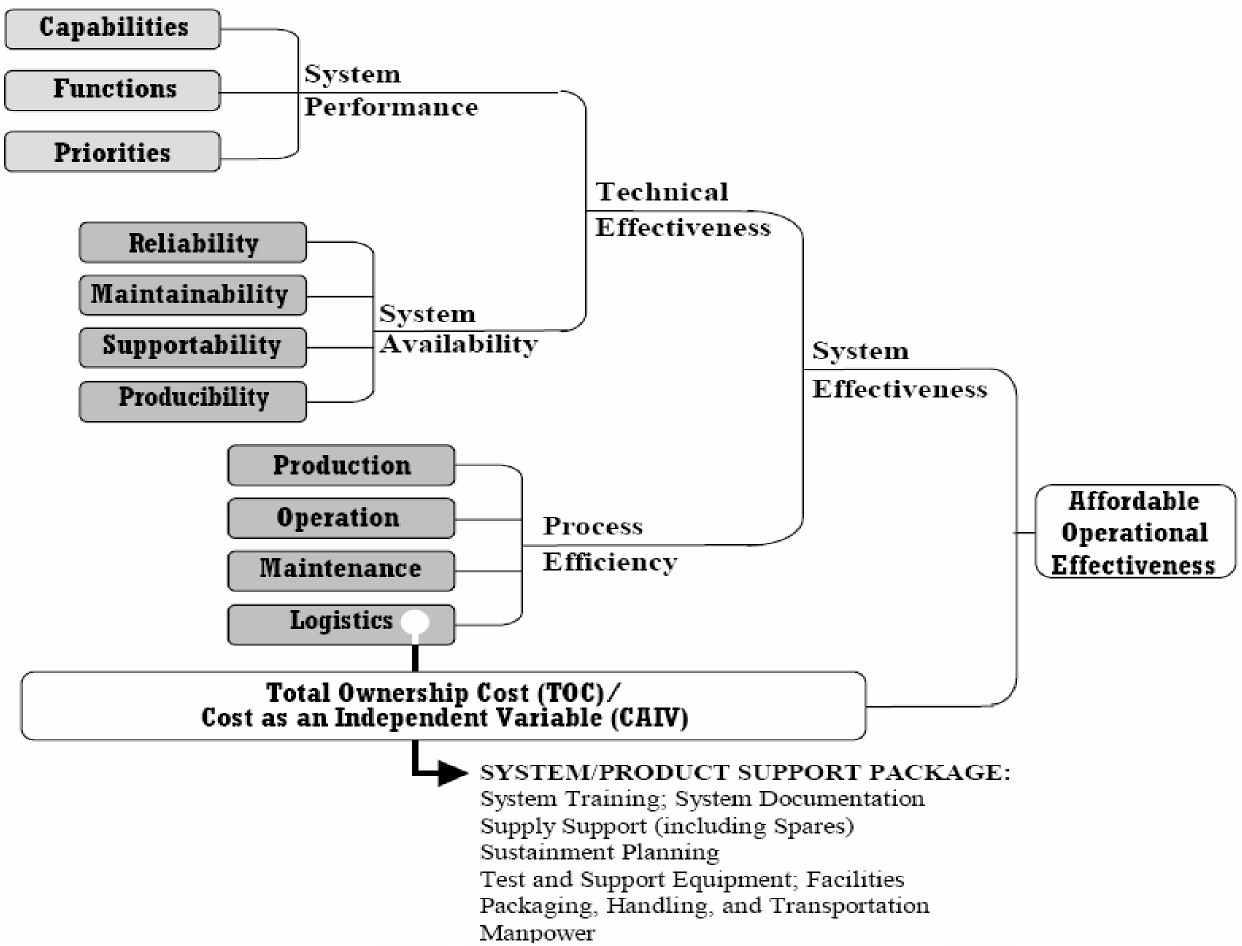
System Design for Operational Effectiveness, instead of just System Design

This was the emphasis in the Supportability Guide. This concept is also inherent in the Defense Acquisition Guide (DAG)

Design for System Operational Effectiveness



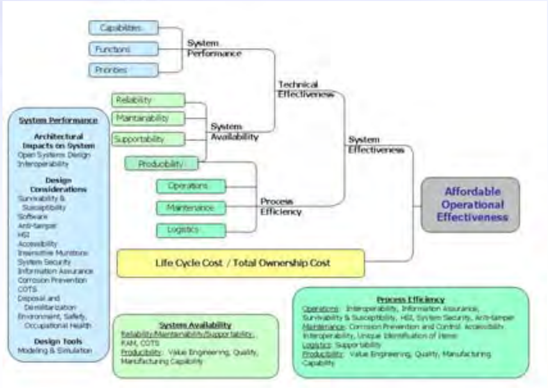
SDOE Components and Relationships



As articulated in the Supportability Guide…

SE Decisions: Important Design Considerations
Defense Acquisition Guidebook; Chapter 4, Section 4.4

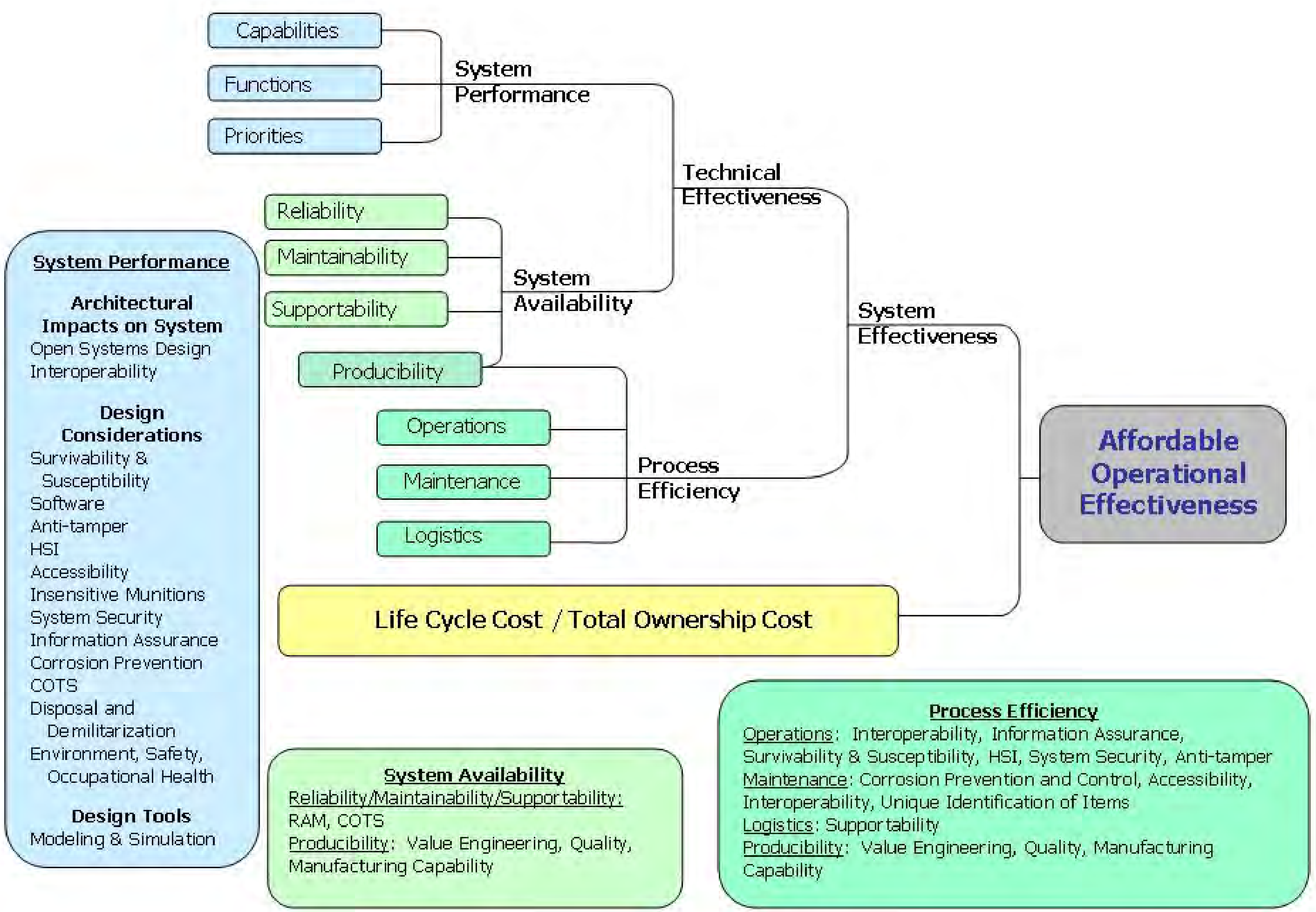
- SE must manage all requirements as an integrated set of design constraints
  - KPPs
  - Statutory
  - Regulatory
  - Derived performance requirements
    - Constraints
    - Usage, duty cycle, mission profiles



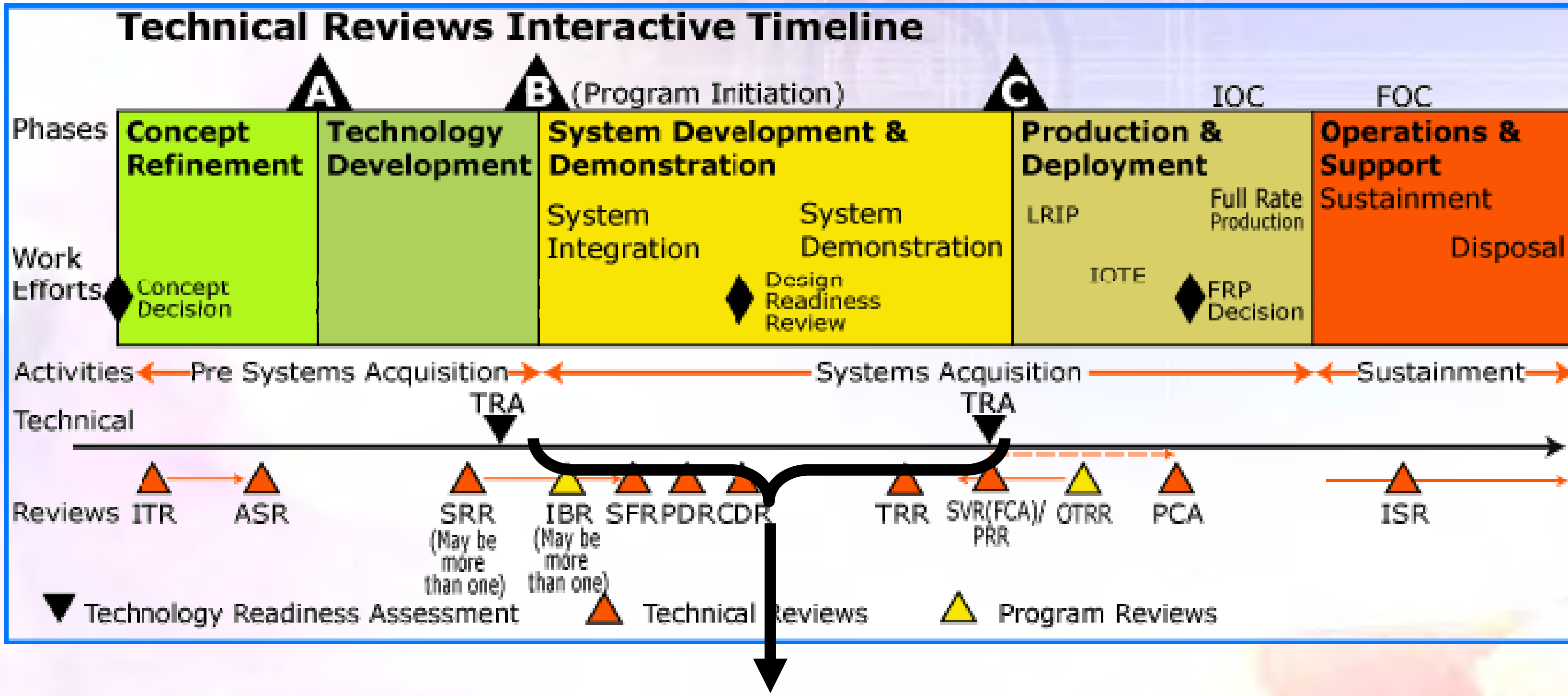
- Decomposition and allocation must address entire set at each level of recursion
- Integrated set of requirements and associated stakeholders are a primary driver for program staffing (non-trivial and a major source of program risk)

As articulated in the Defense Acquisition Guide...

Important Design Considerations "The Fishbone"



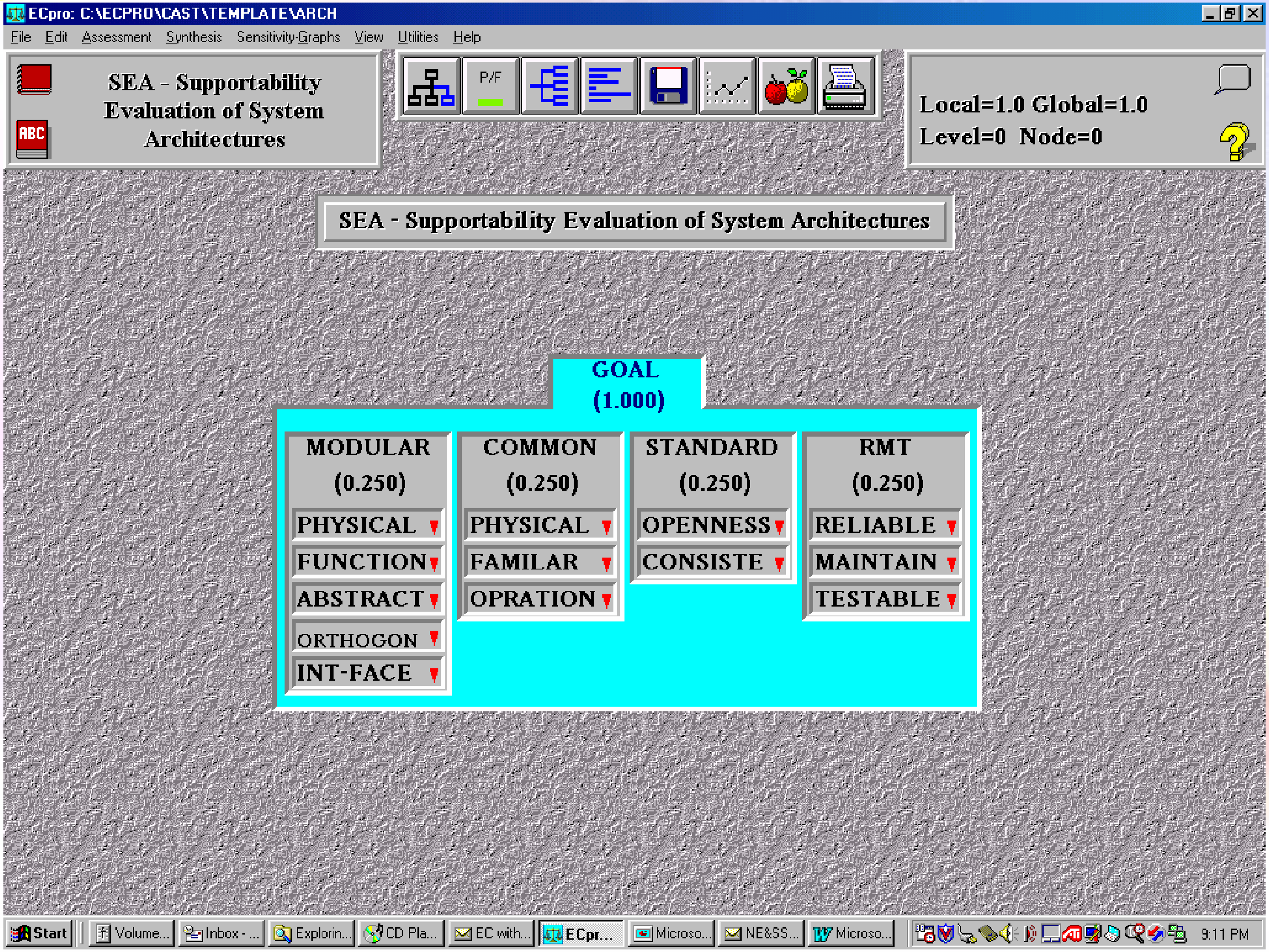
A Simpler View!



System Design for Operational Effectiveness, instead of just System Design

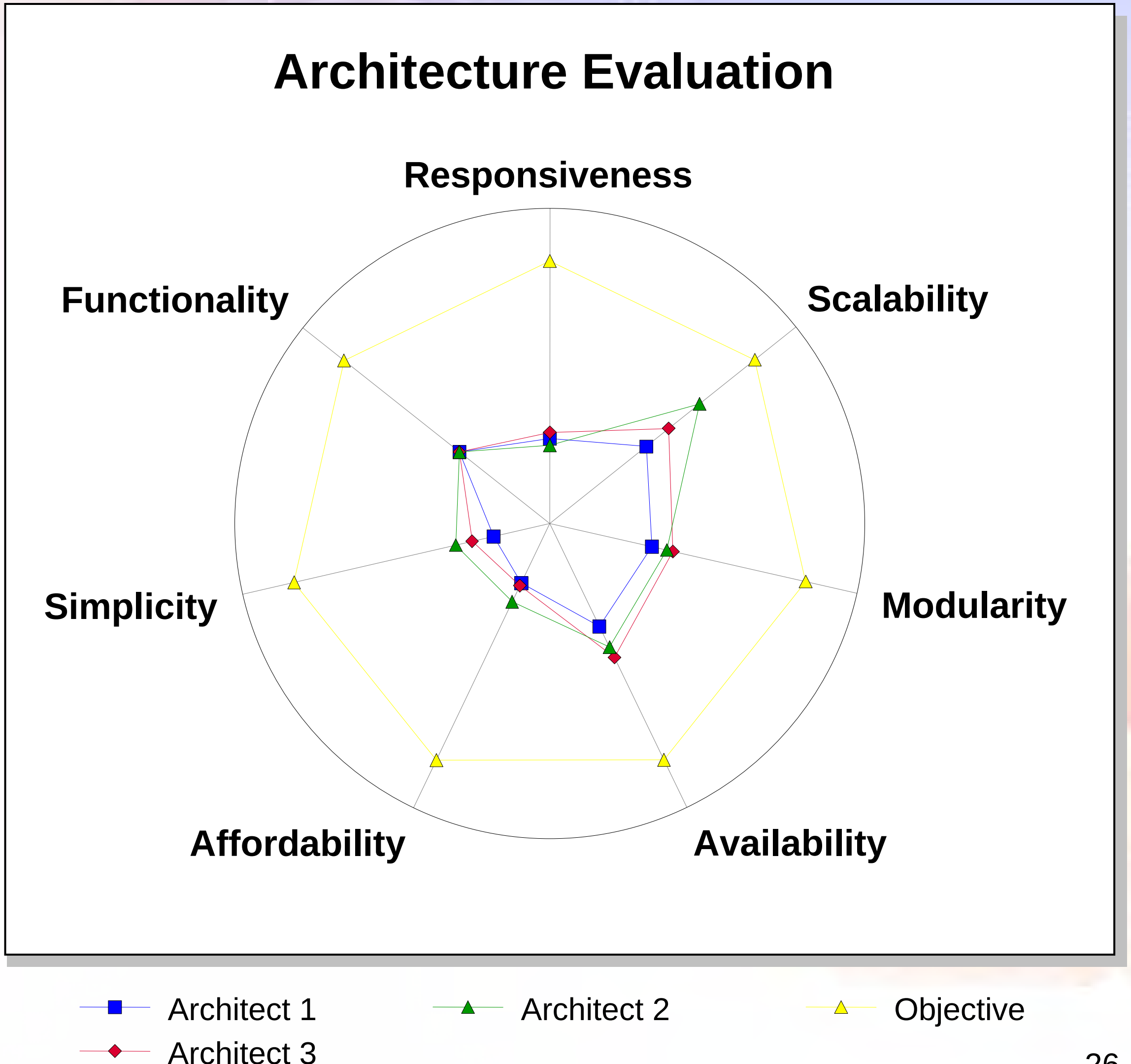
Let us consider System Architectures to illustrate the concept…

Evaluating Architectures from a Sustainment Perspective – Industry Sponsorship (COTS Focus)



Architecture Development:
Architecture Assessment and Evaluation – IT Context

- Architecture assessment conducted by three senior architects knowledgeable about the system
- Created a baseline for comparison with other alternatives
- Architectures are a strategic tool in today's environment for increased competitiveness and profitability
- Good requirement definition, understanding of stakeholder/customer expectations is key



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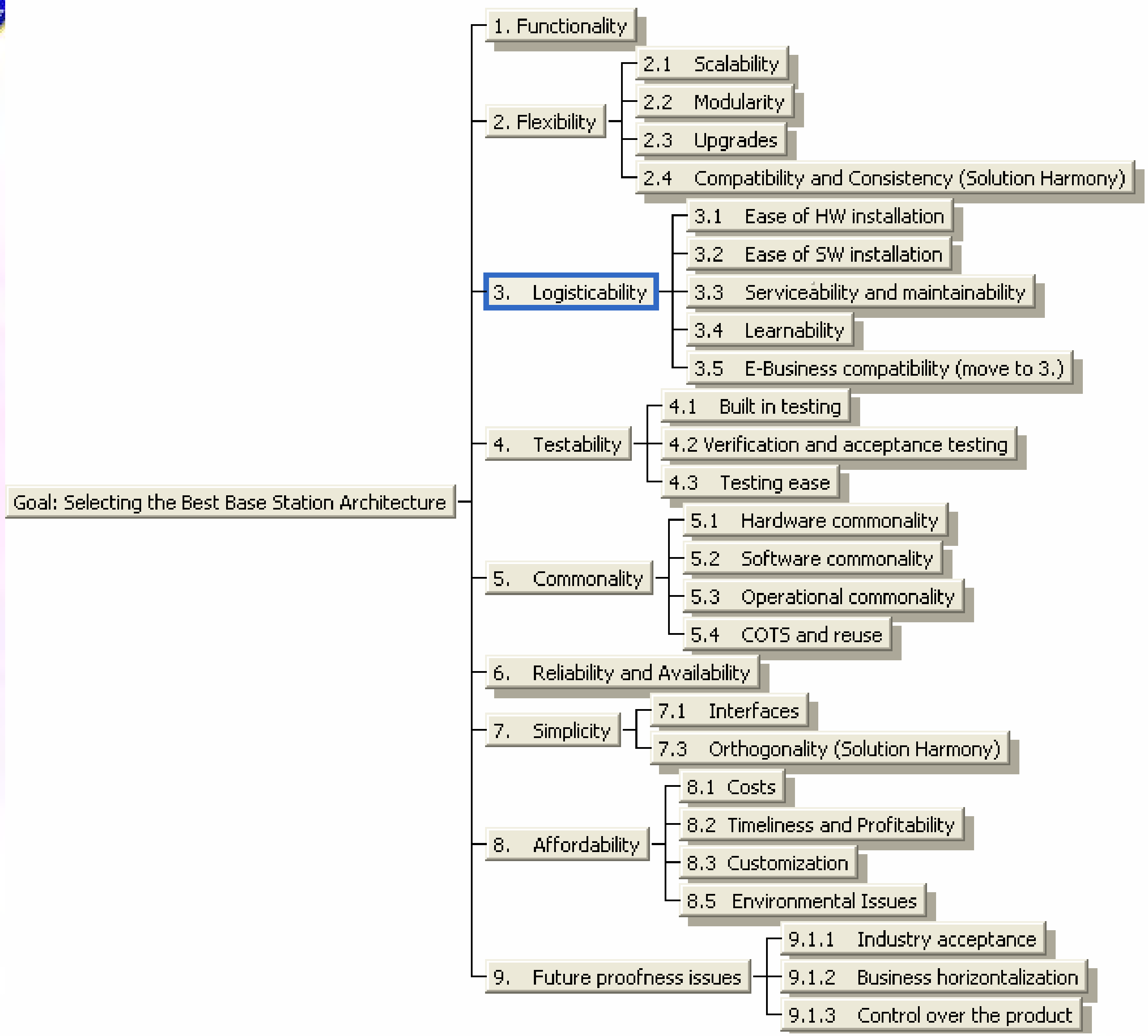
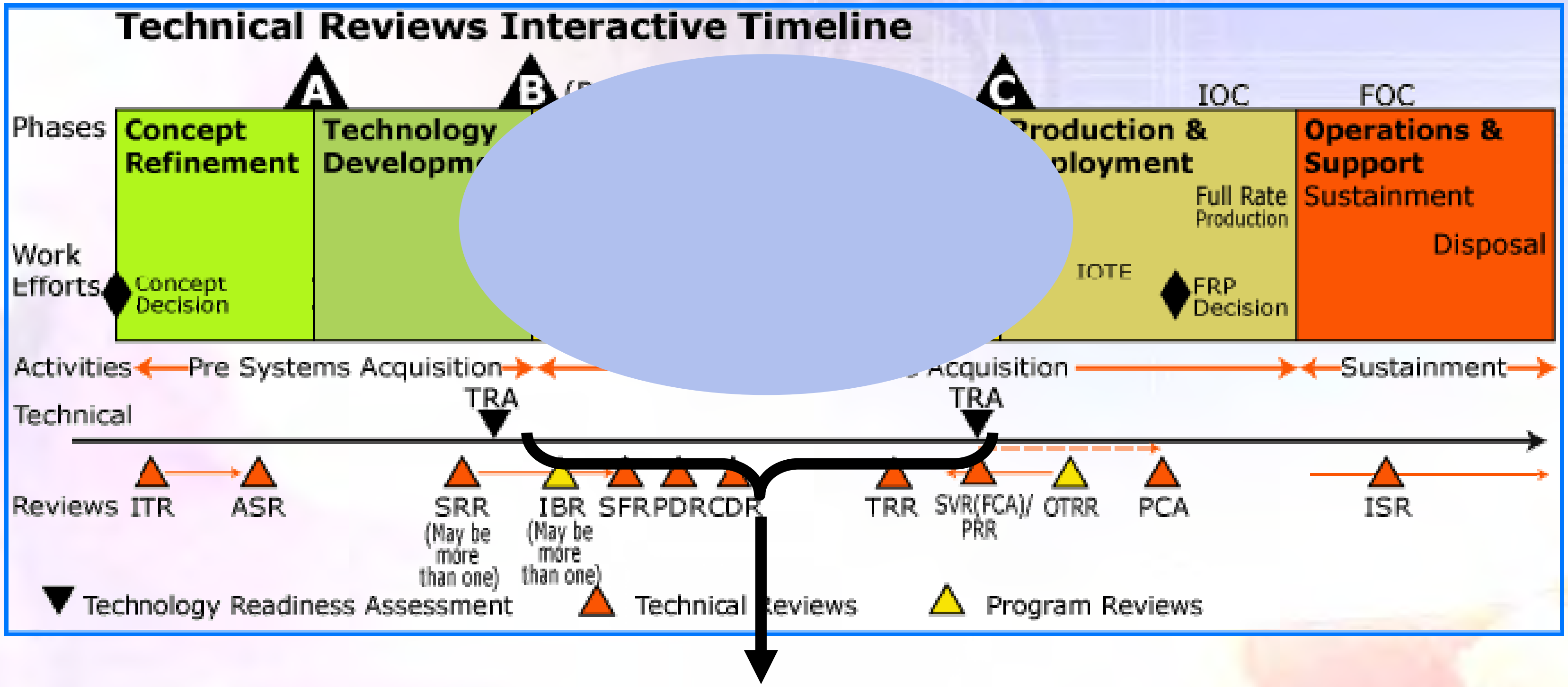
Architecture Development:
Architecture Assessment and Evaluation – Telecom



A Simpler View!



System Design for Operational Effectiveness, instead of just System Design

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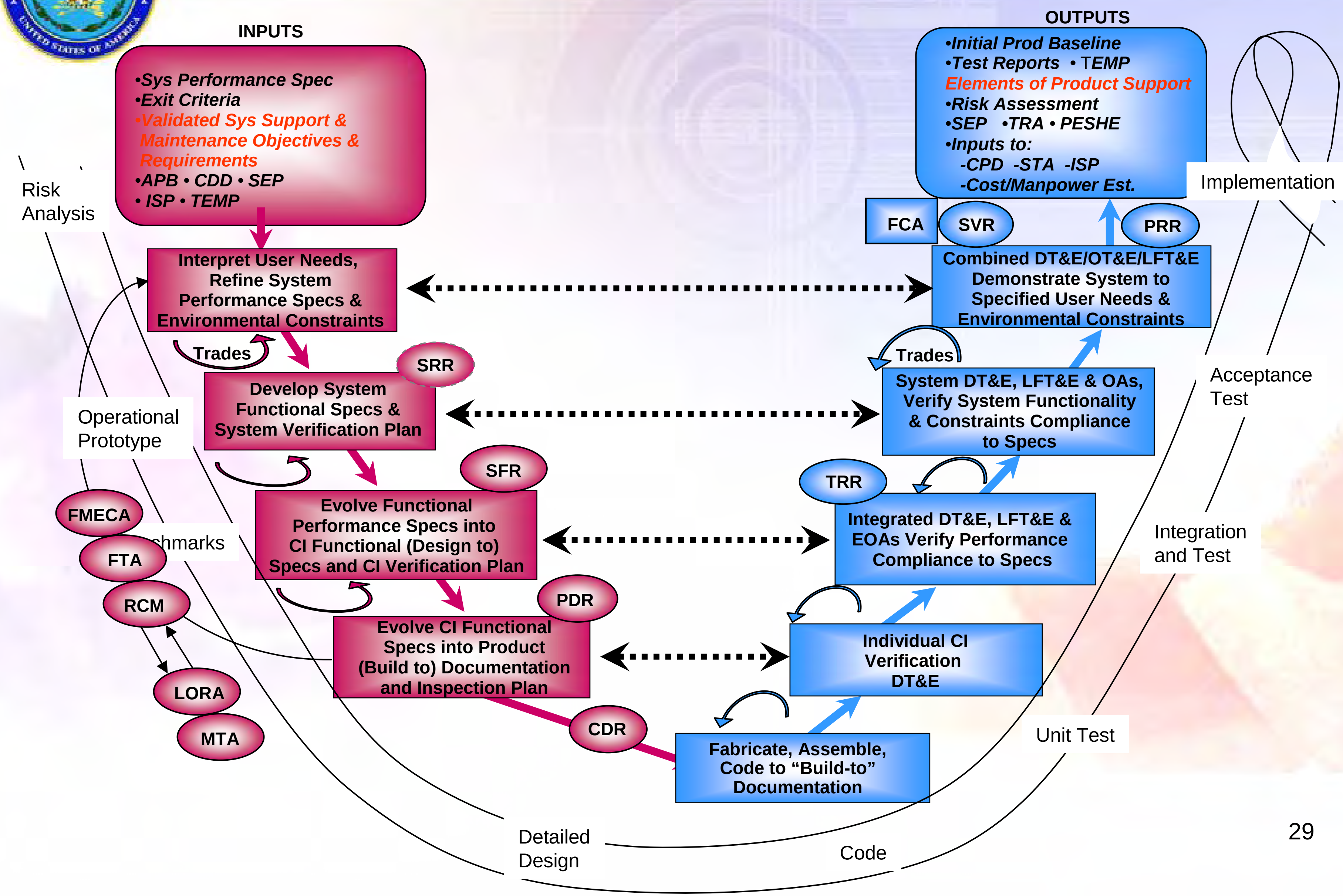
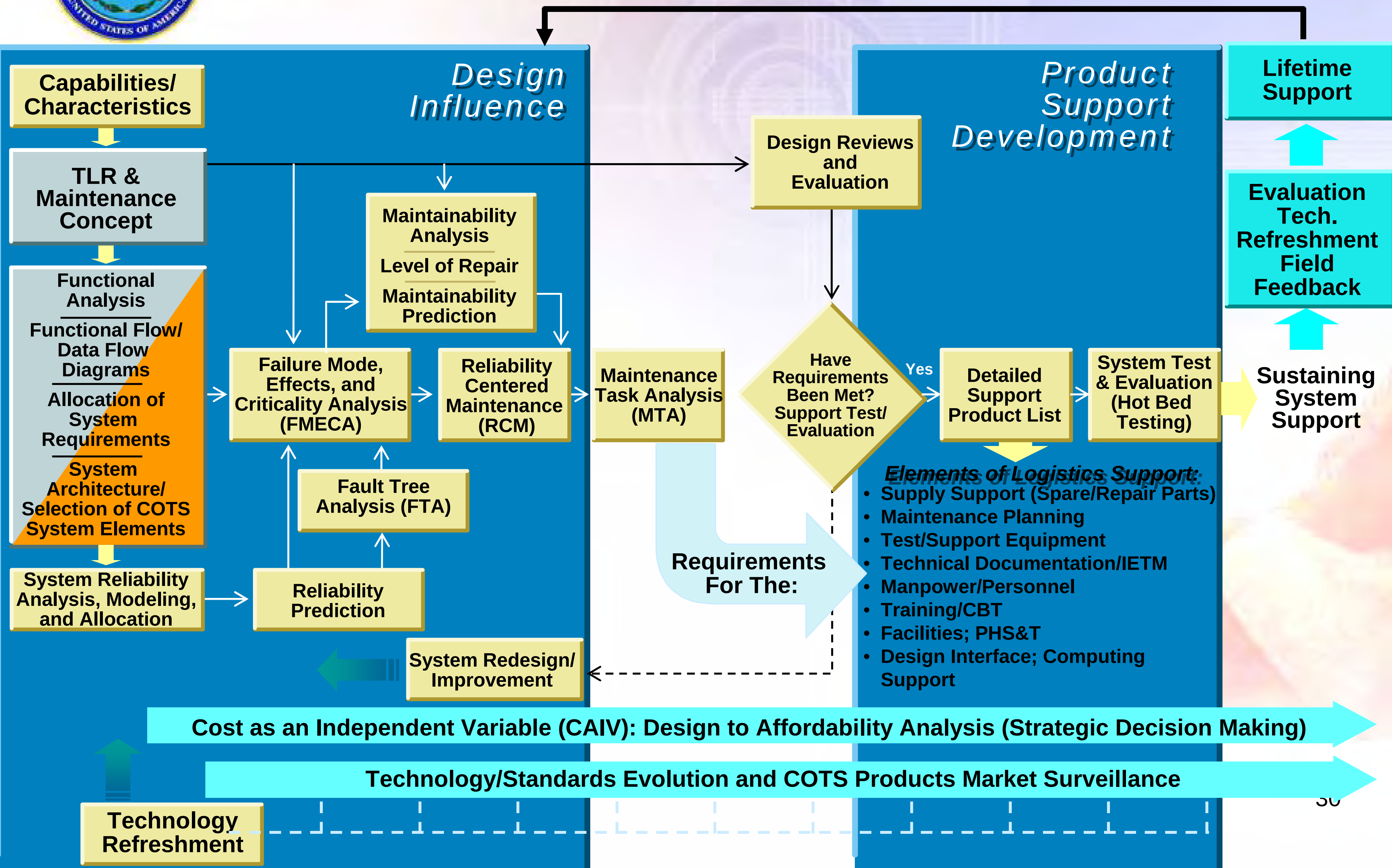
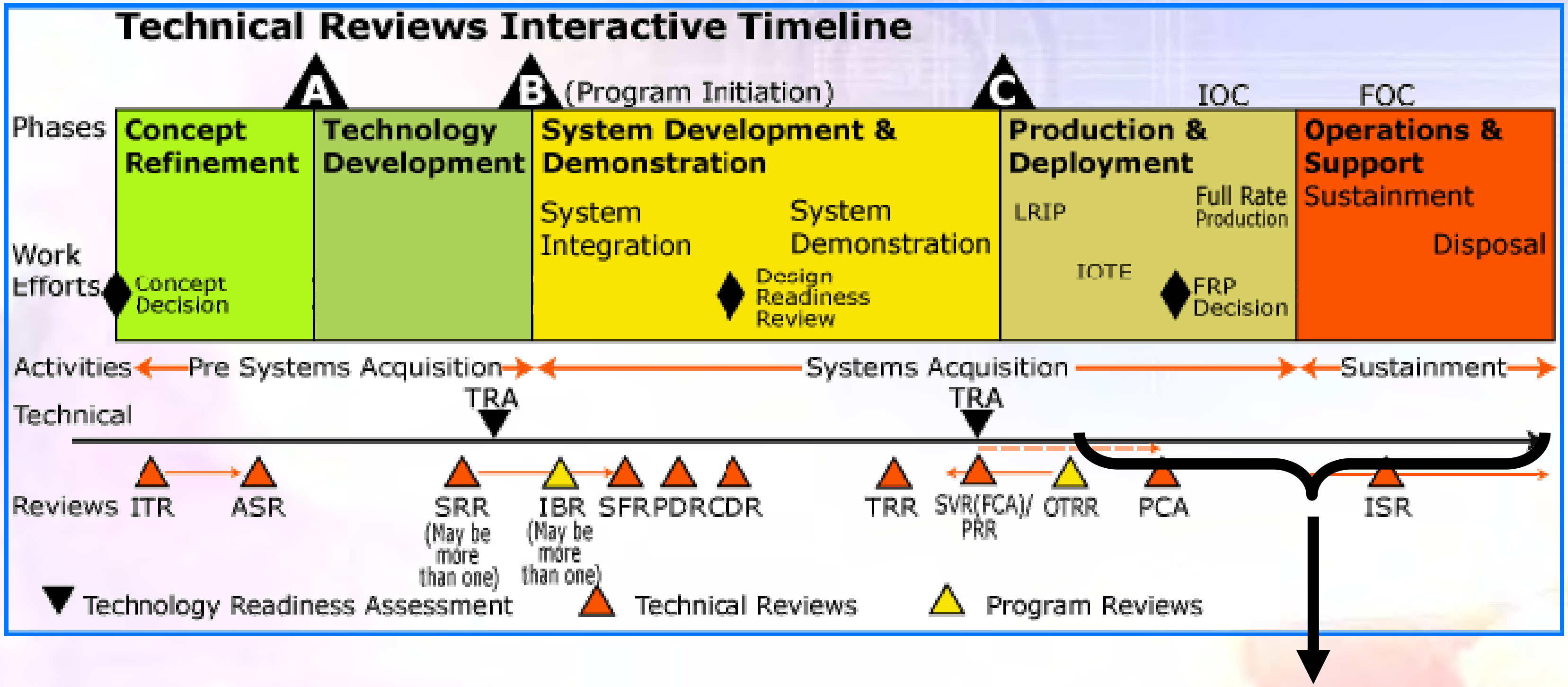
System Development and Demonstration Phase



Systems and Supportability Engineering Process



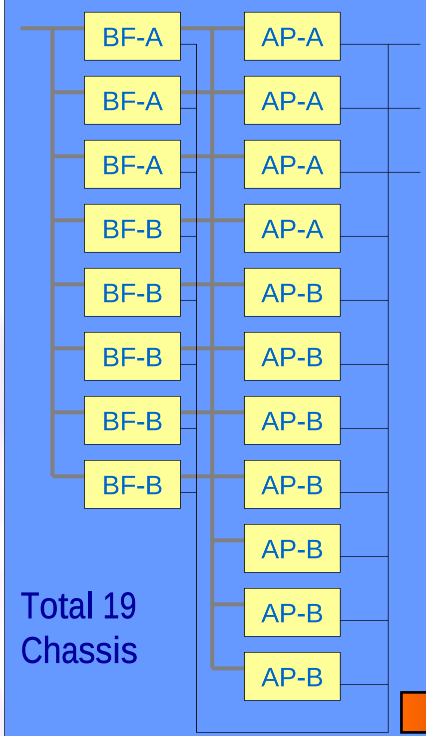
A Simpler View!



Performance Based Logistics, instead of just Material Readiness, Spares Optimization, and the like…

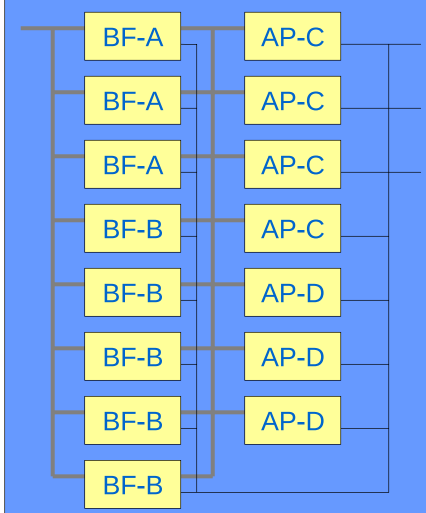
Current Trends in System Development:
COTS, Reusable and Common Platforms and Components

Reference Configuration



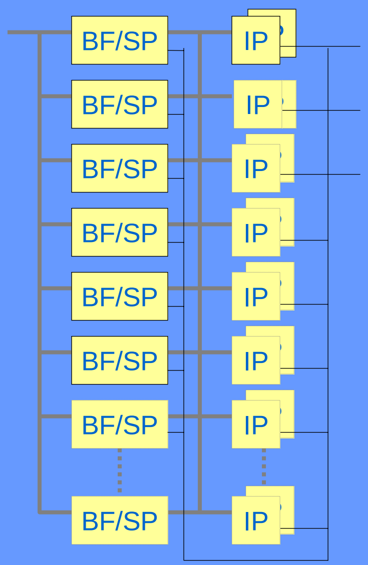
Total 19 Chassis

'98 Technology Update



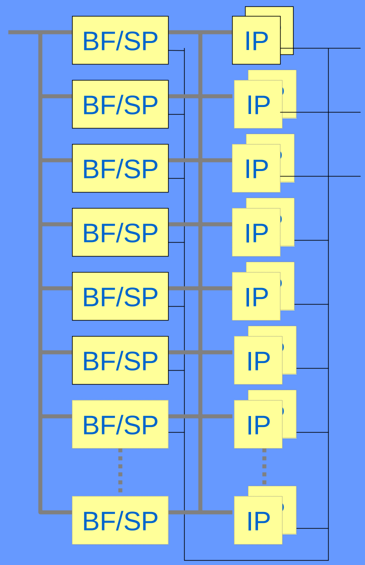
Total 15 Chassis

'00 Technology Update



Total 7 Chassis

Technology Refresh



Total 7 Chassis

Processing Summary
1995-Level Technology

8 Beamformers - 75 GOPS

11 Allocatable Processors - 65 GOPS

Total Throughput - **140 GOPS**

Processing Summary
1998-Level Technology

8 Beamformers - 75 GOPS

7 Allocatable Processors - 75 GOPS

Total Throughput - **150 GOPS**

Processing Summary
2000-Level Technology

6 BF/Signal Processors - 240 GOPS

2 Information Processors - 30 GOPS

Total Throughput - **270 GOPS**

Processing Summary
2003-Level Technology

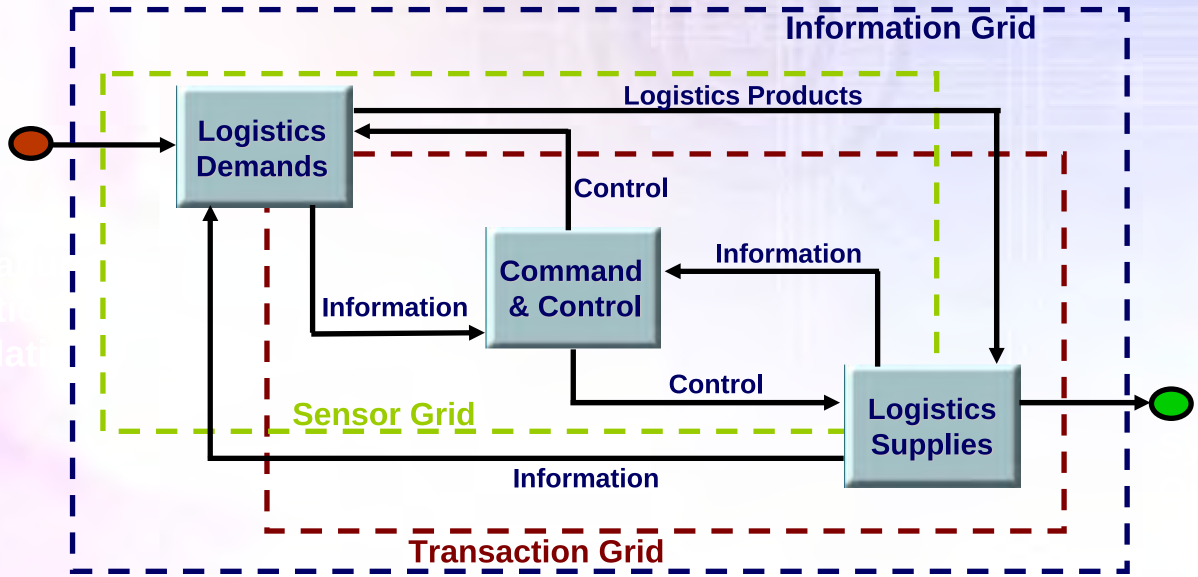
6 Beamformers - 380 GOPS

2 Information Processors - 50 GOPS

Total Throughput - **430 GOPS**

Current Trends in System Development:

Network Centric Warfare must be supported by Network Centric Logistics Planning



Sense demands and requirements at the Equipment Level . . .

Supply at the Fleet Level (Cross Platform) . . .

The Metrics...

- Operational Availability
- Operation Reliability
- Cost per Unit Usage
- Logistics Footprint
- Logistics Response Time

Multi-Asset, Multi-Echelon... Modeling and Simulation

An offer!!

Architecture Development:
Architecture Assessment and Evaluation – Telecom

- Goal: Selecting the Best Base Station Architecture
  - 1. Functionality
  - 2. Flexibility
    - 2.1 Scalability
    - 2.2 Modularity
    - 2.3 Upgrades
    - 2.4 Compatibility and Consistency (Solution Harmony)
  - 3. Logisticability
    - 3.1 Ease of HW installation
    - 3.2 Ease of SW installation
    - 3.3 Serviceability and maintainability
    - 3.4 Learnability
    - 3.5 E-Business compatibility (move to 3.)
  - 4. Testability
    - 4.1 Built in testing
    - 4.2 Verification and acceptance testing
    - 4.3 Testing ease
  - 5. Commonality
    - 5.1 Hardware commonality
    - 5.2 Software commonality
    - 5.3 Operational commonality
    - 5.4 COTS and reuse
  - 6. Reliability and Availability
  - 7. Simplicity
    - 7.1 Interfaces
    - 7.3 Orthogonality (Solution Harmony)
  - 8. Affordability
    - 8.1 Costs
    - 8.2 Timeliness and Profitability
    - 8.3 Customization
    - 8.5 Environmental Issues
  - 9. Future proofness issues
    - 9.1.1 Industry acceptance
    - 9.1.2 Business horizontalization
    - 9.1.3 Control over the product

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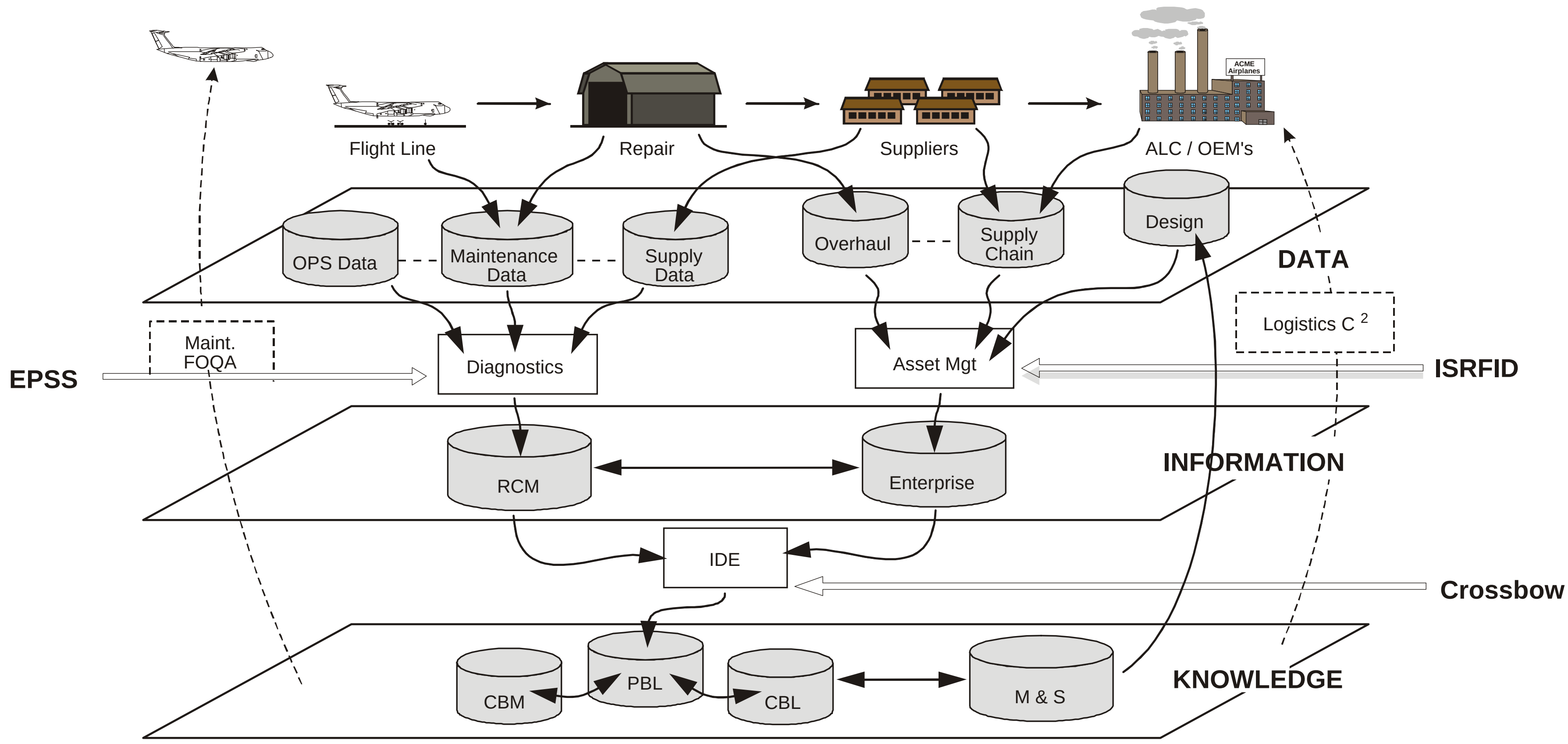
CoBaLt TECHNOLOGY

Presents

Condition Based Logistics

Condition Based Logistics Technology

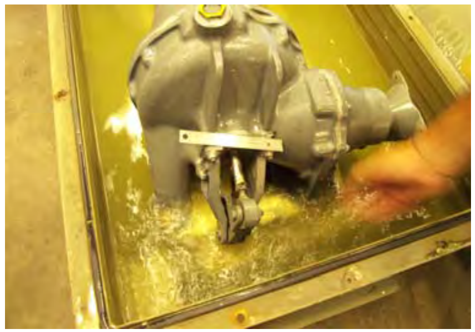


IMPROVE PERFORMANCE, ELIMINATE WASTE, REDUCE RESOURCES

Navy Aircraft Engine Container Situation

Water / Moisture Intrusion


H-46 Gear Box


H-3 Tail Rotor Gearbox

Corrosion Inside TF-34 Engine (S-3)

H-46 Transmission

Misidentified / Mislabeled Inventory

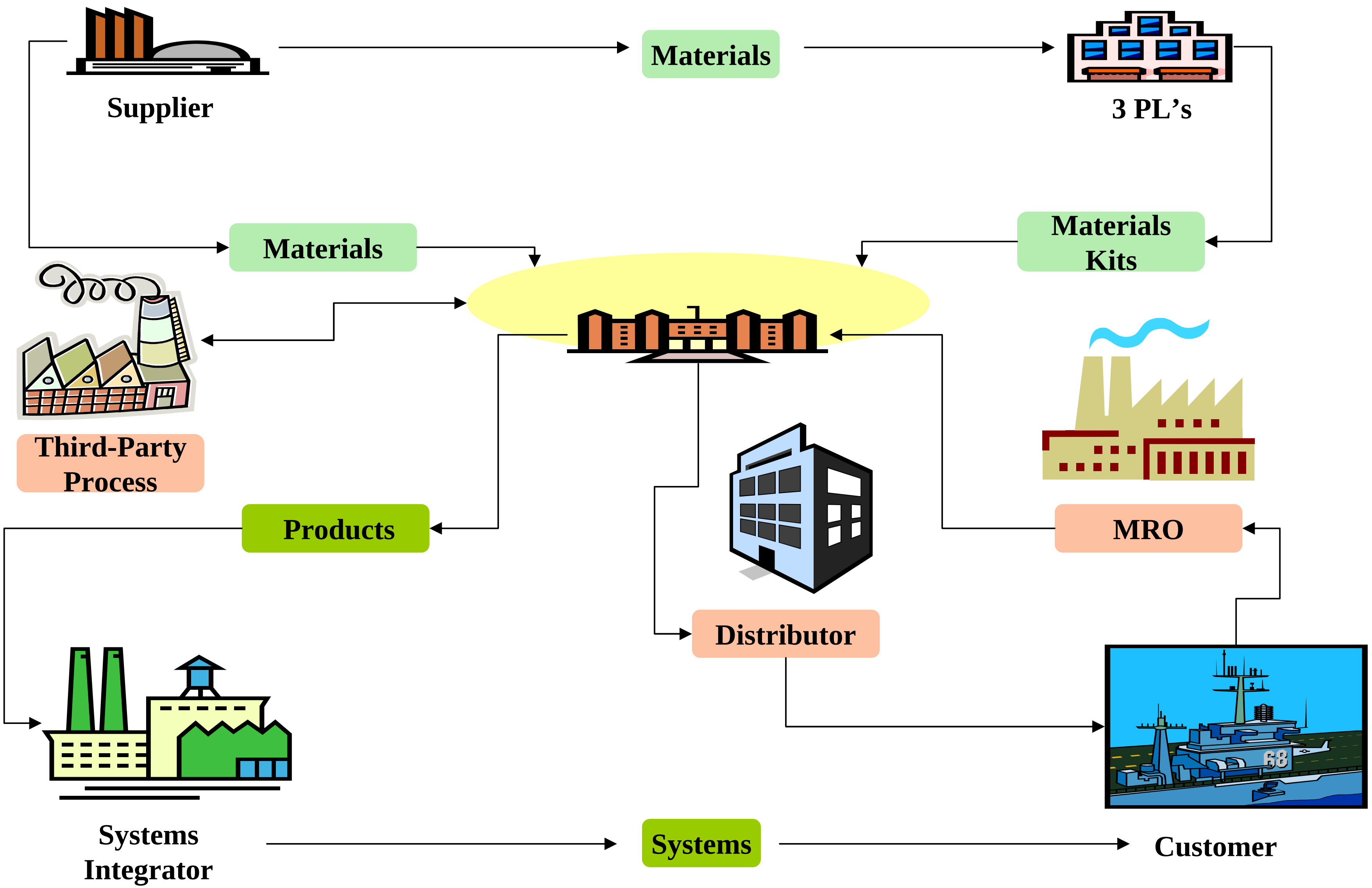
Rotor Container

Lost Engine Visibility

Aircraft Engine Management System database – overdue status report

- 47 RFI Engines as of 7/29/03 (over 40 days)
- 15 Non-RFI Engines as of 7/29/03 (over 80 days)

Supply Chain Situation



Expeditionary Logistics Situation

Situation Summary

- High Value Asset Condition Monitoring

Problem:	Loss of high value assets in transit / in-storage
	Damage in-transit / in-storage
Implication:	Excess inventory
	Higher cost of rework / management

- Supply Chain – End-to-End Supply Chain Visibility

Problem:	Inability to manage schedule
Implication:	Excess inventory / hoarding / expedites

- Expeditionary Logistics – Pre-positioned Material / Condition Visibility

Problem:	Inability to react to changes in priority
Implication:	Excess pipeline material / unnecessary re-orders

Solution = **Condition Based Logistics Technology**

Integrated Sensor / Radio Frequency Identification Devices (*ISRFID™*)

in totes, pallets, containers, & equipment

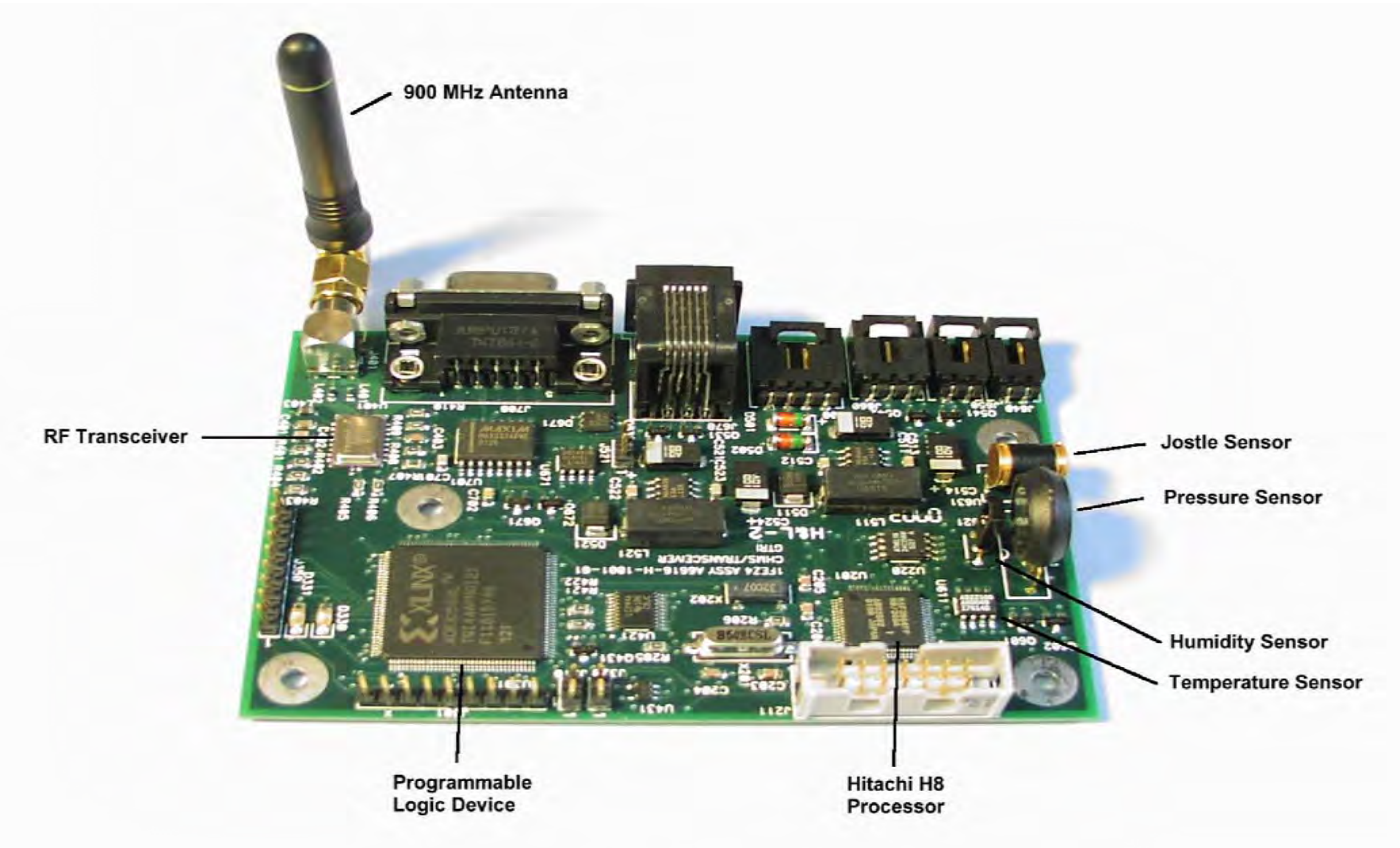
using patent-pending Low Power Sensor Network (*LPSN™)*,

to provide

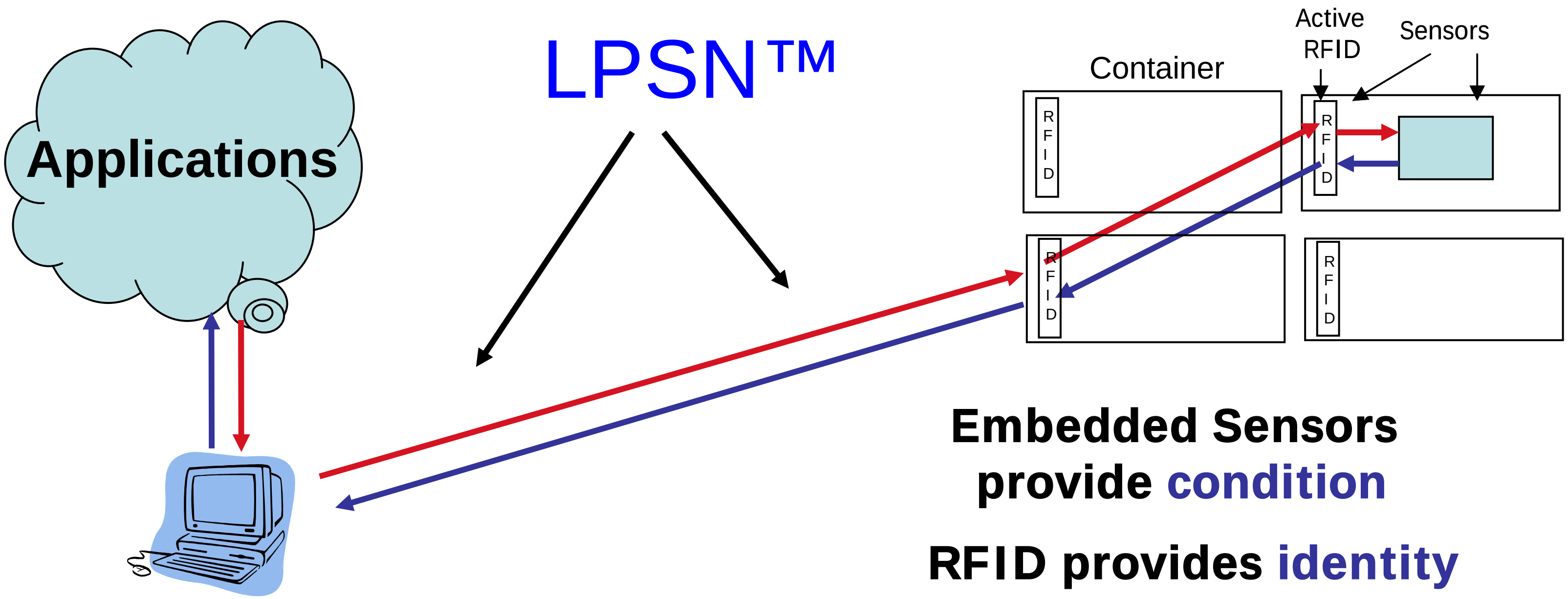
Integrity / Condition / Identity

at the lowest total cost to the user

The ISRFID


900 MHz Antenna
RF Transceiver
Jostle Sensor
Pressure Sensor
Humidity Sensor
Temperature Sensor
Programmable Logic Device
Hitachi H8 Processor

How It Works



Embedded Sensors provide condition

RFID provides identity

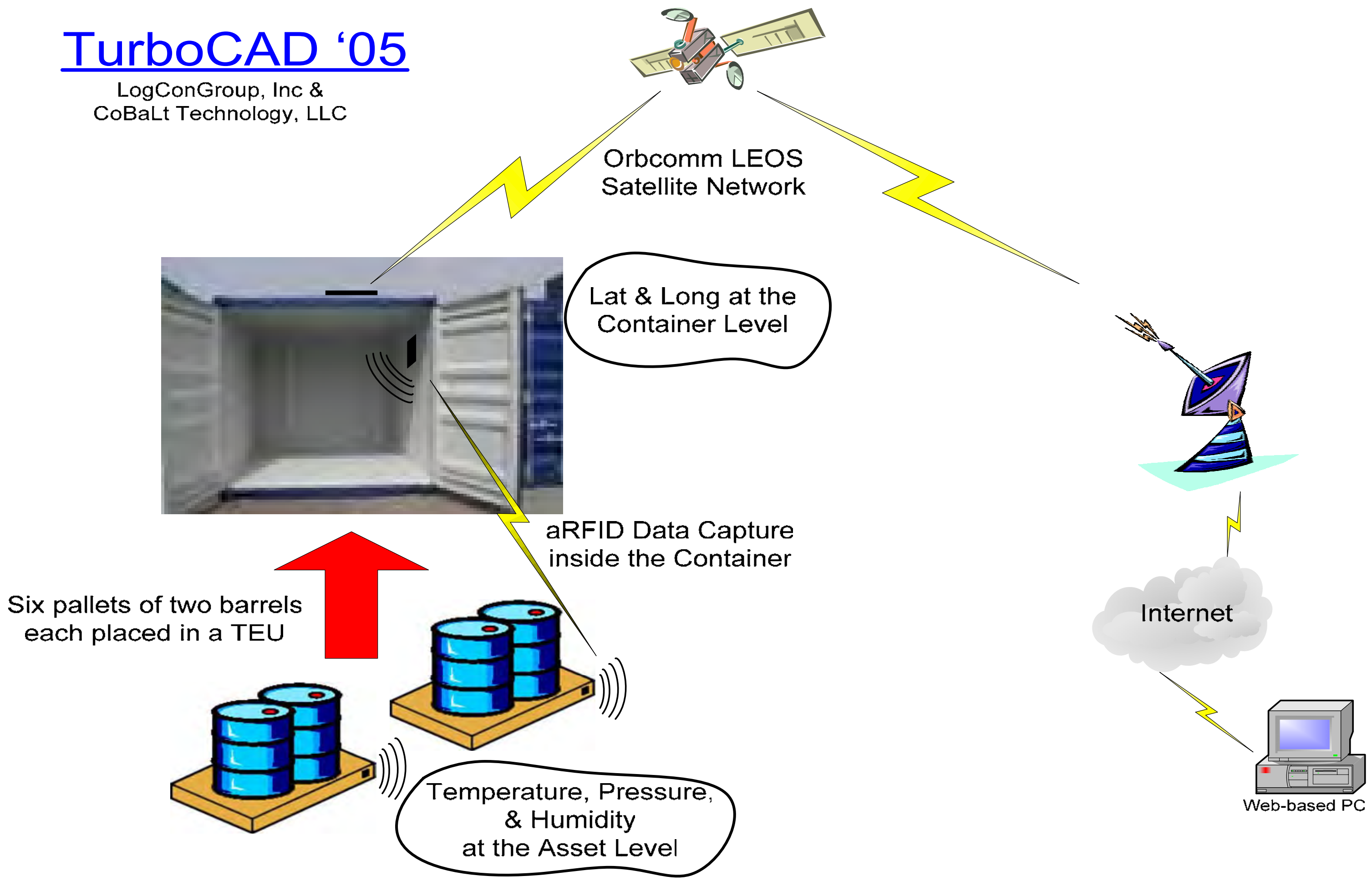
LPSN monitors integrity

isrfid™ & LPSN™

uniquely enable

Condition based logistics

Turbocads Exercise 2005




Position on
25 Apr 05
08:13 UTC
Position on
24 Apr 05
12:13 UTC
Position on
23 Apr 05
14:13 UTC
Position on
22 Apr 05
14:13 UTC
Position on
21 Apr 05
15:55 UTC
Position on
20 Apr 05
21:56 UTC
Position on
19 Apr 05
16:13 UTC
Position on
18 Apr 05
15:30 UTC
C A N A D A
GULF OF MEXICO
Compiled by U.S. Geological Survey
2001

Container ID: TGHU 202581-2	Date/Time (UTC): 21Apr05 18:30
Ship to: N61755 Pri:12	Ship from: W53XMD
STATUS 4/18/05 Shipped via rail from Crane, IN	
Container Temp: 75.0F History	Pressure: 14.7 PSI
1325014936405	
AIRFOIL, MXU-667A/B,W/COMPUTER CONTROL GROUP GUIDANCE	
EA68	
N61755 5066 TC06 XGX	
853	
2005102	
6 pallets, 2 canisters per pallet	
09516 Temp: 77.2 Condition Code:A	
09470 Temp: 77.2 Condition Code:A	
09474 Temp: 76.0 Condition Code:A	
09514 Temp: 76.0 Condition Code:A	
09492 Temp: 79.9 Condition Code:A	
09475 Temp: 79.9 Condition Code:A	
09496 Temp: 77.1 Condition Code:A	
09502 Temp: 77.1 Condition Code:A	
09483 Temp: 77.1 Condition Code:A	
09506 Temp: 77.1 Condition Code:A	
09507 Temp: 77.3 Condition Code:A	
09489 Temp: 77.3 Condition Code:A	

Container ID: TGHU 202581-2	**Date/Time (UTC): 05May05 19:36**
Ship to: N61755 Pri:12	**Ship from: W53XMD**
STATUS **4/18/05 Shipped via rail from Crane, IN** **4/24/05 Arrived at Concord. Awaiting xfer to ship**	
Container Temp: 75.0F History	**Pressure: 14.7 PSI**
1325014936405	
AIRFOIL, MXU-667A/B,W/COMPUTER CONTROL GROUP GUIDANCE	
EA68	
N61755 5066 TC06 XGX	
853	
2005102	
6 pallets, 2 canisters per pallet	
09511 Temp: 77.2 Condition Code:A	
09505 Temp: 77.2 Condition Code:A	
09463 Temp: 76.0 Condition Code:A	
09514 Temp: 76.0 Condition Code:A	
09508 Temp: 79.9 Condition Code:A	
09493 Temp: 79.9 Condition Code:A	
09513 Temp: 77.1 Condition Code:A	
09512 Temp: 77.1 Condition Code:A	
09399 Temp: 77.1 Condition Code:A	
09517 Temp: 77.1 Condition Code:A	
09515 Temp: 77.3 Condition Code:A	
09503 Temp: 77.3 Condition Code:A	

Container ID: TGHU 202581-2	**Date/Time (UTC): 17May05 16:00**
Ship to: N61755 Pri:12	**Ship from: W53XMD**
STATUS **4/18/05 Shipped via rail from Crane, IN** **4/24/05 Arrived at Concord. Awaiting xfer to ship** **5/16/05 Container loaded on SS Cape Flattery for transport to Guam** **5/17/05 Ship departed MOTCO**	
Container Temp: 75.0F History	**Pressure: 14.7 PSI**
1325014936405	
AIRFOIL, MXU-667A/B,W/COMPUTER CONTROL GROUP GUIDANCE	
EA68	
N61755 5066 TC06 XGX	
853	
2005102	
6 pallets, 2 canisters per pallet	
09511 Temp: 77.2 Condition Code: J	
09505 Temp: 77.2 Condition Code: A	
09463 Temp: 76.0 Condition Code: A	
09514 Temp: 76.0 Condition Code: A	
09508 Temp: 79.9 Condition Code: A	
09493 Temp: 79.9 Condition Code: J	
09513 Temp: 77.1 Condition Code: A	
09512 Temp: 77.1 Condition Code: A	
09399 Temp: 77.1 Condition Code: A	
09517 Temp: 77.1 Condition Code: J	
09515 Temp: 77.3 Condition Code: A	
09503 Temp: 77.3 Condition Code: A	

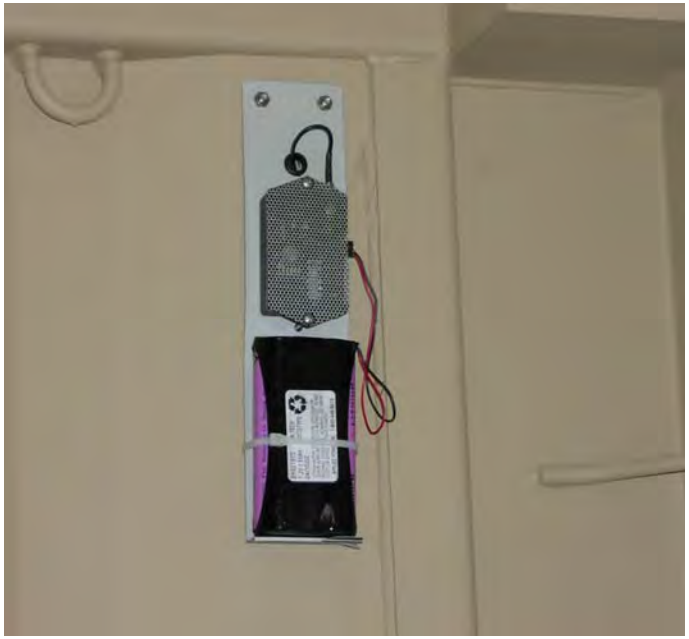
Direct Satellite Communications / GTN
Turbo Cads 2005


Direct Satellite
Communications GTN

Results

Parameter	Competitor 1	Competitor 2	CoBaLt
Reduce Infrastructure	Cannot Network	Cannot Network	Yes Networked
Record data sent & received	No	Yes to container level	Yes to tag / pallet level
Store multiple ID's at tag / pallet level	No – not a pallet level tag	No	Yes
Integrate location with ITV systems (JTAV, GTN, IRRIS)	Partial visibility	Partial visibility	Yes
Response on demand	No	Only at container level	Yes
Re-tasking pallet level tag data	0%	0%	100%

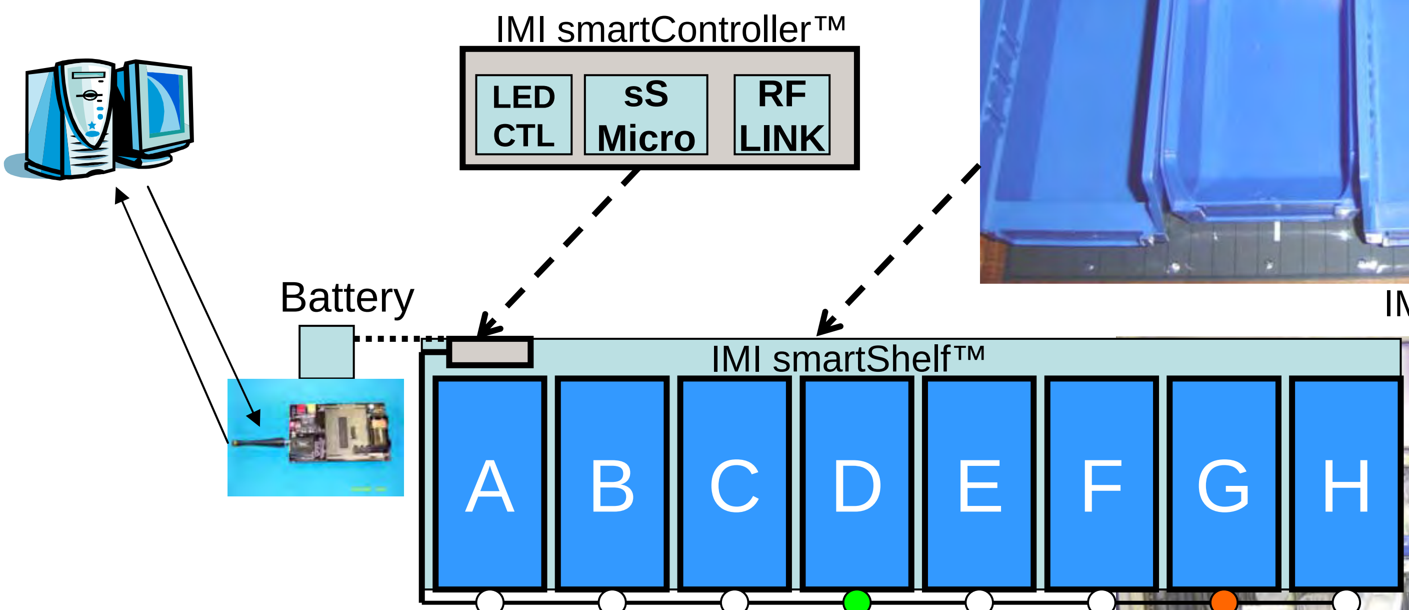
Integrity Monitoring



USMC TRICON with prototype Integrated Sensor / RFID

Electronic Shelf Paper

IMI smartShelf™ Project

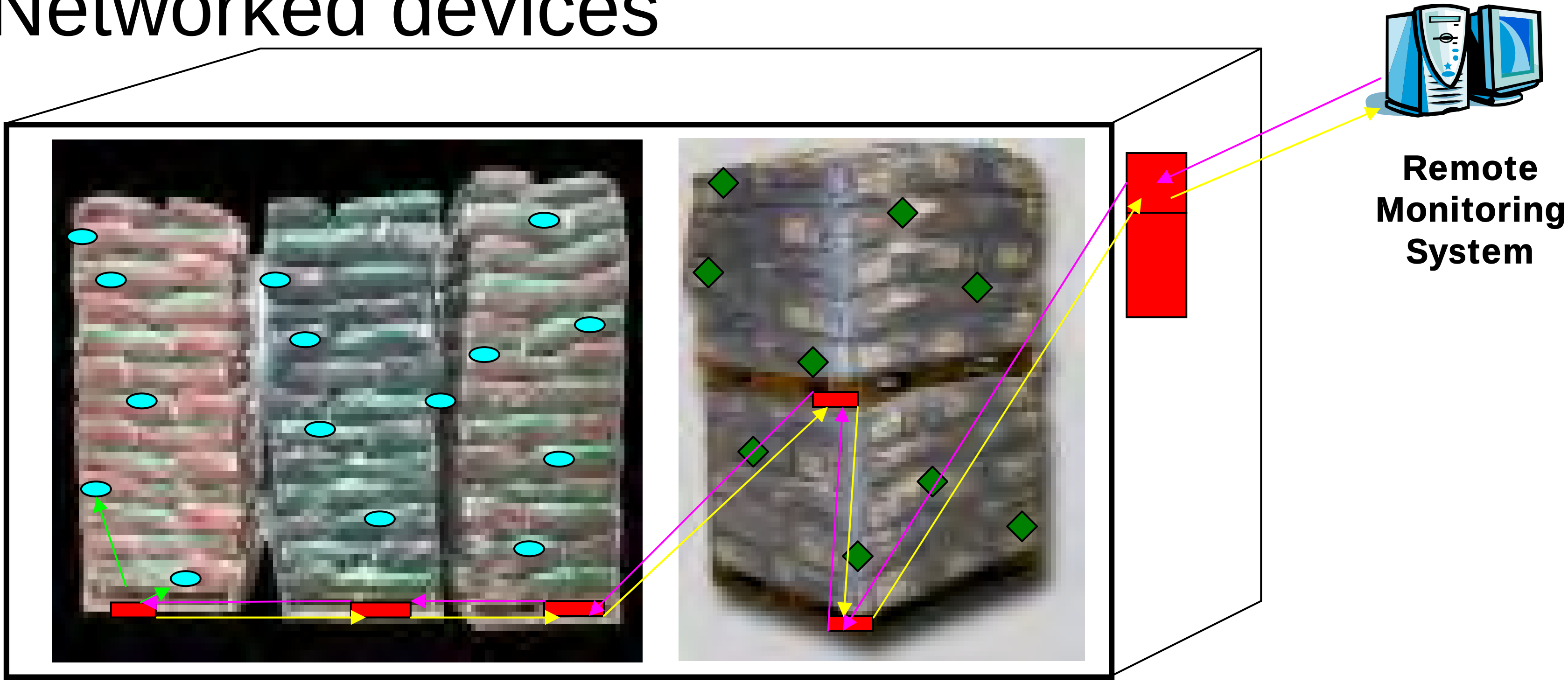


IMI smartShelf™

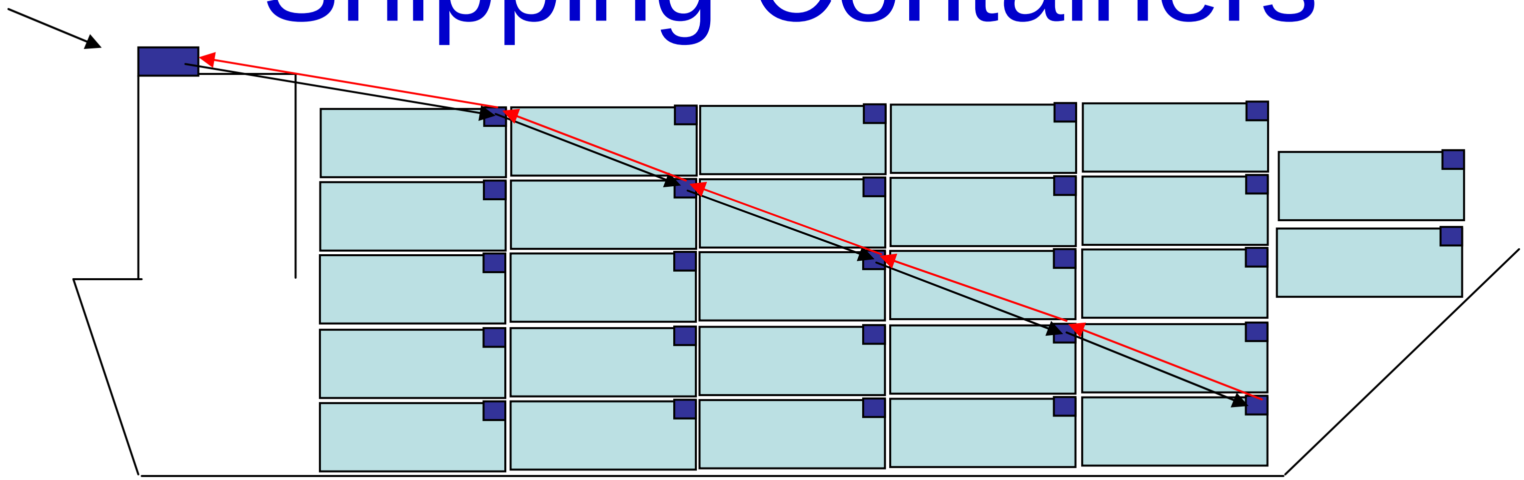
Bin Monitoring with Pick LEDs

Integrated Applications

- Integrated Totes/Pallets/Containers & RFID
- Embedded RFID Sensors in pallets / totes
- Networked devices



Unique Solutions
Shipping Containers



CoBaLt is the only solution!

Integrity / Condition / Identity

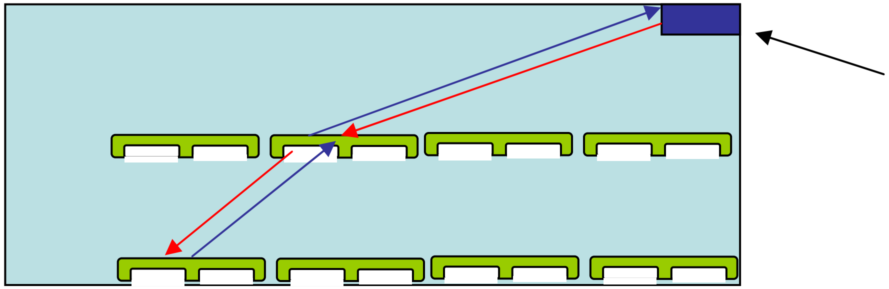
At an acceptable cost per trip

CoBaLt = $XX per trip

Competition = $XXX per trip*

* Source = CHCP Study

Unique Solutions
Specialty Containers



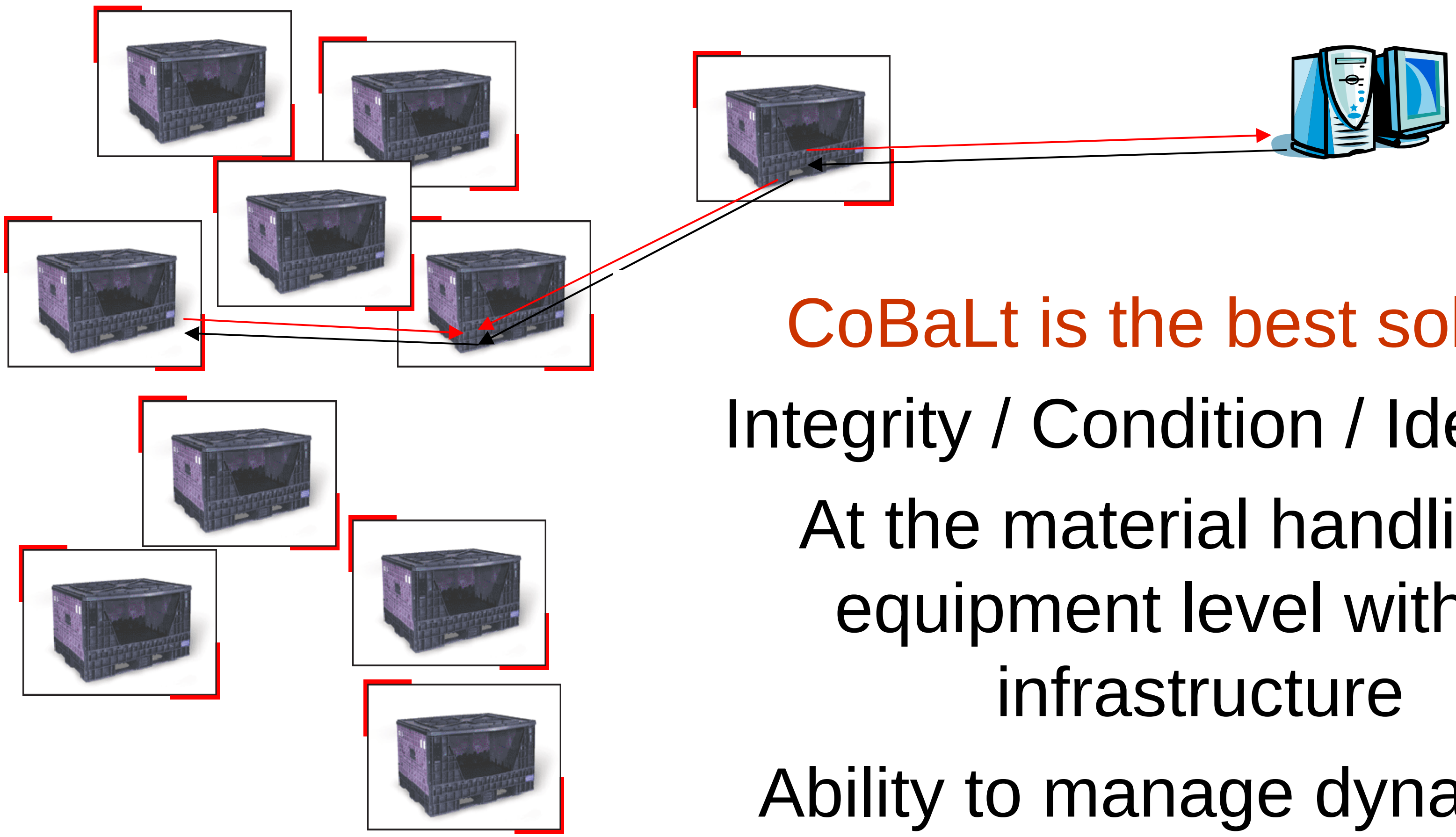
CoBaLt is the only solution!

Integrity / Condition / Identity

At the pallet level without infrastructure

Ability to dynamically retask

Unique Solutions
Unit Load Devices



CoBaLt is the best solution!

Integrity / Condition / Identity

At the material handling equipment level without infrastructure

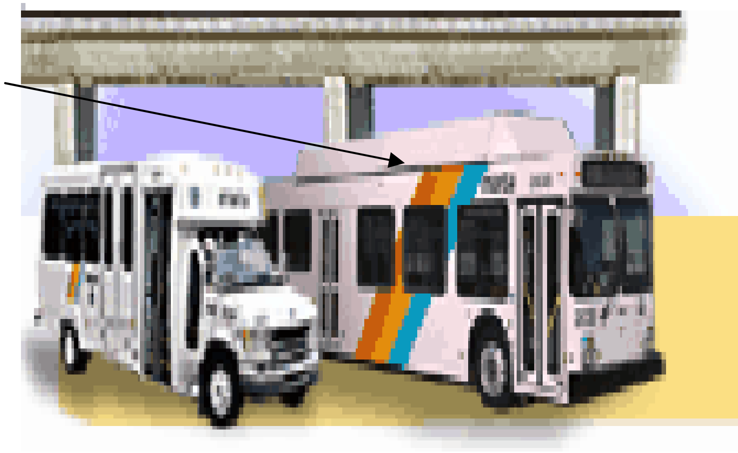
Ability to manage dynamic warehouse inventory

Unique Solutions
Equipment Prognostics

Integrated Sensor
RFID Data Collector

↓

Handheld
RF Interrogator



CoBaLt is a unique solution!

Integrity / Condition / Identity

At the equipment level without infrastructure

Ability to manage dynamic inventory

Uniqueness

- With **Condition Based Logistics** Technology:

  Enterprises can **know**:
  - Location of their entire supply chain – Total Asset Visibility
  - Condition of their assets in-transit, in-storage, in-use
  - Real time exceedance monitoring of critical parameters
    - Temperature / Humidity / Pressure / Battery / Motion

  Enterprises can **optimize**
  - Transportation
  - Distribution

  Enterprises can **minimize**
  - Labor
  - Time

- Result: Improved Performance: **Velocity & Cost**
  - Shorter customer wait times
  - Leaner supply chain

<u>Technical</u> <u>Discriminators</u>

Integrated Sensors
Addt'l Sensor Interface
Low Power
Controlled Network
Minimum Infrastructure
HERO Certified
Flexible Architecture

Army SE Overview NDIA System Engineering Conference

25 October 2005

Douglas K. Wiltsie
Assistant Deputy
Acquisition and Systems Management
Office of the Assistant Secretary of the Army
Acquisition Logistics and Technology

Army Status

- System Engineering Is Being Done in Army Programs; We Need to Ensure That It Is Consistent Across the PEOs.
- Training Is Widely Available but Standards Need to Be Established
  - One PEO/RDEC Has Established a Masters Program With a Local University. Is That the Right Benchmark?
- Metrics Are Widespread and Industry Focused; Need a Minimum Set of Common Metrics to Measure Overall Program Performance.
- Requirements Are Done Outside of the SE Process; Should SE Support the Requirements Generation Process?
- Army Needs to Establish an Easily Accessible Set of Best Practices That Can Be Shared Across PEOs.
- System Engineering Is Not Formally Integrated Into S&T Programs How Should It Be Integrated Into S&T? At What Level

Sec. Bolton's Challenges

- Systems Engineering:
  - Does Not Help Us Politically
  - Does Not Stabilize Funding
  - Does Not Belong in the Requirements Process
  - Does Not Clearly Address System of Systems

Army System Engineering Policy

The **Army System Engineering** program and policy approved (13 June 2005)

- Requires a SEP for each program
- Establishes a System Engineer within each program and PEO.
- Establishes Peer review at all major technical reviews
- Establishes the PEO as the SEP approval authority

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY OF THE ARMY
ACQUISITION LOGISTICS AND TECHNOLOGY
103 ARMY PENTAGON
WASHINGTON D.C. 20310-0103

JUN 13 2005

SAAL-SSI

MEMORANDUM FOR PROGRAM EXECUTIVE OFFICERS
DIRECT REPORTING PROJECT MANAGERS

SUBJECT: Army Systems Engineering Policy

The Under Secretary of Defense for Acquisition, Technology and Logistics issued policy to reinvigorate systems engineering within the Department of Defense. Guidance for implementing systems engineering across Army Acquisition, Logistics and Technology is enclosed.

The Assistant Deputy for Acquisition and Systems Management, Office of the Assistant Secretary of the Army for Acquisition, Logistics and Technology, will chair an Army Systems Engineering Forum (ASEF) that is chartered to institutionalize effective systems engineering practices across our workforce and programs, and to promote collaboration across our requirements, acquisition, logistics, and testing communities. Each Program Executive Officer and Direct Reporting Program Manager is to designate a Chief System Engineer to participate on the ASEF. I expect the ASEF to plan, coordinate, manage, and execute initiatives for the resurgence of effective systems engineering, balancing programmatic cost, schedule, and supportability with technical reality. Within two weeks, please provide the name of your Chief System Engineer to Dr. James Linnehan, SAAL-SSI, (703) 604-7430, or e-mail: james.linnehan@saalt.army.mil.

Systems engineering excellence can integrate all elements of our U.S. Army community into a process driven disciplined team, producing timely, affordable, high quality products meeting the needs of our warfighters. I look forward to working with you to make this vision a reality and compelling success.

Claude M. Bolton, Jr.
Assistant Secretary of the Army
(Acquisition, Logistics and Technology)

Enclosure

CF:
USD(AT&L)
CG, AMC
CG, TRADOC

SE Proposed Initiatives

- Develop Army policy & SEP Implementation Instructions

- Training/ certification
  - Review institutional training for NDU, DAU, USMA.

- System Of Systems engineering
  - Determine strategy for maintaining SoS interdependencies
    - PEO - technical lead for System Architecture
    - TRADOC – Oper. Architecture lead w/JFCOM

Capability Based Acquisition

Army is transitioning to more and more Capability Based acquisition

- Software blocking – Ensures end to end operability for all current and future battle command
- Future Combat System- 1st Army System of Systems capability based acquisition focused on developing and procuring a brigade level set of equipment
- Army Air and Missile Defense – Develops the requirements and products to provide AMD capability

Future Initiatives

- Contract language – How do we write templates that capture real value and discriminate between offerors?
- The Requirements Development process – How do we integrate SE to take advantage of the first level of Trade space?
- Joint Strategic Level System of Systems - How do we work SE across the involved service programs?

Army SE Overview
NDIA System Engineering Conference
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- Joint Strategic Level System of Systems - How do we work SE across the involved service programs?

System Safety in Systems Engineering DAU Continuous Learning Module

NDIA Systems Engineering Conference

October 25, 2005

Amanda Zarecky
Booz Allen Hamilton
703-604-5468
zarecky_amanda@bah.com

Course Context - Drivers

- **Increased DoD emphasis on safety**
  - **May 2003 SECDEF Memo**
  - **July 2003 Defense Safety Oversight Council**
    - **Joint Chiefs of Staff & Undersecretaries of the Services**
    - **Nine Task Forces**
- **April 2004 Acquisition and Technology Programs Task Force**
  - **Chair: Mr. Mark Schaeffer, USD (AT&L) Director of Systems Engineering**
  - **Focused on improving System Safety implementation**
  - **Linked efforts to Systems Engineering revitalization initiatives**
  - **23 Sep 04 USD(AT&L) Memo "Defense Acquisition System Safety"**

Course Context - DoD Policy

- 23 May 03 DoDI 5000.2 E7, Environment, Safety, and Occupational Health (ESOH)
  - Strategy for integrating ESOH into Systems Engineering
  - Identification of ESOH risks
  - Acceptance of ESOH risks per "industry standard for system safety"
  - NEPA/E.O. 12114 Compliance Schedule
- 23 Sep 04 USD (AT&L) Defense Acquisition System Safety memo
  - Mandates integration of System Safety into Systems Engineering
  - Mandates use of MIL-STD-882D
- Oct 04 Defense Acquisition Guidebook
  - Chapter 4, Systems Engineering
  - Section 4.4.11, ESOH: "industry standard" = MIL-STD-882D

Course Development Team Effort

- **USD (AT&L)/Systems Engineering**
  - **Col Warren Anderson, Program Manager**
  - **Ann Marie Choephel, Program Manager Support**
  - **DAU Course Developer contractors: MTC & CTC**
- **Subject Matter Experts from each Component and DAU**
  - **Trish Huheey, DUSD(I&E) (Team Lead)**
  - **Sherman Forbes, SAF/AQRE**
  - **Ben Mack, USMC (AOT, Inc.)**
  - **George Murnyak, US Army CHPPM**
  - **Paige Ripani, DUSD(I&E) (Booz Allen Hamilton)**
  - **Amanda Zarecky, CNO N45 (Booz Allen Hamilton)**

Course Description

- **Course developed**
  - **In response to need for training depicting how System Safety fits into the overall DoD Systems Engineering process throughout a system's life cycle**
  - **To teach the learning objectives and encourage active participation and coordination between System Safety Engineers and Systems Engineers**
- **Top Level Outcomes**
  - **Recognize the Defense Acquisition policy and guidance on System Safety in Systems Engineering**
  - **Recognize System Safety methodology as the Systems Engineering approach for eliminating Environment, Safety, and Occupational Health (ESOH) hazards or minimizing ESOH risks across the system's life cycle**

Course Description (cont)

- **Target Audience**
  - **Primary: Systems Engineers, Chief Engineers**
  - **Secondary: Program Managers, System Safety Engineers**
- **DAU Systems Engineering Elective - not required; no pre-requisites**
- **Counts towards 80 hours of DAWIA certified continual learning**
- **3 ½ hours web-based training**

Course Description (cont)

- Built around the Systems Engineering (SE) Process V-Model
- Identifies System Safety activities supporting each of the Systems Engineering activities in each phase of a systems life cycle
- Enables Systems Engineers and System Safety Engineers to understand what to expect, what to provide, and when
- Not intended to teach details of System Safety
- Assumes an understanding of Systems Engineering

Course Outline

- System Safety Overview
- System Safety Terminology
- Eight Mandatory Steps of System Safety
- Risk Assessment
- System Safety Order of Precedence
- Typical System Safety Tasks
- System Safety Throughout the System's Life Cycle
- Module Summary

System Safety Overview - Explains MIL-STD-882D methodology is DoD's SE approach for eliminating ESOH hazards or minimizing ESOH risks across the system's life cycle

Why Implement System Safety?

- Protects military and civilian personnel by reducing hazards/risk to personnel and equipment
- Reduces accidents proactively
- Improves warfighting capability and combat readiness
- Reduces total ownership costs
- Lowers the risk of environmental damage
- Prioritizes hazards for corrective action
- Reduces need for system retrofits
- Required by DoDI 5000.2 (May 2003) and USD(AT&L) Memo (Sep 23, 2004)

D

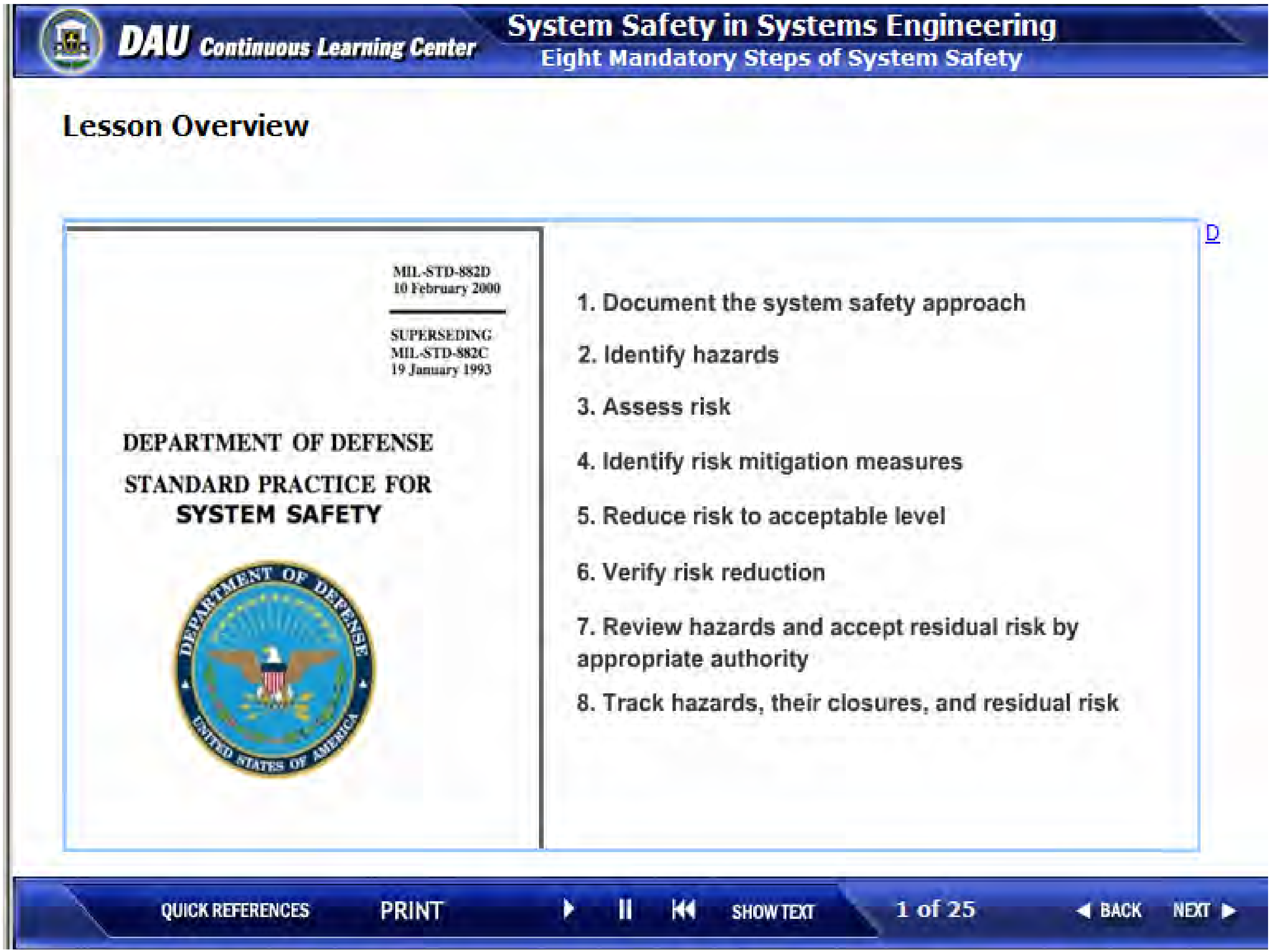
System Safety Terminology - Defines terms pertinent to use of system safety in the SE process

System Safety Terminology

Directions: Listed below are terms that are relevant to system safety and the systems engineering process. You may already be familiar with some of the terms. Please click each term below that is unfamiliar to you (or that you would like to review) to reveal its definitions.

System Safety Terms		
System	System Life Cycle	Systems Engineering
System Safety	System Safety Engineering	Environment, Safety, and Occupational Health (ESOH)
Programmatic Environment, Safety, and Occupational Health Evaluation (PESHE)	Human Systems Integration (HSI)	Hazard
Causal Factor	Mishap	Risk
Mitigation Measure	Residual Risk	

Eight Mandatory Steps of System Safety - Describes application of each of the steps in the system safety process outlined in MIL-STD-882D



Eight Mandatory Steps of System Safety – Knowledge Review

DAU Continuous Learning Center

System Safety in Systems Engineering

Eight Mandatory Steps of System Safety

Drag-and-Drop Challenge

Directions: The following are the steps taken by the (fictitious) Marauder Howitzer Program Office team to mitigate the risk of extreme temperatures causing the gun barrel to warp, a round to jam in the barrel, followed by an in-bore explosion that severely injures or kills the operators and destroys the Howitzer. Arrange the activities in the order that accurately reflects the system safety process. Then click the Submit button. The Next button will return to the navigation bar when the answer is correct. Click here if you require a text-based version of this challenge.

D

- Discover potential round jamming hazard.
- Install LBDD to detect gun barrel warping.
- Document the system safety approach.
- Track rounds jamming in the gun barrel.
- Document PM acceptance of residual risk.
- Assign initial risk category as high.
- Verify residual risk following installation of LBDD.
- Identify alternatives for eliminating hazard or reducing risk.

Submit

Risk Assessment - Provides a systematic process for assessing risk and determining appropriate risk acceptance authority

Overview of Mishap Assessment, Cont.

The following pages provide further details of each of these steps along with the three sample tables:

1. Severity Categories
2. Probability Levels
3. Risk Assessment and Acceptance Matrix (shown here)

MIL-STD-882D provides definitions for severity categories, probability levels, risk assessment values and risk assessment categories that will be used unless otherwise documented by the Program Office in the system safety approach.

Components of Step 1

D

Risk Assessment and Acceptance Matrix

PROBABILITY LEVEL	SEVERITY CATEGORY			
	I CATASTROPHIC	II CRITICAL	III MARGINAL	IV NEGLIGIBLE
(A) Frequent	1 (IA)	3 (IIA)	7 (IIIA)	13 (IVA)
(B) Probable	2 (IB)	5 (IIB)	9 (IIIB)	16 (IVB)
(C) Occasional	4 (IC)	6 (IIC)	11 (IIIC)	18 (IVC)
(D) Remote	8 (ID)	10 (IID)	14 (IIID)	19 (IVD)
(E) Improbable	12 (IE)	15 (IIE)	17 (IIIE)	20 (IVE)

Values	Category	Acceptance Authority
1, 2, 3, 4, 5	HIGH	Component Acquisition Executive
6, 7, 8, 9	SERIOUS	Program Executive Officer
10, 11, 12, 13, 14, 15, 16, 17	MEDIUM	Program Manager
18, 19, 20	LOW	Program Manager

Risk Assessment – Knowledge Review

Risk Acceptance Authority, Cont.

Directions: Use the Risk Assessment and Acceptance Matrix to answer each of the following challenges.

Challenge: Who is the acceptance authority if the severity category is marginal and the probability level is frequent? Answer

Challenge: Who is the acceptance authority if the severity category is catastrophic and the probability level is improbable? Answer

D

Risk Assessment and Acceptance Matrix

PROBABILITY LEVEL	SEVERITY CATEGORY			
	I CATASTROPHIC	II CRITICAL	III MARGINAL	IV NEGLIGIBLE
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System Safety Order of Precedence - Identifies and explains application of DoD's system safety order of precedence for eliminating ESOH hazards or minimizing ESOH risks

DAU Continuous Learning Center — System Safety in Systems Engineering — System Safety Order of Precedence

System Safety Order of Precedence

When comparing potential alternatives for eliminating the hazard or reducing the risk, the system developer should apply the MIL-STD-882D system safety design order of precedence. The following are listed in order from the most to the least preferred risk mitigation methods:

Most to Least Preferred Risk Mitigation Measures		
1.	Eliminate hazards through design selection	If unable to eliminate an identified hazard, reduce the associated risk to an acceptable level through design selection.
2.	Incorporate safety devices	If unable to eliminate the hazard through design selection, reduce the risk to an acceptable level using protective safety features or devices.
3.	Provide warning devices	If safety devices do not adequately lower the risk of the hazard, include a detection and warning system to alert personnel to the particular hazard.
4.	Develop procedures and training	Where it is impractical to eliminate hazards through design selection or to reduce the associated risk to an acceptable level with safety and warning devices, incorporate special procedures and training. Procedures may include the use of personal protective equipment. **Note:** For catastrophic or critical hazards, avoid using warning, caution, or other written advisory as the **only** risk reduction method.

System Safety Order of Precedence (cont)

Marauder Howitzer SHA
Risk Mitigation Measure 1b

EXAMPLE ONLY

Example - Marauder Howitzer System Hazard Analysis Worksheet - Risk Mitigation Measure 1b												
Hazard	**Hazardous Effects**	**Causal Factors**	**IS**	**IP**	**IRV**	**IRC**	**Risk Mitigation**	**FS**	**FP**	**FRV**	**FRC**	**Status**
Round jams in barrel when fired	Round initiates causing in-bore explosion resulting in personnel death and weapon destruction	Warped gun barrel from a combination of extreme external temperature, e.g., in Desert Warfare, and high fire rate	I	B	2	High	Develop new barrel design using new technology composite material that will contain blast over pressure. New barrel design will minimize warping and is a line replaceable unit that costs $50K to minimize downtime in the event of an in-bore explosion. This design change allows only minor system damage and no injury to personnel.	III	D	14	Medium	Closed. The Program verified that new barrel design using the new technology composite material reduced the probability of warping (causal factor) and reduced the severity of the mishap occurring by being able to contain and dissipate the blast over pressure. The Program Manager formally accepted the FRC.

IS = Initial Risk Severity Category
FS = Final Risk Severity Category
CAE = Component Acquisition Executive

IP = Initial Risk Probability Level
FP = Final Risk Probability Level
PEO = Program Executive Officer

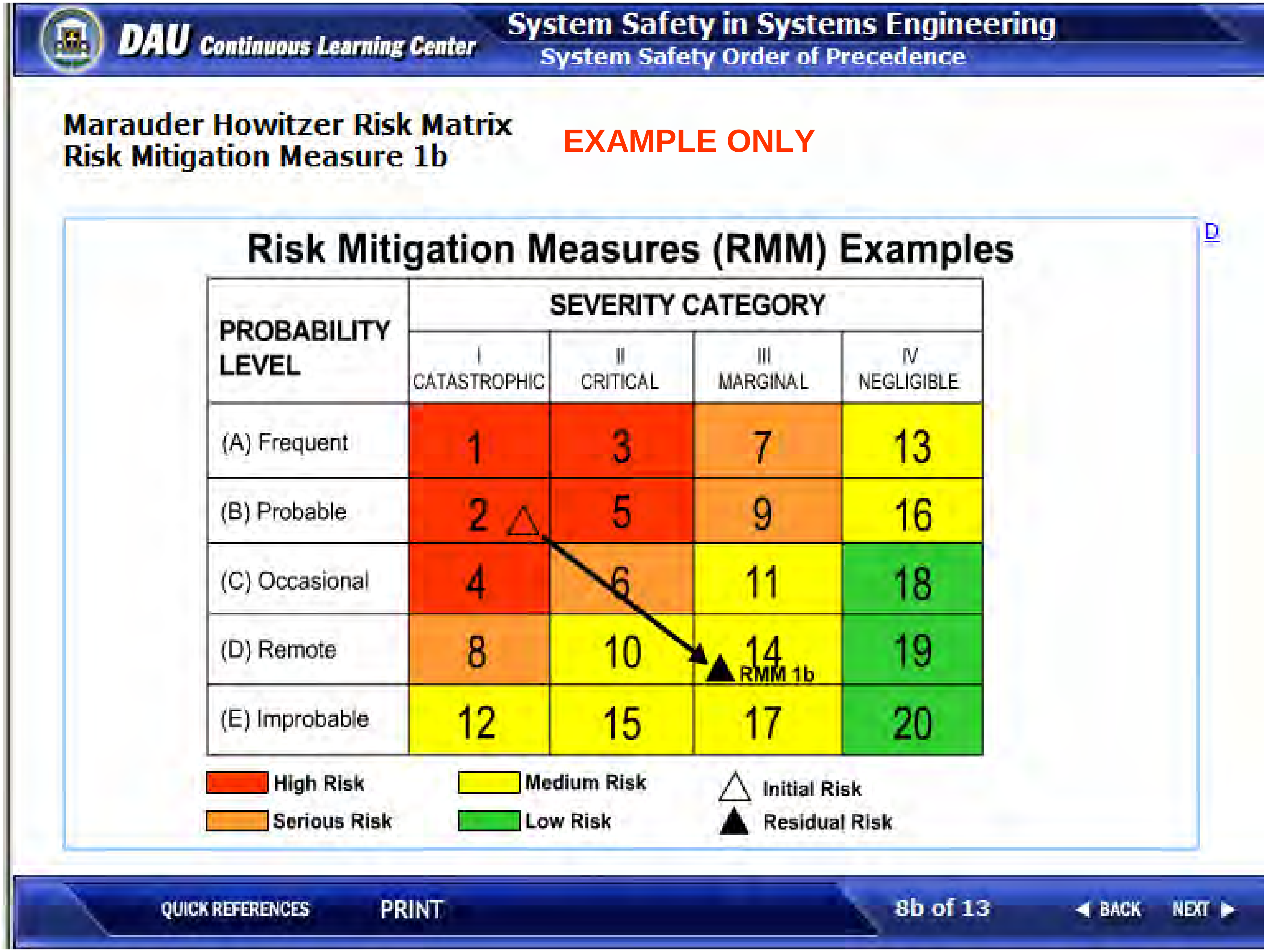
IRV = Initial Risk Value
FRV = Final Risk Value
PM = Program Manager

IRC = Initial Risk Category
FRC = Final Risk Category

D

Close

System Safety Order of Precedence (cont)



System Safety Order of Precedence – Knowledge Review

DAU Continuous Learning Center

System Safety in Systems Engineering

System Safety Order of Precedence

Drag-and-Drop Challenge

You are leading the Program Office team of the (fictitious) Marauder Howitzer. Please click round jamming hazard to review critical background information before completing the following challenge.

Directions: Listed below are four alternative measures to mitigate the round jamming hazard. Based on the system safety design order of precedence, indicate the order in which each alternative should be applied by placing the Number 1 beside the most preferred; the Number 2 beside the second preferred; etc. Then click the Submit button. The Next button will return to the navigation bar when the answer is correct. Click here if you require a text-based version of this challenge.

D

1		Train operators to routinely check for barrel warping.
2		Install alarm to alert operators to gun barrel warping.
3		Install safety interlock that prevents firing if the barrel is warped.
4		Change the design to preclude a round jamming in the barrel.

Submit

QUICK REFERENCES PRINT

Typical System Safety Tasks - Provides detailed descriptions of several widely-used system safety analytical and assessment tools

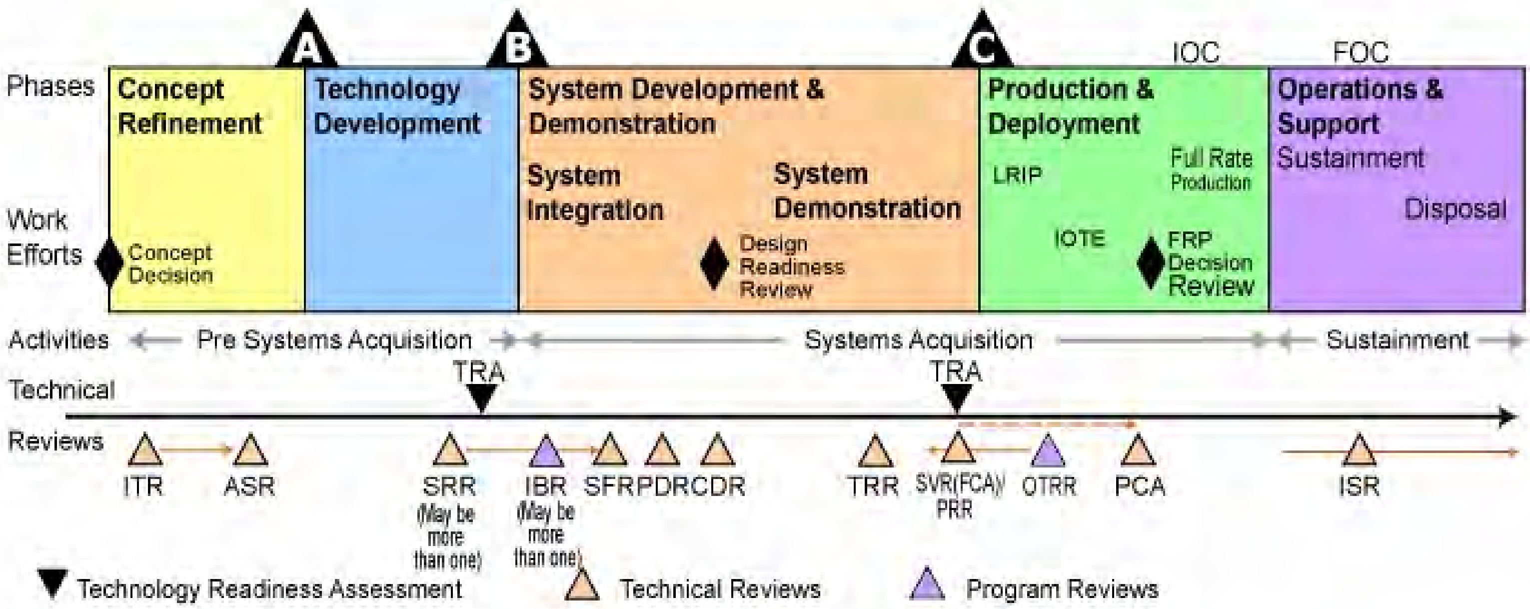
Typical System Safety Tasks, Cont.

Typical System Safety Tasks		
Safety Requirements/Criteria Analysis (SRCA)	Health Hazard Assessment (HHA)	Safety Assessment Report (SAR)
Preliminary Hazard List (PHL)	Preliminary Hazard Analysis (PHA)	Subsystem Hazard Analysis (SSHA)
System Hazard Analysis (SHA)	Operating & Support Hazard Analysis (O&SHA)	Sneak Circuit Analysis (SCA)
Fault Tree Analysis (FTA)	Failure Modes and Effects Analysis (FMEA) Failure Modes, Effects, and Criticality Analysis (FMECA)	Operational Trend Analysis
Threat Hazard Assessment (THA)	System Safety Program Plan (SSPP)	

System Safety Throughout the System's Life Cycle - Provides an overview of key system safety activities completed during each phase of the system life cycle

System Safety Activities Throughout the System Life Cycle

Directions: Please click each of the five phases of the System Life Cycle to discover key safety activities completed by the system safety staff during that phase. After you have clicked each of the five phases, please click the Next button to continue.



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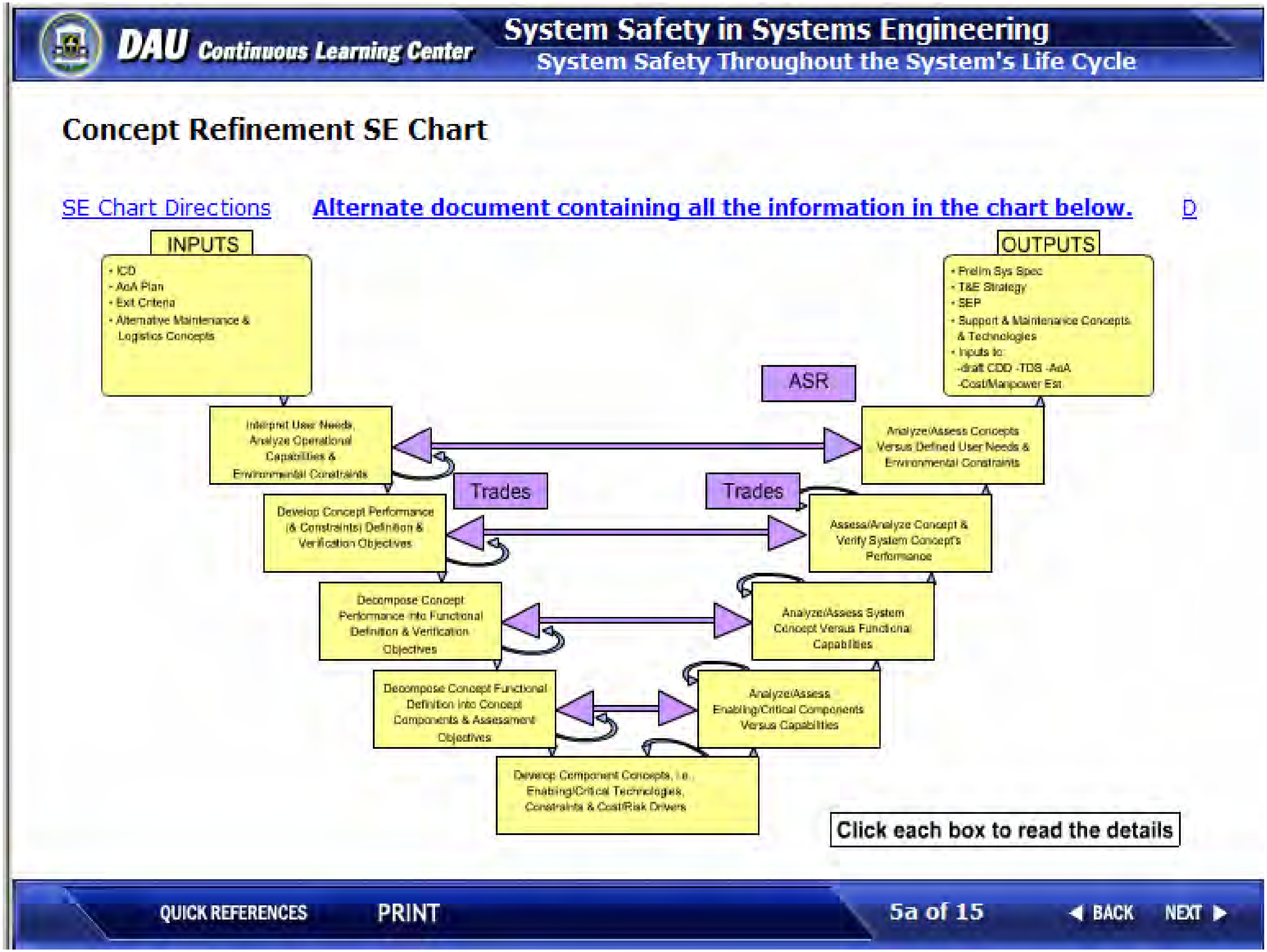
System Safety Throughout the System's Life Cycle (cont)



System Safety Throughout the System's Life Cycle (cont)

Concept Refinement SE Chart

SE Chart Directions   **Alternate document containing all the information in the chart below.**   D

X Close Window

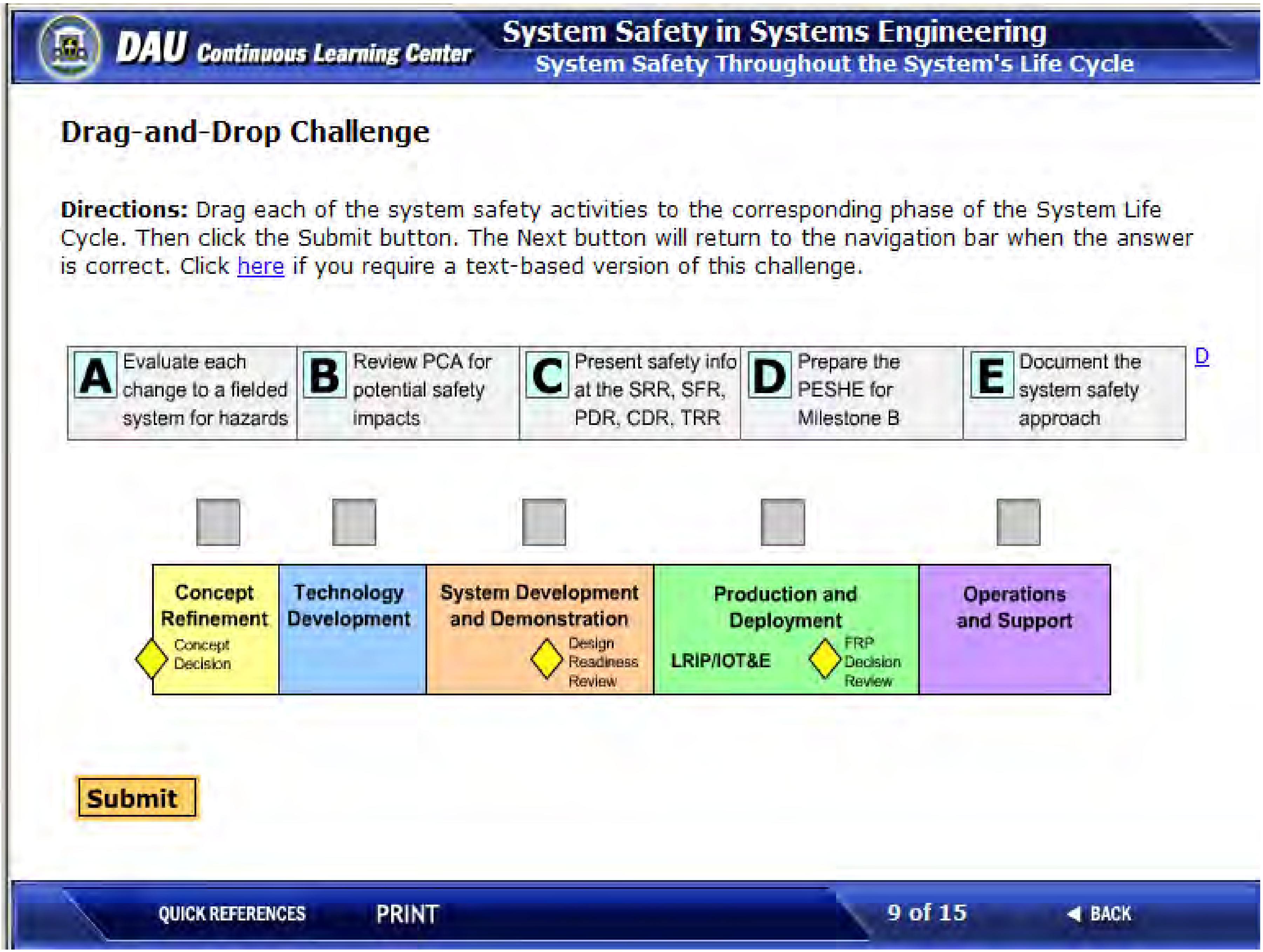
Inputs	System Safety Should:
Initial Capabilities Document (ICD)	Provide inputs as requested
Analysis of Alternatives (AoA) Plan	Participate in AoA development
Exit Criteria	Provide the following exit criteria: 1. Preliminary Hazard List (PHL) 2. Strategy for integrating Environment, Safety, and Occupational Health (ESOH) risk management into the Systems Engineering Plan (SEP)
Alternative Maintenance and Logistics Concepts	Provide inputs as requested

Objectives

Develop Component Concepts, i.e. Enabling/Critical Technologies, Constraints & Cost/Risk Drivers

Click each box to read the details

System Safety Throughout the System's Life Cycle – Knowledge Review



Module Summary - Recaps essential information to reinforce attainment of the learning objectives of each lesson

Module Summary Organization

The module summary is organized by lesson. It presents the following for each lesson:

- Learning goal(s) of the lesson
- Summary of the key learning points needed to attain each learning goal

The Module Summary includes only the following lessons:

- System Safety Overview
- System Safety Terminology
- Eight Mandatory Steps of System Safety
- Risk Assessment
- System Safety Order of Precedence
- Typical System Safety Tasks
- System Safety Throughout the System's Life Cycle

Conclusion

- **Continuous Learning Course helps students**
  - **Recognize the Defense Acquisition policy and guidance on System Safety in Systems Engineering**
  - **Recognize System Safety as the Systems Engineering approach for eliminating ESOH hazards or minimizing ESOH risks across the system life cycle**
- **Course (CLE009) available for registration at DAU's website http://www.dau.mil/basedocs/continuouslearning.asp**





Net-Centricity & Net-Ready - Beyond Technical Interoperability & C4ISR

Jack Zavin
Chief, Information Interoperability
DoD CIO/A&I Directorate
(703) 607-0238
Jack.Zavin@osd.mil

NDIA SE Conference 2005

Achieving Interoperability: A journey not a destination

Interoperability is more than just the technical exchange of information:
Solutions Sets must cover Process, Organization, People, Information, and Materiel over the life cycle;
and it must be balanced with Information Assurance

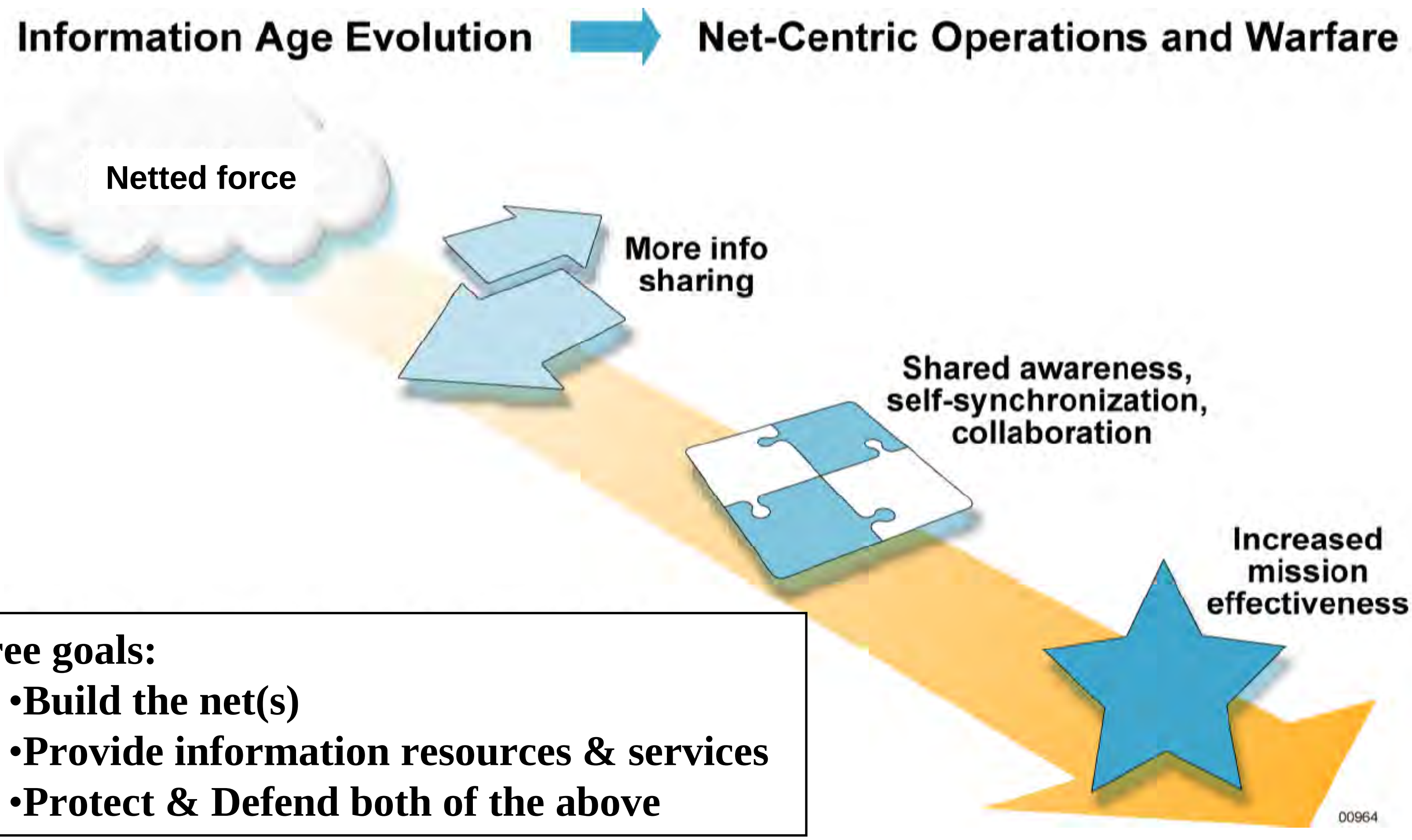
Interoperability:
" The ability of systems, units or forces to provide services to and accept services from other systems, units or forces and use the services to enable them to operate effectively together." *(JP 1-02 (emphasis added)*

Information Assurance:
"The ability to provide the measures that protect and defend information and information systems by ensuring their availability, integrity, authentication, confidentiality, and non-repudiation. This includes providing for restoration of information systems by incorporating protection, detection, and reaction capabilities." (CNSSI 4009)

References: DoDD 4630.5, May 5, 2004 & DoDI 4630.8 , 30 June 2004

Net-Centric Operations
A Transformation Enabler

Net-Centricity **is the empowerment of all users with the ability to easily discover, access, integrate, correlate and fuse data/information that support their mission objectives unconstrained by geospatial location or time of day .**



Three goals:

- **Build the net(s)**
- **Provide information resources & services**
- **Protect & Defend both of the above**

Net-Centric Attributes

Attribute	Description
Internet Protocol (IP) & WWW Standards based	Adapting Internet & World WideWeb standards with additions as needed for mobility, surety, and military unique features.
Protect & Defend Information & Information Systems	Ensure availability, integrity, authentication, confidentiality and non-repudiation. Provides protection, detection and reaction capabilities for restoration.
Levels of protection	Data/Information tagged by originator for classification & handling instructions
Post in parallel	Information Producers make information visible and available at the earliest point of usability
Smart pull (vice smart push)	Users can find and pull directly or use subscription services.
Information/Data centric	Data separate from applications and services.
Applications & Services	Users can pull multiple apps to access same data or choose same applications (e.g., for collaboration). Applications on "desktop" or as a service
Role Based access to resources.	Access to the net, applications & services tied to user's role and identity.
Quality of service	Tailored for information form: voice, still imagery, video/moving imagery, data, and collaboration. Provide for precedence & preemption.

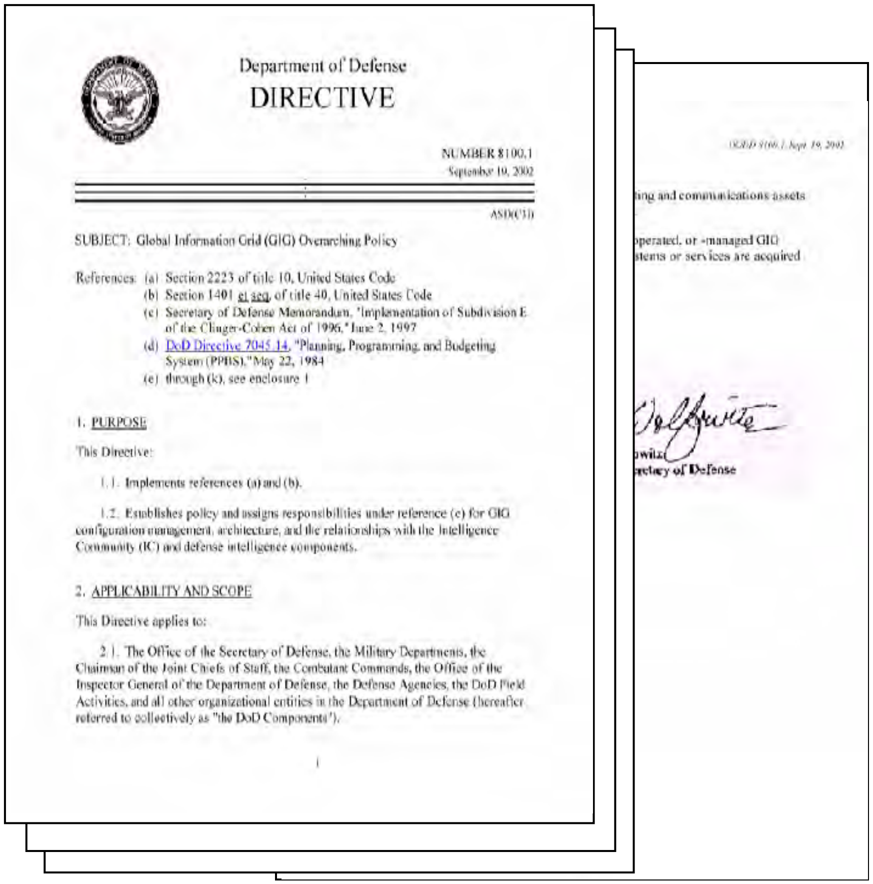
DoD's Net-Centric Data Strategy

- **The Net-Centric Data Strategy (May 9, 2003 +) is a key enabler of the Department's transformation:**
- **The Strategy provides the foundation for managing the Department's data in a net-centric environment, including:**
  - ✓ **Ensuring data are visible, accessible, and understandable when needed and where needed**
  - ✓ **"Tagging" of all data (intelligence, non-intelligence, raw, and processed) with metadata to enable discovery by known and unanticipated users in the DoD**
  - ✓ **Posting of all data to shared spaces for users to access except when limited by security, policy, or regulations**
  - ✓ **Organizing around Communities of Interest (COIs) that are supported by Warfighter, Business, and Intelligence Domains.**

+ DOD Directive 8320.2, December 2, 2004

The Global Information Grid

DoDD 8100.1



Department of Defense
DIRECTIVE

NUMBER 8100.1
September 19, 2002

ASD(C3I)

SUBJECT: Global Information Grid (GIG) Overarching Policy

References: (a) Section 2223 of title 10, United States Code
(b) Section 1401 et seq. of title 40, United States Code
(c) Secretary of Defense Memorandum, "Implementation of Subdivision E of the Clinger-Cohen Act of 1996," June 2, 1997
(d) DoD Directive 7045.14, "Planning, Programming, and Budgeting System (PPBS)," May 22, 1984
(e) through (k), see enclosure 1

1. PURPOSE

This Directive:

1.1. Implements references (a) and (b).

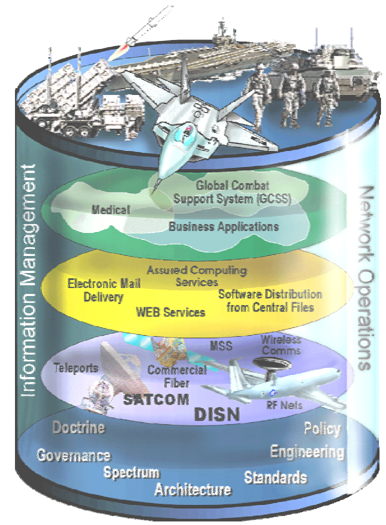
1.2. Establishes policy and assigns responsibilities under reference (c) for GIG configuration management, architecture, and the relationships with the Intelligence Community (IC) and defense intelligence components.

2. APPLICABILITY AND SCOPE

This Directive applies to:

2.1. The Office of the Secretary of Defense, the Military Departments, the Chairman of the Joint Chiefs of Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities in the Department of Defense (hereafter referred to collectively as "the DoD Components").

1

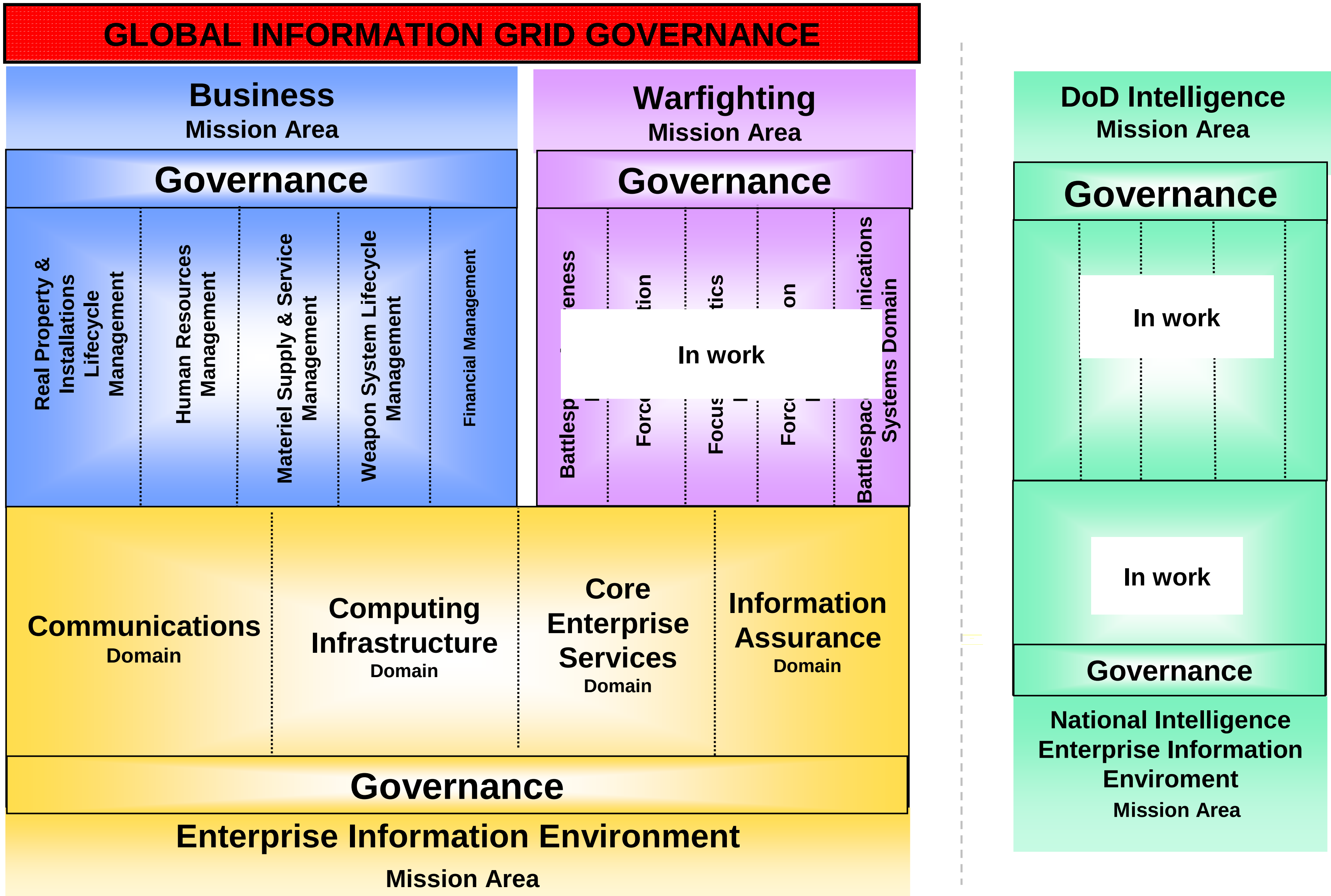


The GIG supports all Department of Defense, National Security and related Intelligence Community missions and functions in war and in peace.

The GIG encompasses the globally interconnected, end-to end set of information capabilities, associated processes and personnel for collecting, disseminating, distributing and managing information on demand by warfighters, policy makers and support personnel.

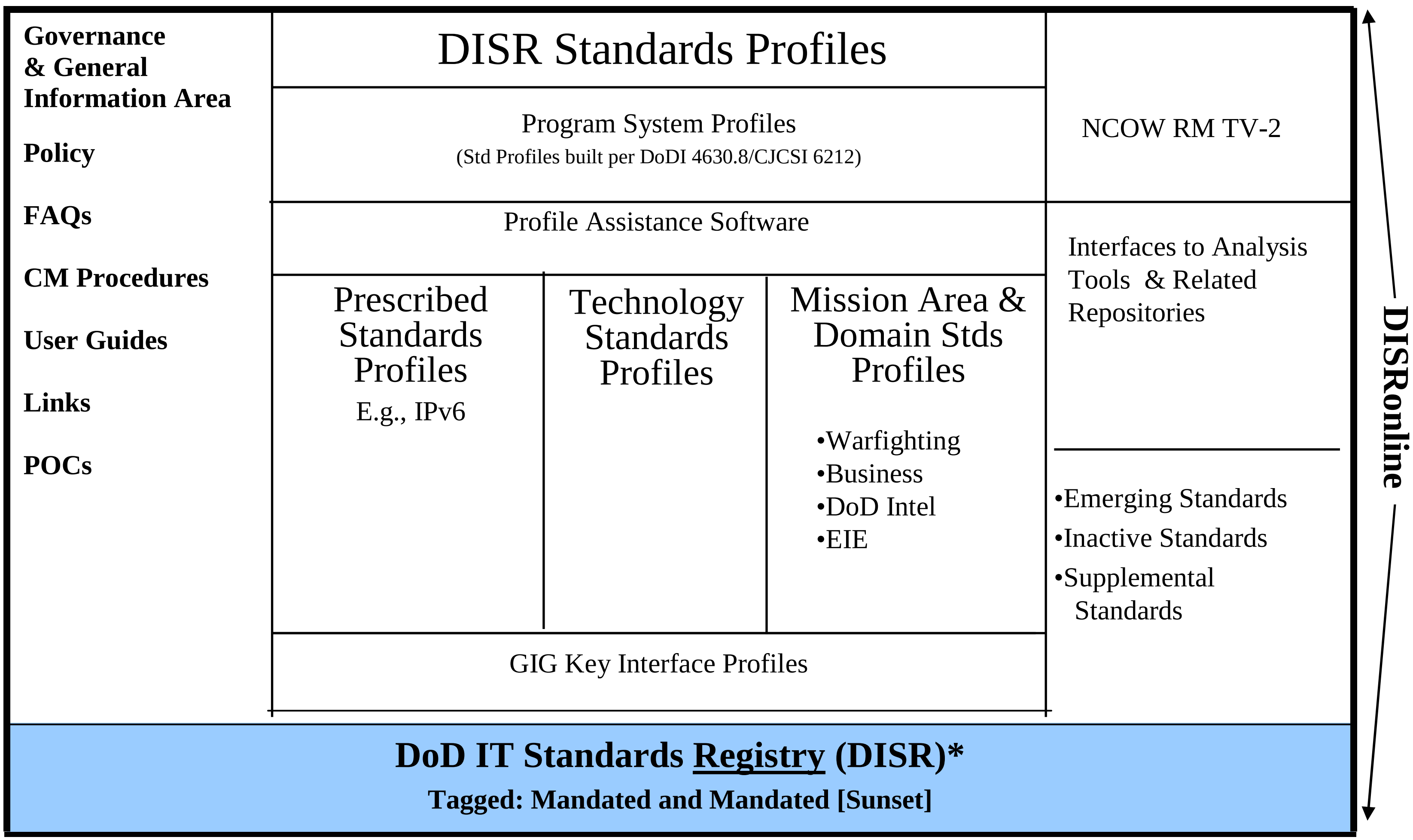
A Organizing Construct : An Integrated Architecture : Entities/Segments

Governance & Portfolios



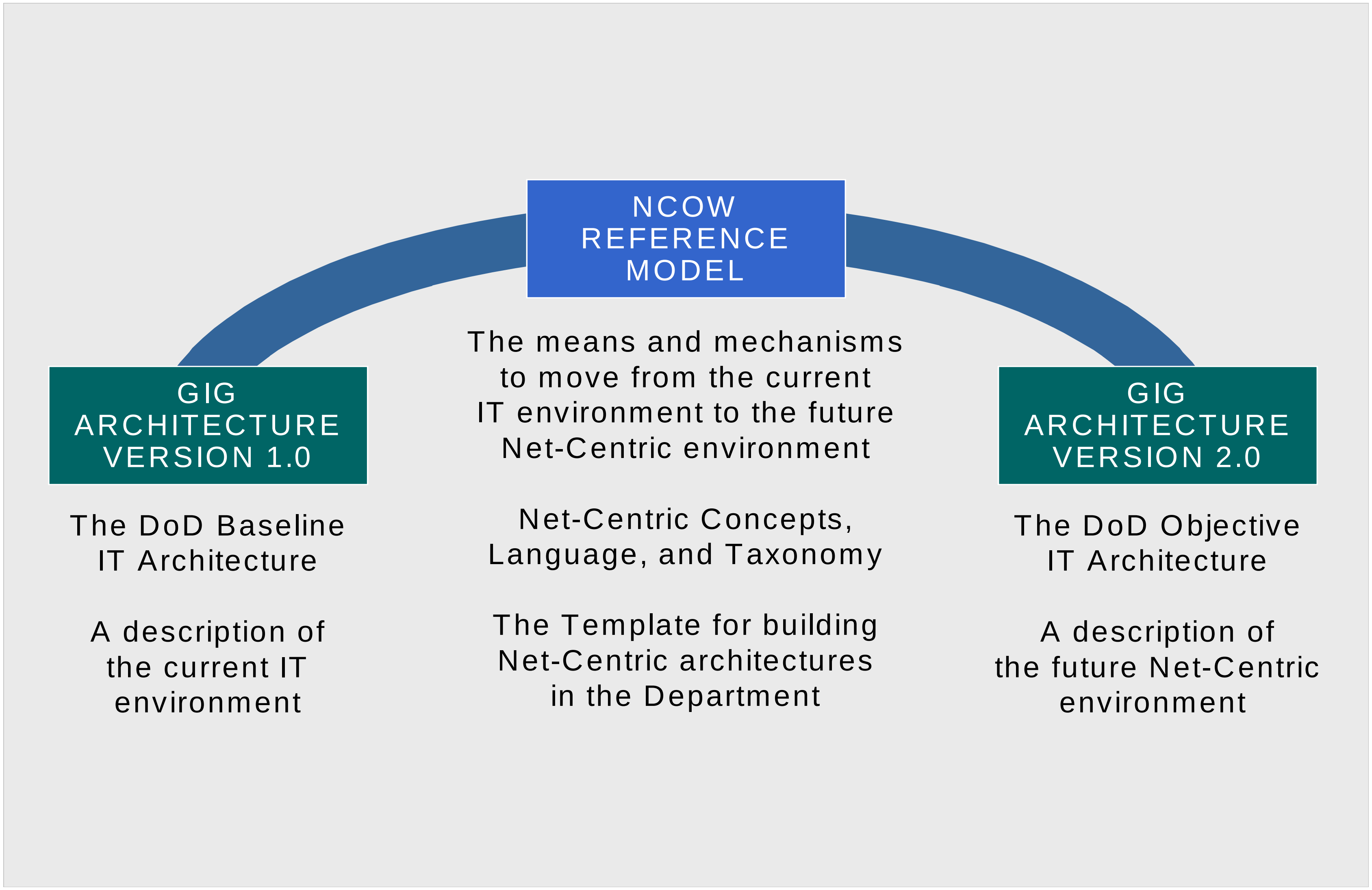
(DOD Directive 8115.01, 10 October 2005

DISR & DISRonline
(The Net-Centric IT Standards Resources)



The content of the Joint Technical Architecture

Net-Centric Operations & Warfare Reference Model



Net-Ready Key Performance Parameter Attributes

Information needs …

Information timeliness …

Information assurance …

Net-enabled …

- ☑ **Information Needs: A condition or situation requiring knowledge or intelligence derived from received, stored, or processed data and information.**
- ☑ **Information Timeliness: Occurring at a suitable or appropriate time for a particular condition or situation.**
- ☑ **Information Assurance: Protecting and defending information and information systems by ensuring their availability, integrity, authentication, confidentiality, and non-repudiation. This includes providing for restoration of information systems by incorporating protection, detection, and reaction capabilities.**
- ☑ **Net-Enabled: The continuous ability to interface and interoperate to achieve operationally secure exchanges of information in conformance with enterprise constraints.**

References: DoDD 4630.5, May 5, 2004 & DoDI 4630.8 , 30 June 2004

OEF/OIF Observations*

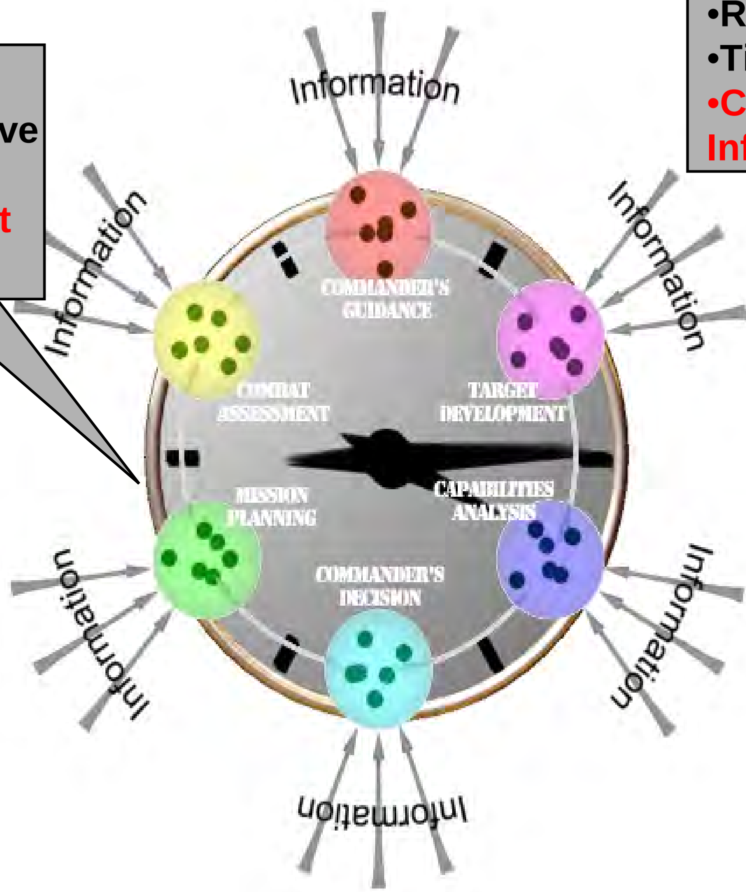
- Network Management
  - Network planning only at brigade level, not division.
  - Primarily used for situational awareness.
- **Meteorological Support Team**
  - Not used. Rather USAF weather info posted on SIPRNET.
- Topographic Support
  - Provides decision makers with the products required.
  - Operators cited difficulties in operating, transporting and maintaining the system.

**** Extract from Briefing on ABCS in OEF/OIF, Dr. Hutchison, DOT&E, NDIA Interoperability 2004***

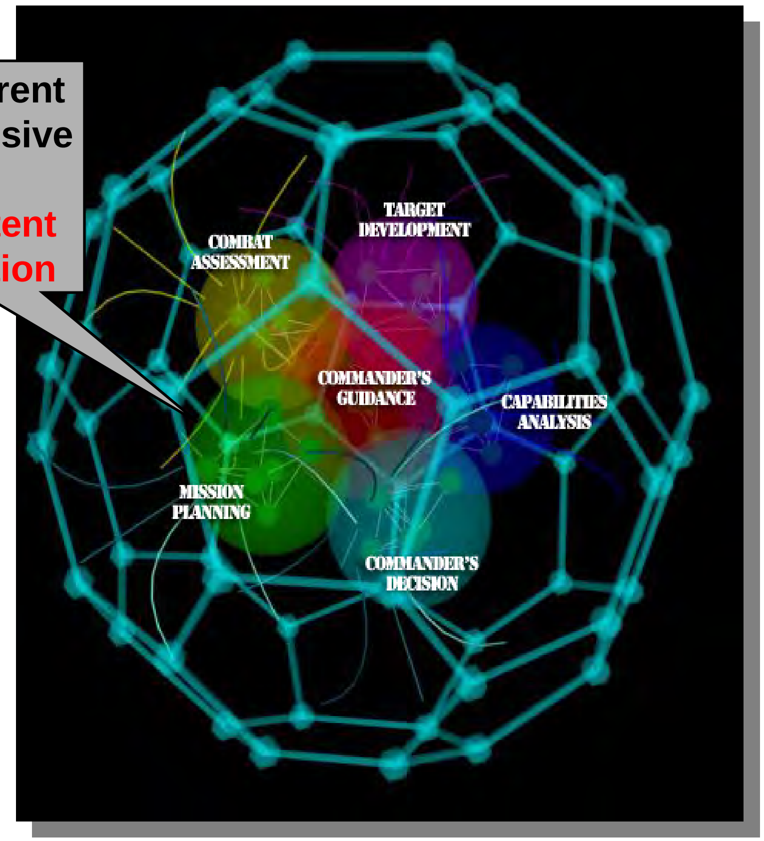
The Joint Targeting Cycle in a Net-Centric Environment

"As Is"

- Sequential
- Unresponsive
- Untimely
- Inconsistent Information



- Concurrent
- Responsive
- Timely
- Consistent Information



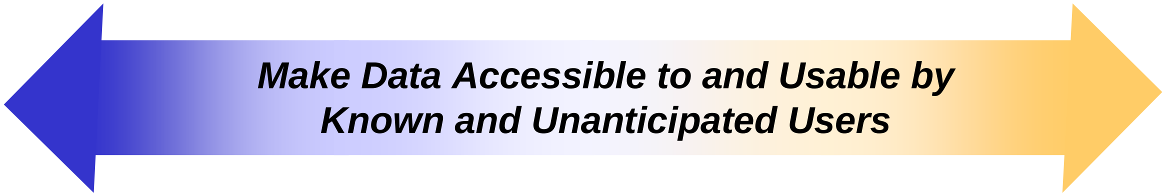
"To Be"

Empowering Known and Unanticipated Users

Shift Power to the User:

- Bring data consumers, producers, and system developers closer together through Communities Of Interest
- Guide data management activities through user-driven metrics, user ratings/feedback, and data sharing incentives
- Provide the infrastructure and services (e.g., GIG BE, NCES, Shared Spaces, Catalogs) to permit the user to find and retrieve data

Producer and Developer



Consumer

Net-Centric Operations Industry Forum (NCOIF)

- **NCOIF Mission**
  - **Support the migration to an open business model that supports full competition but enables horizontal integration of the resulting capabilities and systems, regardless of who developed or provides the systems.**
  - **Review and comment on industry-wide frameworks which will support horizontal integration of platforms and systems.**
  - **Provide an industry advisory service for the DoD CIO regarding the net centric strategies, programs, acquisitions, implementation, and sustainment.**
  - **Provide industry-wide critiques and analysis in response to government stakeholders.**
  - **Provide a forum for industry discussion and collaboration on evolving enterprise service models.**

OASD (NII)/DoD CIO and AFEI Charter
2/18/05

NCOIF Working Groups

Net-Centric Operations Industry Forum (NCOIF)
Dr. Jacques S. Gansler, Chairman

- **Data Sharing & Service Strategy** (GIG ES IAC)
- **Intelligence, Surveillance and Reconnaissance**
- **Information Assurance (IA) & Security**
- **Wireless & Communications**
- **Commercial Acquisition Practices**
- **Architecture & Standards**

OASD (NII)/DoD CIO and AFEI Charter
2/18/05

QUESTIONS ?

Future Direction For Defense

Department of Defense
Transformation
Planning
Guidance

April, 2003

"Services will explicitly identify initiatives to improve … adoption of "post before process" intelligence and information concepts, achievement of data level Interoperability; and deployment of "net-ready" nodes of platforms, weapons and forces.

From
Supplier Dominates

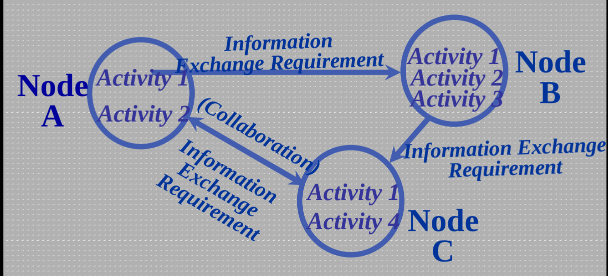
Task
Process
Exploit
Disseminate

To
Consumer Dominates

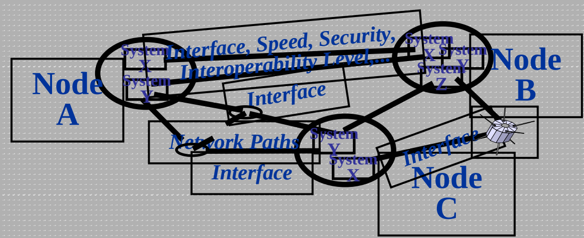
Task
Post
Process
Use

Integrated Architecture* In Context

All View



The Operational View **describes and interrelates the operational elements, tasks and activities, and information flows required to accomplish mission operations.**



The Systems View **describes and interrelates the existing or postulated technologies, systems, and other resources intended to support the operational view.**

- **Information Format & Content**
- **Information Processing**
- **Information Assurance**
- **Information Transfer**
- **User Interface**

The Technical Standards View **describes the profile of rules, standards, and conventions governing systems implementation.**

Functional & Organizational

"AS-IS" & "T0-BE(s)"

Non-Materiel Solutions

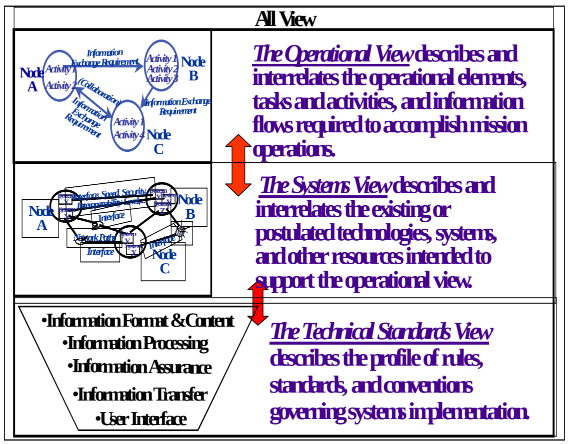
DoD Information Technology Standards Registry

***as described in theDoD Architecture Framework DoDAF V 1.0**

The bottom line: keep this equation balanced:OV = SV + Non-Materiel

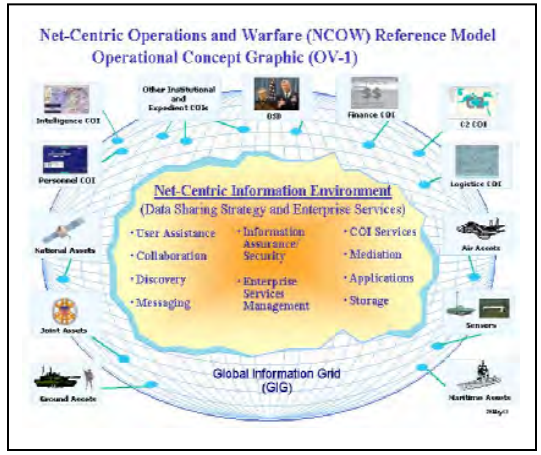
Net-Ready Key Performance Parameter Components & Verification

Supporting Integrated Architecture(s)



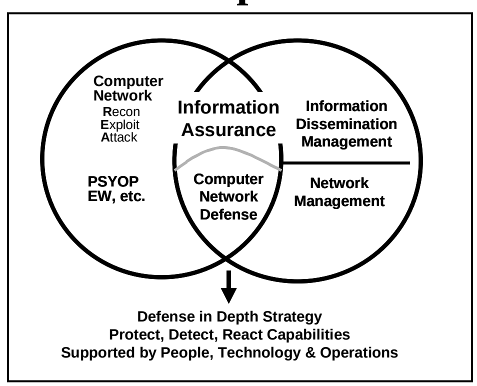
- Inspection
- Analysis
- Test

NCOW RM Compliance



- Inspection
- Analysis

IA Compliance



- Inspection
- Analysis

Compliance With Applicable Key Interface Profiles

	Communications KIPs
1.	Logical Networks to DISN Transport Backbone
2.	Space to Terrestrial Interface
3.	JTF to Coalition
4.	JTF Component to JTF Headquarters
5.	Teleport (i.e., deployed interface to DISN)
6.	Joint Interconnection Service
7.	DISN Service Delivery Node
8.	Secure Enclave Service Delivery Node (e.g., SCI/Collateral KIP)
	Computing KIPs
9.	Application Server to Database Server
10.	Client to Server
11.	Applications to COE/CCP
	Network Operations KIPs
12.	End System to PKI
13.	Management Systems to (integrated) Management Systems
14.	Management Systems to Managed Systems
15.	IDM to Distribution Infrastructure
16.	Information Servers to IDM Infrastructure
	Applications
17.	Application Server to Shared Data - HCP(SAD)

- Inspection
- Test